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**Second Quarterly Technical Progress Report
(January 1, 1993 through March 31, 1993)**

**Bench-Scale Testing of On-Line Control of Column Flotation
Using a Novel Analyzer
(Contract No. DE-AC22-92PC92207)**

April 16, 1993

Submitted To:

Document Control Center
U.S. Department of Energy
Pittsburgh Energy Technology Center
Mail Stop 921-118, Wallace Road
Pittsburgh, PA 15236

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Table of Contents

<u>Section</u>	<u>Section Description</u>	<u>Page</u>
	Executive Summary	1
1	Task 100 - Project Planning and Management	7
2	Task 200 - Equipment and Circuit Design and Procurement	9
3	Task 300 - Equipment Fabrication, Construction & Shakedown	12
4	Task 400 - Software Development	12
5	Task 500 - Circuit Fabrication and Installation	15
6	Task 600 - Coal Procurement	17
7	Task 700 - Circuit Commissioning and Shakedown	20
8	Task 800 - ET Circuit Testing and Sample Preparation	22
9	Task 900 - PTI Analytical	26
10	Task 1000 - Circuit Decommissioning	27
11	Task 1100 - Data Evaluation	27

<u>Figure</u>	<u>Figure Description</u>	<u>Page</u>
1	Project Plan and Approach	2
2	Project Schedule Timeline	3
3	ET Circuit Flowsheet and Flow Balances	5
4	Project Team Organization Chart	8
5	ET Circuit Electrical Layout	13
6	Vertical Skid Module and ET Circuit Equipment Layout	16
7	Layout of PTI's ET Circuit and Outside Installation	18

<u>Table</u>	<u>Table Description</u>	<u>Page</u>
1	Project Reporting Requirements	10
2	Major Processing, Process Control and Ancillary Equipment	11
3	ET Circuit Instrumentation, Computer Monitoring and Control Approach	14
4	ET Circuit Design, Fabrication, Construction and Installation Requirements for Lincoln Contracting	19
5	Test Matrix For Commissioning Tests	21
6	Test Plan For Each of Two Coals	23
7	Feed Lot Sampling & Sample Preparation Procedures	24
8	Slurry Sampling Procedures	24
9	PRDA Slurry Sample Prep Procedure	25
11	Optimum 2" Lab Column Results - PTI Laboratory Dry Grind Upper Freeport Seam Coal	29
12	Optimum 2" Lab Column Results - PTI Lab Grind vs. PETC/CPPRF Plant Grind	30
13	Optimum 2" Lab Column Results - PTI Laboratory Dry Grind Pittsburgh No. 8 Seam Coal	32
14	Feed Lot Sample Comparison and Test Sample Variability	34
15	Back-To-Back Sample Repeatability Results	37
16	Back-To-Back Test Repeatability	37
17	Composition Comparisons DOE's LECO Furnace vs PTI's Calumet Lab	38
18	QA/QC On Coal Laboratory Analyses	38
19	Preliminary Multivariable Test Matrix	44
20	Primary Multivariable Test Matrix	45
21	Composite 2" Column Test, Size Analyses Results Comparing PETC and PTI Laboratory Dry Grinds	46
22	Microtrac Size Comparison PETC Dry Grind vs. PTI Lab Grind	47
23	Conventional Wet Screening Comparison	48

Appendices

A	Test Conditions and Results To Date at PETC/CPPRF
B	Vertical Mounted Skid Module Drawings
C	Additional 2" Lab Column Tests - Upper Freeport Seam Coal
D	All 2" Lab Column Tests - Pittsburgh No. 8 Seam Coal

Second Quarterly Technical Progress Report (January 1, 1993 through March 31, 1993)

Bench-Scale Testing of On-Line Control of Column Flotation Using a Novel Analyzer (Contract No. DE-AC22-92PC92207)

Executive Summary

This document contains the second quarterly technical progress report for PTI's Bench-Scale Testing Project of a circuit integrating PTI's KEN-FLOTE™ Column Flotation Technology and PTI's On-Line Quality Monitor and Control System. The twelve-month project involves installation and testing of a 200-300 lb/hr. bench-scale testing circuit at PETC's Coal Preparation Process Research Facility (CPPRF) for two bituminous coals (Upper Freeport and Pittsburgh No. 8 Seam Raw Coals). Figure 1 contains the project plan, as well as the approach to completing the major tasks within the twelve-month project schedule. The project is broken down into three phases, which include:

- Phase I - Preparation: The preparation phase was performed principally at PTI's Calumet offices from October through December, 1992. It involved building of the equipment and circuitry, as well as some preliminary design and equipment testing.
- Phase II - ET Circuit Installation and Testing: This installation and testing phase of the project is being performed at PETC's CPPRF from January through mid-June, 1993, and is the major focus of the project. It involves testing of the continuous 200-300 lb/hr. circuit.
- Phase III - Project Finalization: The project finalization phase will occur from July through September, 1993, at PTI's Calumet offices and will involve finalizing analytical work and data evaluation, as well as final project reporting.

This second quarterly progress report principally summarizes the results from the Phase II installation and the initial testing on the first coal, which occurred in the January through March 1993 time frame. It also includes a summary of the results from the commissioning tests, preliminary multivariable and primary multivariable tests for the Upper Freeport Seam Coal (Coal #1), as well as the results from all QA/QC testing to date.

Figure 2 contains the project schedule timeline by task series for the twelve month project, as it was laid out in the initial Project Work Plan. At the present time, all tasks are progressing according to schedule with the exception of the Task 800 Circuit Testing and Sample Prep and Task 1000 Circuit Decommissioning, which have slipped approximately five weeks due to delays incurred within in the project. Those delays include:

- A two-week delay on PTI's entry to site to begin installation.
- A one-week delay due to problems incurred by PTI during the commissioning period.

Figure 1
PROJECT PLAN AND APPROACH
(Twelve Months)

MONTH	PLANS	CONTROL SOFTWARE	TESTING CIRCUIT	ON-LINE MONITORS	
MONTH 1 (OCT. 92)	PROJECT WORK PLAN AND DESIGN REPORT		EQUIPMENT DESIGN AND PROCUREMENT	PTI ON-LINE MONITOR DESIGN & PARTS PROCURE.	PHASE I PROJECT PREPARATION
MONTH 2 (NOV. 92)	ADDITIONAL PLANS AND REPORTS	INITIAL CONTROL SOFTWARE PROGRAM	FINAL ET CIRCUIT DESIGN AND FABRICATION	PTI ON-LINE MONITOR CONSTRUCTION	
MONTH 3 (DEC. 92)	ADDITIONAL PLANS AND REPORTS	INITIAL ALGORITHM PROGRAMMING	FINAL EQUIPMENT SHAKEDOWN	PTI ON-LINE MONITOR DEBUGGING	
WEEKS 12-14 (3 WEEKS)			ET CIRCUIT INSTALLATION		PHASE II ET CIRCUIT INSTALLATION AND TESTING
WEEKS 15-17 (3 WEEKS)	TEST, SAMPLING AND ANALYTICAL PLAN		ET CIRCUIT COMMISSIONING	PTI ON-LINE MONITOR SEQUENCING	
WEEKS 18-23 (6 WEEKS)		FINALIZE CONTROL SOFTWARE (GOAL NO. 1)	PRELIMINARY & PRIMARY MULTI-VARIABLE TESTING (GOAL NO. 1)	PTI ON-LINE MONITOR CALIBRATION (GOAL NO. 1)	
WEEKS 24-25 (2 WEEKS)			ET CONTROL TESTING (GOAL NO. 1)		
WEEKS 26-29 (4 WEEKS)	DECOMMISSIONING PLAN	FINALIZE CONTROL SOFTWARE (GOAL NO. 2)	MULTIVARIABLE TESTING (GOAL NO. 2)	PTI ON-LINE MONITOR CAL. (GOAL NO. 2)	
WEEKS 30-31 (2 WEEKS)			ET CONTROL TESTING (GOAL NO. 2)		
WEEK 32 (1 WEEK)			ET CIRCUIT DECOMMISSIONING		PHASE III PROJECT FINALIZATION
MONTHS 3-10 (JUNE-JULY 93)			FINAL DATA ANALYSIS		
MONTH 11 (AUG. 93)			ECONOMIC EVALUATION		
MONTH 12 (SEPT. 93)			FINAL REPORTING		
⊕ DATES OF PROJECT TEAM MILESTONE MEETINGS AT DOE'S PETC FACILITIES					

Figure 2
PROJECT SCHEDULE TIMELINE
(By Month)

- A two week delay caused by a plant power outage, which occurred in late March, coupled with a scheduled one week down time for DOE to straighten out limitations with the grinding and coal blending system.

Based on these delays, PTI now plans to complete Task 800 Circuit Testing and Sample Prep on June 11th, rather than at the end of April. Decommissioning will be conducted the week of June 14 through 18, rather than the first two weeks of May. All other major tasks shown in Figure 2 should remain on schedule.

Figure 3 contains the ET Circuit flow sheet, including flow balances for the circuit that was installed at PETC's CPPRF in January and early February. The major pieces of equipment include:

- The agitated feed sump and pump to accept product from the existing CPPRF comminution circuit and feed it to the KEN-FLOTE™ Column at the desired capacity (GPM and Wt% solids). PTI and PETC staff have targeted a nominal 100M topsize grind (95% passing 100M) to be used for the project.
- The 12" diameter x 14' high KEN-FLOTE™ Column which is equipped with inner sleeves which have been used to test PTI's dual cylinder design option.
- The column tailings pump which is used to control the froth/pulp interface level within the column.
- PTI's Multiplexer Sampling System which collects samples of column feed, product and tailings and divide the samples into a split for PTI's Quality Monitor and a bypass split for ASTM analyses (five gallon bucket).
- PTI's On-Line Quality Monitor which makes nuclear measurements on the sample splits reporting to the monitor and correlate the resultant measurements to compositions obtained from the bypass split (ASTM analyses). This information was then used to determine calibration relationships which will eventually be used to control the column performance (yield and product quality) during the upcoming control testing.
- Circuit discharge sump and pump which pumps the circuit discharge streams to the CPPRF thickener or sludge tank for solid/liquid separation and water recycling.

The circuit shown in Figure 3, also contains state-of-the-art instrumentation which tightly controls the material balance within the circuit from PTI's control room computer, which is not illustrated in the diagram.

All circuit equipment as well as the skid modules and frames on which the equipment was mounted were constructed during the October through December time frame at PTI's Calumet facilities and Lincoln Contracting's Boswell, Pennsylvania facilities. PTI subcontracted Lincoln Contracting to do the mechanical and electrical installation of the ET Circuit at the CPPRF site. As mentioned, PTI and Lincoln Contracting began installation on December 28, 1992. The schedule of events that occurred from the beginning of commissioning through the March 31st period of this report, are as follows:

- December 28, 1992 through January 20, 1993 - PTI and Lincoln Contracting completed mechanical and electrical installation of the ET Circuit at the CPPRF, including all PTI's control room equipment and Mobile Laboratory.
- January 25 through February 5, 1993 - PTI completed functionality testing and water commissioning on the ET Circuit to insure that there were not circuit leaks and that the circuit could be accurately monitored and balanced using the existing plant instrumentation. During this period, PTI also submitted the Operation and Maintenance Manual and the Test, Sampling and Analytical Plan, which were reviewed and accepted by DOE prior to beginning the multivariable testing.
- February 8 through February 12, 1993 - PTI conducted the initial coal/water slurry commissioning of the ET Circuit (CT#1 through CT#7). These tests were used to determine key parameters for the upcoming circuit tests.
- February 22 through February 26, 1993 - PTI repeated the coal/water slurry commissioning tests (DT#1 through DT#6) due to problems that were incurred during the initial testing. Having to repeat these tests caused an approximate one week delay in the project.
- February 26 through March 8, 1993 - PTI conducted the preliminary multivariable testing for the Upper Freeport Seam Coal (Coal #1). These 33 tests (PT#1 through PT#33) provided the background information to set the desired test conditions, particularly reagent dosages and air rates for the primary multivariable testing.
- March 10 through March 30, 1993 - PTI conducted the 87 primary multivariable tests (FT#1 through FT#87) for the Upper Freeport Seam Coal (Coal #1). A vast range of test conditions were implemented during this test matrix to obtain final calibrations for the Ash Monitor for the upcoming control testing.

The conditions and results for all the commissioning and multivariable tests are listed in Appendix A. A summary of those results, as well as results from all QA/QC tests to date will be discussed under the Task 1100 Data Evaluation portion of this report.

At the present time, PTI is incurring a two-week exodus from the facility due to a power system repair and DOE's grinding circuit debugging that is occurring from April 5 through April 16, 1993. PTI plans to return to site on April 19th, to complete the remainder of the on-site testing according to the following schedule:

- April 19 through April 30, 1993 - PTI completes the control testing for the Upper Freeport Seam Coal.
- May 3 through May 28, 1993 - PTI completes the primary multivariable testing for the Pittsburgh No. 8 Seam Coal.
- May 31 through June 11, 1993 - PTI completes the control testing for the Pittsburgh No. 8 Seam Coal.
- June 14 through June 18, 1993 - PTI, PETC and Gilbert Commonwealth staff complete decommissioning of the ET Circuit.

Provided that PTI, PETC and Gilbert Commonwealth staff are able to decommission the ET Circuit without the expense of outside subcontractors, PTI is confident that their budget will allow them to remain on-site during this specified testing and decommissioning period. PTI will then work on completing the project analytical data evaluation and final reporting for the remaining three months of the project (July through September 1993).

Section 1

Task 100 - Project Planning and Management

Prior to discussing project management and planning tasks completed during the second quarter of the project, it is worthwhile to first review the project team and structure for the bench-scale testing project. The project team had been put together to insure that all expertise to successfully complete the project were accounted for within the organization. The team also takes advantage of existing license agreements and commercial teaming arrangements that have worked well in past commercial installations, and are being further organized for the future. Figure 4 contains the project team organization chart, including the PETC/CPPRF personnel involved in the project. The key organizations within the project team include:

- DOE PETC project and site management staff.
- PTI management and site personnel, as well as laboratory technicians for required analytical work.
- Gilbert Commonwealth (G/C) Engineers and Technicians to operate the existing CPPRF circuit and to provide feed coal to PTI's ET Circuit. PTI also anticipates that G/C staff will also be utilized in the decommissioning effort.
- Lincoln Contracting and Equipment Company who was subcontracted to install and commission PTI's ET Circuit at the CPPRF site. PTI is hopeful that Lincoln will not be required to perform the decommissioning work, as was first anticipated.
- University of Kentucky engineers and consultants who have assisted in the KEN-FLOTE™ Column debugging and operation, and will also perform dewatering tests to obtain economic information for the final report.
- Stockhausen Mining Chemical technical consultants who have provided guidance on flotation reagent additions and flotation control, and will also provide assistance in developing a market strategy for the technology at the end of the project.

As Figure 4 illustrates, PTI's Project Manager is Peter Suardini, PTI's Vice President of Research and Development, he is stationed in Calumet, Michigan and is responsible for all project reporting and technical project management, as well as management of PTI's laboratory efforts. He is also responsible for all communications, reporting and contracting requirements with DOE's Technical Project Manager (Carl Maronde) and DOE's Contract Specialist (Eric Bell). Mr. Suardini is also substituting as Site Manager on the project on certain occasions to give Robert Greenlund a break from on-site work.

As mentioned, PTI's Site Manager is Robert Greenlund, PTI's Senior Engineer and KEN-FLOTE™ Column Manager. As PTI's Site Manager, Mr. Greenlund is managing the majority of the day-to-day engineering and technical aspects of the project, including overseeing Lincoln's subcontract and PTI's engineers and technicians that have been stationed at the CPPRF during the second phase of the project. PTI decided to split these responsibilities for overall project management and project task management because both responsibilities are often too much for one person to handle. Thus far, this approach has worked out well in coordinating the project and minimizing schedule slippages and miscommunications.

Figure 4
PROJECT TEAM ORGANIZATION CHART
(Including Key Project Personnel)

Table 1 contains a listing of the project reporting requirements which include:

- Part I - A number of routine contract reporting requirements (monthly).
- Part II - A number of technical reporting requirements (weekly, monthly and quarterly).
- Part III - A number of special reporting requirements which needed to be submitted at certain times during the project.

With the submission of this Quarterly Technical Progress Report the routine contract and technical reporting requirements shown in Part I and Part II of Table 1 have all been completed for the months of October 1992 through March 1993 (the first six months of the project). When the five-week delay on-site is incorporated into the schedule, the project spending and task accomplishments, to date, also closely match the cost and schedule plan submitted at the beginning of the project.

Although some of the special reporting requirements, shown in Part III, were submitted slightly behind schedule, PTI has submitted all the Items 1 through 14 in the special reporting requirements during the October 1992 through March 1993 time frame. In addition to these required reports, PTI also submitted short reports on the initial testing of PTI's source block configuration for pyritic sulfur monitoring, as well as short reports on the 2" KEN-FLOTE™ Column laboratory testing which was done with 100M topsize Upper Freeport Seam Coal and Pittsburgh Seam Coal. These test results will be discussed in more detail in the Data Evaluation (Task 1100) portion of this report.

Section 2

Task 200 - Equipment and Circuit Design and Procurement

Table 2 contains a list of all the major process control and ancillary equipment that was purchased to construct the circuit and conduct the Phase II efforts at PETC's CPPRF. The entire Task 200 effort was completed prior to January 1993, so it is not a part of this Quarterly Report. However, it is worth noting that some of the equipment selected for the circuit had to be replaced during the commissioning and testing portions of the project. Those systems that did not function properly, included:

- The three variable speed reagent pumps, listed under Item 8 of Table 2, Part I that had to be changed from peristaltic-type pumps to piston-type pumps to obtain the flow consistency required for the project.
- The column air flow control valve, listed under Item 6 of Table 2, Part II, which was initially a ball-type valve and did not have the level of sensitivity and control required for the application. A globe-type valve was substituted for the ball valve.

In both cases, the new equipment significantly reduced the problem and allowed for acceptable ranges of accuracy and consistency.

Table 1
PROJECT REPORTING REQUIREMENTS

I. Routine Contract Reporting Requirements:

<u>Target Description</u>	<u>Frequency</u>	<u>Variance</u>
1. Project Invoice	Monthly	± 5 Days
2. Cost Management Report (Form)	Monthly	± 5 Days
3. Milestone Schedule/Status (Form)	Monthly	± 5 Days
4. Summary Report (Form)	Monthly	± 5 Days

II. Routine Technical Reporting Requirement:

<u>Target Description</u>	<u>Frequency</u>	<u>Variance</u>
1. Schedule/Status Sheet	Weekly	None (Every Friday)
2. Project Status Report	Monthly	± 5 Days
3. Key Personnel Staffing Report	Quarterly	± 15 Days
4. Technical Progress Report	Quarterly	± 15 Days

II. Special Technical Reporting Requirements

<u>Description</u>	<u>Proposed Delivery Date</u>	<u>Proposed DOE Review/Approval Date</u>
1. Notice of Energy R&D Project	October 9, 1992	October 16, 1992
2. Draft Project Work Plan (ESH & QA/QC)	October 9, 1992	October 23, 1992
3. Final Project Work Plan (ESH & QA/QC)	October 30, 1992	November 13, 1992
4. Hazardous Substance Plan	October 9, 1992	October 30, 1992
5. NEPA Categorical Exclusion Licensing & Environmental Assessment Questions	October 9 1992	October 30, 1992
6. Milestone Schedule and Cost Plans (Forms)	October 16, 1992	October 23, 1992
7. Project Management Plan	October 16, 1992	October 30, 1992
8. Draft ET Circuit Design Report (two SSA's)	October 16, 1992	October 30, 1992
9. Final ET Circuit Design Report (two SSA's)	November 17, 1992	November 30, 1992
10. Procurement and Fabrication Plan	October 23, 1992	November 06, 1992
11. Installation and Shakedown Plan	November 13, 1992	November 27, 1992
12. Coal Procurement, Handling & Logistics Plan	November 27, 1992	December 11, 1992
13. Operation and Maintenance Manual	December 11, 1992	December 25, 1992
14. Test, Sampling and Analytical Plan	January 15, 1993	January 29, 1993
15. Decommissioning Plan	April 23, 1993	May 07, 1993
16. Draft Final Report	August 06, 1993	August 20, 1993
17. Project Final Report	September 10, 1993	September 24, 1993
18. DOE Property Report	September 10, 1993	September 24, 1993
19. Hazardous Waste Report	September 10, 1993	September 24, 1993

Table 2
MAJOR PROCESSING, PROCESS CONTROL AND ANCILLARY EQUIPMENT

. Processing Equipment List

1. Column Feed Sump
2. Variable Speed Column Feed Sump Agitator
3. Variable Speed Column Feed Pump
4. KEN-FLOTE™ Column (12" x 14')
5. Variable Speed Column Tailings Pump
6. Circuit Discharge Sump
7. Circuit Discharge Pump (Air Operated)
8. Three Variable Speed Reagent Pumps

I. Process Control Equipment and Instrument List

1. PTI's 3-Stream Multiplexer Sampling System
2. PTI's On-Line Quality Monitor (Including Control Room Computer and Modem)
3. PTI's Pyritic Sulfur Monitoring Gauge
4. Column Feed Sump Level Controller (DP Cell and Valve)
5. Five Magnetic Flowmeters
 - Column Feed Sump Dilution Water Line
 - Column Feed Line
 - Column Tailings Line
 - Column Spray Water Line
 - Column Launder Water Line
6. Column Air Flowmeter and Control Valve
7. Four DP Transducers For Column Interface Detection
8. Special Input/Output Module For Computer

II. Ancillary Equipment List

1. Office Trailer Installation and Office Equipment (Fax and Phone)
2. Spare Parts (Control and Processing Equipment)
3. Mobile Laboratory Setup and Dust Collector Procurement
4. Process Frames, Gauges, Valves and Regulators (Small Manual Items)

Section 3

Task 300 - Equipment Fabrication, Construction and Shakedown

The equipment fabrication, construction and shakedown task was principally completed during the months of October through December 1992. The only discrepancy in this task series was that the tightness of the schedule did not allow certain instrumentation to be checked prior to bringing it to site for the installation in January and early February. Therefore, the commissioning period lasted slightly longer due to problems and substitutions that had to be made in certain equipment, particularly the reagent feeders and the air control valve. However, Task 300 had been completed prior to the beginning of this second quarterly reporting period.

Section 4

Task 400 - Software Development

As with Task 300, the software development task (Task 400) was mostly completed prior to this reporting period. However, PTI's staff engineers did work during the early parts of January completing the initial control software for the multivariable testing portions of the project. Figure 5 contains an illustration of all the electrical components in the feed, including all instruments that are computer monitored and computer controlled within the circuit. Although the circuit is fairly simple, the process monitoring and control is state-of-the-art.

In essence, the control software includes signal programming for all the computer monitored instruments (inputs) that are listed in Table 3, as well as programming for computer controlled outputs) that are also listed in the lower part of Table 3. The final sequencing of instrumentation and instrument control by the associated algorithms was determined during the multivariable testing portion of the project for the Upper Freeport Seam testing. During that portion of the project most of the process control variables were merely targeted at desired setpoints. During the control testing portion of the project, which will occur during for the Upper Freeport Seam Coal in late April, the on-line control system's ability to accurately alter these variables based on not only the desired setpoint targets, but also the performance measurements (i.e., product quality and yield measurements) obtained from PTI's On-Line Monitor and plant instrumentation will also be tested. The table on the next page shows the proposed control approach for all circuit outputs for the two types of control testing modes which will include a primary mode, where yield will be the most important performance variable, and the secondary, or override mode, where product ash content will become the principal performance target.

Table 3
ET CIRCUIT INSTRUMENTATION, COMPUTER MONITORING
AND CONTROL APPROACH

I. Computer Monitoring (Inputs to Computer)

	<u>Process Variable</u>	<u>Monitoring Comments</u>
1.	On-Line Monitor Instrumentation	Many Measurements and Signals
2.	Level in Feed Sump	Remote DP Signal to Computer (Controlled by local DP controller)
3.	Feed Sump Dilution Water Rate	Magnetic Flowmeter (MFM) Reading to Computer (Flow rate controlled by local DP controller)
4.	Feed Pump Flow Rate	MFM Reading to Computer
5.	Column Spray Water (Plant Water)	MFM Reading to Computer
6.	Column Launder Water (Plant Water)	MFM Reading to Computer
7.	Tailings Flow Rate	MFM Reading to Computer
8.	Air Bubble Tubes into Column	4 DP Probes with Transducers to Computer
9.	Air Flow to Column	Air Flowmeter to Computer

I. Computer Control (Outputs from Computer)

		<u>Controlling Setpoint or Variables</u>	
	<u>Process Variable</u>	<u>Multivariable Testing</u>	<u>Control Testing</u>
1.	On-Line Monitor Instruments (many)	Set Timing Pattern	Set Timing Pattern
2.	Multiplexer Control Valves (4)	Set Timing Pattern	Set Timing Pattern
3.	Column Spray Water	GPM Setpoint	GPM Setpoint
4.	Column Launder Water	GPM Setpoint	GPM Setpoint
5.	Air Flow to Column	cc/min. Setpoint	Feed Rate/Feed GPM
6.	Frother Reagent Dosage (0.14-1.40 cc/min.)	cc/min. Setpoint	Feed Rate/Yield ?/Prod. Ash ?
7.	Collector Reagent Dosage (0.0, 0.14-2.80 cc/min.)	cc/min. Setpoint	Yield/Prod. Ash/Feed Rate ?
8.	Pyrite Depressant Dosage (0.0, 0.14-2.80 cc/min)	cc/min. Setpoint	Prod. Pyr. Sulfur
9.	Feed Pump Feed Rate	GPM Setpoint	GPM Setpoint
10.	Tailings Pump Rate	DP Tube Pressure or Tailings Flow Setpoint	DP Tube Pressure or Tailings Flow Setpoint

PROPOSED CONTROL APPROACH

<u>Control Level</u>	<u>Control Variable</u>	<u>Primary Control Target Variable</u>	<u>Secondary (Override) Control Target Variable</u>
Level 1	Column Air Setting (1.0 to 2.0 CFM)	Product Ash Content	Yield
Level 2	MIBC Frother Dosage (0.75-1.25 #/T)	Product Ash Content	Yield
Level 2	No. 2 Fuel Oil Collector Dosage (1.50-2.50 #/T)	Product Ash Content	Yield
Level 3	Froth Level (26" to 38")	Product Ash Content	Yield

PTI is presently completing the programming for the control testing of the Upper Freeport Seam Coal, which will begin in late April. A separate report will be submitted later this week with the Control Testing Plan for this two-week portion of the project. The control testing will include random variation of the feed rate of coal to the circuit, as well as the quality of the feed by adding a random percentage of pre-cleaned coal into the raw coal feed.

Section 5

Task 500 - Circuit Fabrication and Installation

The circuit fabrication and installation task encompassed the final design and construction of the skid modules by Lincoln Contracting at their Boswell, Pennsylvania facility. It also encompassed the four-week installation period (December 28, 1992 through January 22, 1993) when Lincoln Contracting installed the circuit at PETC's CPPRF. Figure 6 contains a CAD drawing of the south side of the skid module circuit that Lincoln Contracting installed in the ET Circuit area of the CPPRF. The various skid modules included:

- The Floor Skid Module, which has a 5' x 8' footprint and is approximately 5' high. It is offset from the main vertically stacked skid modules to allow for gravity flow from the CPPRF grinding circuit. It includes the column feed sump, agitator and pump, as well as the reagent racks containing the three flotation reagent feeders and catch basins.
- The Elevation 1086 Skid Module on the ground floor (which has a 12' x 10' footprint and is 10' high) contains PTI's On-Line Quality Monitor and a circuit discharge sump and pump.
- The Elevation 1096 Skid Module (which also has a 12' x 10' footprint and is 10' foot high) is mounted on top of the 1086 Skid Module and includes the lower portion of the KEN-FLOTE™ Column, the PTI Multiplexer Sampling System and the column tailings pump.
- The Elevation 1106 Skid Module (which has a 8' x 10' footprint and is also 10' high) is mounted on top of the 1096 Skid Module and contains the mounting supports for the various sections of the KEN-FLOTE™ Column, as well as the KEN-FLOTE™ Column feed line.
- The Elevation 1116 Top Frame Work (which also has a 8' x 10' footprint) sits on top of the 1106 Skid Module. It merely contains the frame work for the top column sprays and launders, as well as the mounting components for the differential pressure air bubble tubes and water additions.

VERTICAL SECTION (Viewed from South Side)

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 DRAWN BY JAC
 CHECKED BY JAC
 FROM 3110 OVERVIEW

The total height of the vertically mounted skid module is 34' 9", and it reaches approximately two feet from the ceiling of the building. The complete drawing package was included in the ET Circuit Design Report, submitted in final version in December 1992. All remaining drawings from this drawing package are enclosed in Appendix B.

As mentioned, PTI and Lincoln Contracting began installation on December 28, 1992. The installation of the equipment was completed on January 22, 1993. Figure 7 contains the layout of PTI's ET Circuit equipment and all outside PTI installations that were required at the CPPRF. The final week of December concentrated on the placement of PTI's main skid module stack and floor skid in the location shown in Figure 7. PTI and Lincoln Contracting also located PTI's control room computer in the Control Room, as well as place all process equipment into their location within the skid module, including PTI's Quality Monitor which was brought down in the Mobile Laboratory. During December, 1992 Gelco Space delivered the office trailer, which contains PTI's office equipment, phone and fax machine. Gilbert Commonwealth provided the electrical installation for the office trailer, and also a drop off point for 100 amps of 220 service for PTI's Mobile Laboratory, which was brought to site in early January, 1993. The Mobile Laboratory was temporarily located, at the location in Figure 7, for the duration of the project.

A complete listing of the design, fabrication, construction and installation requirements for Lincoln Contracting are listed in Table 4. Lincoln Contracting had a welder and electrician on-site during commissioning to correct any flaws within the circuit which appeared during the functionality and shakedown testing. PTI signed off on Lincoln's installation subcontract on January 29, 1993. The ESH Permits for the ET Circuit were then later obtained on February 8th, when DOE safety and environmental inspections were complete and all problems were corrected.

Section 6

Task 600 - Coal Procurement

PTI plans to test two coals during the four-month ET Circuit testing period. Based on PTI's previous experience with other DOE-sponsored projects PTI selected two coals that have the proper characteristics required for the bench-scale testing project. The two coals are Upper Freeport Seam Raw Coal from Valley Camp's Helen Mine in Homer City, PA and Pittsburgh No. 8 Seam Raw Coal from Ohio Valley Coal Company's Preparation Plant in Southeastern Ohio. The table below shows their anticipated compositions, which were obtained by sampling done at the beginning of the project.

RAW COAL ANALYSES
(Dry Basis, Except Moisture)

<u>Coal Seam</u>	<u>Size Content</u>	<u>Quantity Obtained</u>	<u>Moisture (Wt%)</u>	<u>Ash (Wt%)</u>	<u>Sulfur (Wt%)</u>	<u>Pyritic Sulfur (Wt%)</u>	<u>Heating Value (Btu/lb.)</u>
Upper Freeport	3/4" x 0	54 tons	7.0	27.09	2.48	1.77	11,080
Pittsburgh No. 8	2" x 0	50 tons	7.0	28.40	5.17	2.94	10,318

Figure 7
LAYOUT OF PTI'S ET CIRCUIT
AND OUTSIDE INSTALLATION

Table 4
ET CIRCUIT DESIGN, FABRICATION, CONSTRUCTION
AND INSTALLATION REQUIREMENTS FOR LINCOLN CONTRACTING

- 1) Finalize design and construction drawings for module, skid, and equipment support structure. Lincoln additions will include flooring, handrails, bracing and lighting.
- 2) Supply all process and utility piping, hoses, steel, flooring, electricals and lighting for fabrication and installation of the circuit. In general, all that is required beyond PTI's equipment list.
- 3) Fabricate structure, bracing, flooring and handrails.
- 4) Receive equipment from PTI (except Quality Monitor) via truck and install on modules skids as much as possible prior to going to PETC for installation.
- 5) Follow and abide by all applicable local, state and federal codes.
- 6) Follow the PETC Health and Safety Guidelines for the facility while on site.
- 7) Install all structure, equipment, piping, hoses, fittings, electricals, and lighting of the ET Circuit, including tie-in points to CPPRF Circuit. Final electrical connections to the Analyzer, Multiplexer and Control Room Computer will be performed by PTI.
- 8) Provide power and grounding to mobile laboratory breaker box.
- 9) Provide assistance through the Equipment Functionality Testing part of the Commissioning and Shakedown phase of the project to take corrective action for:
 - a) piping and hose leaks
 - b) equipment electrical supply problems
- 10) Clean site area of construction debris.
- 11) Correct any damage occurring through installation to CPPRF property to make whole to the acceptance of the DOE COR.

As mentioned, the Upper Freeport Seam Coal is the first coal being tested and 54 tons of coal was obtained in late December 1992 and early January 1993 for the Upper Freeport Seam Coal testing. The coal was blended and divided into approximately nine 6-ton lots that have been gradually utilized for the testing that has occurred to date. Five of the lots have been used in the commissioning, primary and preliminary multivariable testing, with four lots remaining for the grinding circuit debugging and control testing that remains.

The 50-ton sample of Pittsburgh No. 8 Seam Coal was obtained in early March, and was blended and divided into eight 6-ton lots at Dillner Storage. This coal will be used for grinding circuit debugging tests in mid-April, as well as the Pittsburgh No. 8 Seam primary multivariable and control testing in May and early June.

The composition of the various lots of the Upper Freeport Seam Coal, as well as the variability from test to test obtained through the blending and feeding system at the CPPRF will be discussed in the Data Evaluation Section (Section 11), as part of the QA/QC testing.

Section 7

Task 700 - Circuit Commissioning and Shakedown

Upon completion of the circuit installation on January 22nd, PTI and PETC staff scheduled an inspection by PETC safety and ESH officers to observe the circuit in comment on any safety or environmental infractions prior to commissioning. A number of minor short comings were observed and corrected by PTI and Lincoln staff prior to the beginning of the shakedown and commissioning on January 25th. The commissioning task was broken down into three stages, which occurred along the following schedule:

- Equipment And Instrumentation Functionality And Leak Testing - The functionality and leak testing occurred from January 25 through January 29, 1993 and was the last task in which Lincoln installation personnel was involved. The major noted short coming was the inability of the air control ball valve to accurately control air flow to the aspirator in the column. A globe valve was substituted for the ball valve, and by the end of that week all instrumentation was deemed functional. The leak testing also proved acceptable and Lincoln Contracting was relieved of responsibility for the circuit.
- Circuit Water Commissioning - The circuit water commissioning occurred from February 1 through February 5, 1993. This task focused on precalibration of all flowmeters and instruments within the circuit, and ensured that the proper flow balance could be maintained and that the plant instrumentation was accurate to within the required ranges.
- Coal/Water Slurry Commissioning - This was the final aspect of the commissioning period, and was scheduled to occur from February 8 through February 12, 1993. Unfortunately, there were problems that occurred during the initial coal/water slurry commissioning (CT#1 through CT#7) and the commissioning had to be repeated the week of February 22 through February 25. Therefore, the actual multivariable testing on the circuit did not commence until February 26, 1993.

Table 5 contains the test matrix for the commissioning tests (CT#1 through CT#7) that were conducted the week of February 8 through February 12, 1993. The tests focused on determining the required reagent dosages and air rates to obtain acceptable circuit yields and qualities for the Upper

Table 5
TEST MATRIX FOR COMMISSIONING TESTS
(Upper Freeport Seam Raw Coal)

<u>Date</u>	<u>Test</u>	<u>Reagents (#/T)</u>		<u>Air Rate (SCFM)</u>	<u>Description of Samples Taken</u>
		<u>Frother</u>	<u>Collector</u>		
2-10-93	CT#1	0.4	0.6	2.0	6 feed samples to check variability; one every 5 minutes.
2-11-93	CT#2	0.6	0.8	2.0	6 product and tailings samples every 10 minutes to check stabilization time.
2-11-93	CT#3	0.4	0.6	2.0	6 product and tailings samples every 10 minutes to check stabilization time.
2-11-93	CT#4	0.5	0.5	2.0	Regular test sampled product, tailings, and feed. Duplicated Monitor counts.
2-11-93	CT#5	0.4	0.6	2.0	Sample Repeatability Test. Sampled product, tailings, and feed twice each. Duplicated Monitor counts.
2-12-93	CT#6	0.4	0.6	3.0	High air rate test. Sampled product, tailings, and feed. Duplicated counts.
2-12-93	CT#7	0.6	0.8	3.0	Duplicate of Test #6, but higher reagents.

Notes:

- 45 total slurry samples and 1 feed lot sample.
- All tests done at targets of 6% solids, 3.0 GPM launder and froth wash water, and 28" froth height.

Freeport Seam Coal. The testing also focused on fulfilling a number of the QA/QC aspects of the testing, including:

- Determining the variability of the feed material and repeatability and reproducibility of PTI's sampling approach.
- Checking the stabilization time for the column.
- Determining the repeatability and reproducibility of the On-Line Monitor counts.

As mentioned, this series of tests was repeated as Test DT#1 through DT#6 during the week of February 22 through February 25, 1993 due to problems incurred with the reagent feeders during the first set of commissioning tests. The test conditions and results from all of the commissioning tests are shown in Appendix A, and will be discussed in detail in the Data Evaluation Section (Section 11).

Section 8

Task 800 - ET Circuit Testing And Sample Preparation

The ET Circuit testing and sample preparation for the first coal (Upper Freeport Seam Raw Coal) began on February 26, 1993, and is still ongoing. Table 6 contains the test matrix for both the Upper Freeport and Pittsburgh No. 8 Seam Coals. The first two portions of the Upper Freeport Seam Testing (preliminary and primary multivariable testing) were completed on March 30th, prior to PTI leaving site for the two-week down time period. The matrix in Table 6 had specified 40 tests in the preliminary multivariable testing and 82 tests in the primary multivariable testing for both coals. Due to the problems and delays incurred during the commissioning, these matrices were slightly reduced to 33 tests in the preliminary multivariable testing (CT#1 through CT#33 in Appendix A) and 87 tests for the primary multivariable testing (FT#1 through FT#87 in Appendix A). The matrices were also slightly different than the test matrix shown in Table 6 due to knowledge obtained during the commissioning period, and as tests were progressively conducted. However, the matrix was still quite similar to that outlined in the initial plan. The upcoming section on data evaluation (Section 11) summarizes the results for the preliminary and primary multivariable test matrices, as well as all QA/QC results to date.

The two-week control testing portion of the Upper Freeport test matrix will be performed from April 19 through April 30th when PTI returns to site. A separate plan will be submitted later this week that summarizes the plan and logistics for the Upper Freeport control testing.

Prior to discussing the analytical, that PTI performs at its Calumet facilities, it is worthwhile to note the sample preparation procedures that are utilized at site to obtain samples and to run moisture and ash composition, for the feed lot samples, as well as the slurry samples taken with PTI's Multiplexer System. Tables 7 contains the procedures used for sampling the individual feed lots (five of which have been fed into the CPPRF system and tested to date). Table 8 contains the slurry sampling procedures for the various feed, concentrate and tailings samples that are collected for each multivariable test (preliminary and primary). Table 9 contains the sample preparation procedure utilized in PTI's Mobile Laboratory to obtain total solids content on the samples and to obtain a pulverized split that could be analyzer for ash, and if necessary, sulfur, pyritic sulfur and Btu/lb. All the data listed in Appendix A was obtained from ASTM analyses on the feed lot and individual test sample splits obtained by the procedures listed in Tables 7 through 9.

Table 6
TEST PLAN FOR EACH OF TWO COALS
Upper Freeport Seam Raw and Pittsburgh No. 8 Seam Raw Coals
(142 Tests For Upper Freeport and 102 Tests for Pittsburgh)

I. Preliminary Multivariable Testing: Determine Best Froth Height. (Only for Upper Freeport Seam Raw Coal).

<u>Variable</u>	<u>Number of Options</u>	<u>Description</u>	<u>Total Tests</u>
Collector Dosage (No. 2 Fuel Oil)	2	1.3X, 1.6X #/Ton	2
Frother Dosage (Betz M-150)	2	X, 1.3X #/Ton	4
Froth Height	2	24, 32 Inches	8
Air Rate	2	2, 3 SCFM (at 40 PSI)	16
Cylinder Configuration	2	None, 11 3/8" OD	32
Plus 8 Duplicates	---	---	40

Primary Multivariable Testing (Both Coals): Optimize Cylinder Configuration and Reagent Dosages, Generate Control Algorithms, and Calibrate On-Line Monitor.

<u>Variable</u>	<u>Number of Options</u>	<u>Description</u>	<u>Total Tests</u>
Collector Dosage (No. 2 Fuel Oil)	2	1.3X, 1.6X #/Ton	2
Frother Dosage (Betz M-150)	2	X, 1.3X #/Ton	4
Depressant Dosage (Polyacrylic Acid)	3	0, X, 2X #/Ton	12
Cylinder Configuration	3	None, 11 3/8", 11 3/4" OD	36
Froth Height	1	Optimum	36
Air Rate	2	2, 3 SCFM (at 40 PSI)	72
Plus 10 Duplicates	---	---	82

II. Control Testing (Both Coals): Optimize and Control Performance of Flotation Column

<u>Variable</u>	<u>Number of Options</u>	<u>Description</u>	<u>Total Tests</u>
Collector Dosage	1	Controlled	1
Frother Dosage	1	Controlled	1
Depressant Dosage	1	Controlled	1
Air Rate	1	Controlled	1
Froth Height	1	Optimized	1
Grinds Topsize	2	65M, 150M	2
Cylinder Configuration	1	Best	2
Feeds Solids Content	2	5%, 7%	4
Yield Target	2	Low Yield, High Yield	8
Product Ash Override	2	Tight Range, Loose Range	16
Plus 4 Duplicates	---	---	20

Notes: Unless Specified Differently, All Tests Will Be Run at 6.0% Wt% Solids, and 300 lb./hr. Solids Feed Rates, Using Normal 100M Topsize Feed Coal (90-95% Passing 100M).

Table 7
FEED LOT SAMPLING AND SAMPLE PREPARATION PROCEDURES

1. When feeding 5-6 ton lots into the product bin, get 35-50 lb. sample of crushed to 1/4 inch topsize material using CPPRF sampling system.
2. Riffle down to 30 lbs. Dry at 40° C and get surface moisture content. Return remainder to product bin.
3. Riffle out 15 lbs. and send to PTI.
4. Pulverize remaining 15 lbs. Riffle down to envelope quantity. Bag and label. Put remainder into product bin.
5. Run residual moisture and ash on envelope portion (see Table 2 in Appendix C).
6. Send envelope and 15 lb. bag to PTI.

Table 8
SLURRY SAMPLING PROCEDURES

1. Computer Operator notifies the Field Operator that sampling will soon begin.
2. Field Operator places a 5-gallon sample bucket in position above the circuit discharge sump.
3. Computer Operator activates sampling of a desired stream (concentrate, tailings, feed) through computer software and keyboard control.
4. Automatically the desired stream is diverted in the multiplexer to the Quality Monitor via three-way valve.
5. The desired stream then flows to a three-way valve in the monitor that toggles alternate full stream cuts to the Quality Monitor and sample bucket.
6. When the monitor is full for operation a pressure switch automatically activates the multiplexer to its normal operating position. Control Room Operator informs Field Operator that sampling is complete.
7. The Quality Monitor cycles this sample portion it received then generates count data for multivariable tests or quality data for control tests.
8. The split in the sample bucket is labeled and covered with a lid by the Field Operator.
9. The Quality Monitor automatically discharges its sample to the circuit discharge sump.
10. The Quality Monitor and associated multiplexer line is then automatically flushed clean by spray water into the circuit discharge sump.
11. The Field Operator sets the next sample bucket in place and the sequence is repeated until concentrate, tailings and feed samples (if required) have been obtained for each test condition.
12. After that test condition the circuit is readied for the next test condition.
13. As the circuit attempts to reach steady state, the Sample Prep Technician begins weighing and filtering samples.
14. Filter cakes are then taken to the Mobile Lab for drying, sample prep and ash analysis (see Tables 1 and 2 in Appendix C).

TABLE 9
PRDA SLURRY SAMPLE PREP PROCEDURE

- . Work in kilograms with buckets (big scale) and grams with pans (small scale).
- . Number buckets. Tare with lids (T_B).
- . Record Test No., Sample, Bucket No. and T_B in Table 1.
- . Take Sample and cover.
- . Record Sample plus Bucket Weight (GW_1).
- . Calculate Slurry Sample Weight (W_1).
$$W_1 = GW_1 - T_B$$
- . Filter sample and discard water.
- . Select a pan. Tare pan include one filter paper (T_P). Record Pan No. and T_P in Table 1.
- . Put sample in pan. Sample should include one filter paper just like when you tared pan.
5. Dry sample at temperature between 40-65°C, until weight stabilizes. If drying overnight, dry at 40°C. If drying 2-3 hours, dry at 65°C. Alter this approach as you learn how long it takes for weights to stabilize.
1. Weigh pan plus surface dry sample, two towels, and filter paper (GD_1).
2. Calculate Surface Dried Sample Weight (D_1).
$$D_1 = GD_1 - T_P$$
3. Note all weights in Table 1 and calculate Surface Solids Content.
$$\text{Surface Solids (Wt\%)} = \frac{D_1 \times 0.1}{W_1}$$
4. Clean all sample off of filter paper and push through 16mi screen. If pulverizing is necessary, follow Step 15. If pulverizing is not necessary, follow Step 16.
5. A. Split out approximately 1/2 of sample and pulverize. Riffle out approximately 50 grams and envelope and label. Discard remaining pulverized portion. Run ash analysis on enveloped sample.
B. Bag, label and store unpulverized portion. Send all bags and envelopes to Pete after enveloped portions have been analyzed for ash.
6. A. Riffle out approximately 50 grams and envelope and label. Run ash analysis on enveloped sample.
B. Bag, label, and store unused portions. Send all bags and envelopes to Pete after enveloped portions have been analyzed for ash.

Section 9

Task 900 - PTI Analytical

PTI's Calumet facility's analytical efforts will occur over the entire duration of the ET Circuit testing period. They will also probably continue through the month of July, to allow longer lead time analyses (i.e., flotation release analyses and washabilities) to be completed. A detailed initial estimate of PTI's analytical requirements was included in the Final Project Work Plan, as well as the Test, Sampling and Analytical Plan, which were submitted in late December 1992 and the first week of January 1993, respectively. The analytical will be slightly altered from these initial plans to ensure that the overall analytical budget of \$49,000 is met, without compromising the overall project goals.

PTI's analytical efforts to date have focused on three major efforts:

- Conducting 2" column tests with both the Upper Freeport and Pittsburgh No. 8 Seam Coals using samples ground at PTI's Calumet facility, and for the Upper Freeport Seam Coal samples ground using PETC's CPPRF circuit. The results from these tests form a basis of performance to which the plant circuit can be compared, and provide information as to anticipated impacts of various process variables. The results from all 2" column testing on the Upper Freeport Seam Coal and the Pittsburgh No. 8 Seam Coal, which were conducted during this quarterly period are listed in Appendix C and D, respectively, and will be discussed in the Data Evaluation Section (Section 11).
- Head analyses, in particular sulfur and pyritic sulfur, on all of the test samples obtained from the various commissioning and multivariable tests with the Upper Freeport Seam Coal (CT#1 through CT#7, DT#1 through DT#6, PT#1 through PT#33 and FT#1 through FT#37) to date. The results from these head analyses are shown in Exhibit A.4 of Appendix A, and will also be discussed in more detail in the Data Evaluation Section (Section 11).
- Head analyses of the various feed lots which will also be discussed in Section 11.
- Size analyses on some of the optimum separations performed in the 2" column tests, and the plant trials with the Upper Freeport Seam Coal.

The analyses shown above will also be performed for the control testing on the Upper Freeport Seam Coal, as well as all plant testing for the Pittsburgh No. 8 Seam Coal. In addition to these analyses, there are more detailed laboratory analyses that PTI has yet to perform, and will perform with both the Upper Freeport Seam Coal and the Pittsburgh No. 8 Seam Coals, they include:

- Laboratory batch tests on each feed lot to determine yields and qualities at constant batch reagent dosages and test conditions. Any differences in these results would indicate different flotation characteristics from lot to lot or changes in oxidation levels.
- Flotation release analyses on ground composites on each of the test coals to determine the optimum performance which could be anticipated in any flotation project.
- Washability analyses of ground samples of the two test coals to determine the degree of impurities liberation within the coals, or the optimum that could be expected in a perfect density separation.

PTI plans to perform all of these analyses at their Calumet facilities using ASTM procedures, as well as optimum washability procedures determined by PTI, and flotation release analysis procedures determined VPI and the University of Kentucky.

Section 10

Task 1000 - Circuit Decommissioning

As mentioned, PTI plans to conduct the circuit decommissioning the week of June 14 through June 18, 1993, provided that PTI's on-site budget allocation for the project lasts until to that period of the project. The details of the Decommissioning Plan still need to be worked out between PTI, DOE and Gilbert Commonwealth staff. However, PTI anticipates that the decommissioning work will be conducted jointly by that group, thereby shifting the approximately \$15,000 from anticipated subcontract for decommissioning with Lincoln Contracting to other aspects of the testing (i.e., PTI's decommissioning efforts and additional travel costs for June). The original Decommissioning Plan was scheduled to be submitted on April 23, 1993. However, due to the approximately five-week delay in the testing, PTI does not plan to submit the Decommissioning Plan until late May 1993, after the exact schedule and scope of decommissioning has been determined.

Section 11

Task 1100 - Data Evaluation

The data evaluation task will occur over the entire duration of the circuit commissioning, testing and analytical periods, forming the basis for the Project Final Report. PTI's Site Manager is compiling information on operating conditions within the circuit for every test, as well as ash and solids content results from the testing and is faxing the results to PTI's Calumet offices. These results have been put onto spreadsheets along with the analytical results PTI obtains from its Calumet laboratories, and have been submitted to the DOE on a weekly and monthly basis through the Weekly Status Sheets and monthly reporting requirements. Calibration and performance results from PTI's Ash Monitor are also being compiled and modemed to PTI by PTI's Staff Engineer, to form a basis for the upcoming control testing.

The following discussion contains separate sub-sections on various aspects of the testing. Those subsections include:

- 2" Column Laboratory Results With Upper Freeport Seam Coal
- 2" Column Laboratory Results With Pittsburgh No. 8 Seam Coal
- QA/QC Results Obtained From Commissioning, Preliminary and Primary Multivariable Testing With Upper Freeport Seam Coal
- Impact of Key Process Variables As They Relate To The Upcoming Control Testing
- Optimum Separation Results, By Size For Various Bench and Lab-Scale Testing

The following discussion summarizes the main points from PTI's testing to date. The performance results for PTI's On-Line Monitor, as well as the Control Testing Plan for the Upper Freeport Seam Coal that is scheduled for the period of April 19 through April 30, 1993 will be discussed separately in a Control Testing Outline, to be submitted by PTI later this week.

Section 11.1 - 2" Column Laboratory Test Results (Upper Freeport Seam Raw Coal)

During the period from October through December 1992, PTI conducted a series of 2" column tests with the Upper Freeport Seam Coal to establish the behavior of the coal, as well as to determine anticipated reagent dosages, product quality and yield. These tests were all performed with Betz M-150 frother using a one drum sample of Upper Freeport Seam Coal collected last fall. The coal was dry ground at PTI's Calumet laboratory facilities to obtain a nominal 100M topsize grind, which was the target for the plant testing. The 2" laboratory column tests in October through December 1992 also indicated that the polyacrylic acid depressant did not significantly improve sulfur or pyritic sulfur removal at various product yields and product ash contents.

The initial 2" column test results illustrated that yields in the range of 75-85% could be obtained at product qualities of 11-13% ash for the Upper Freeport Seam Coal. They also determined ranges of reagent additions, air rates, froth wash and froth heights that were then tested in the plant environment. During the commissioning period PTI determined that MIBC frother provided higher yields than the M-150, in the plant environment. Since the low level of yields were a concern during the commissioning period, PTI switched to MIBC frother for the plant testing. Because of this switch, PTI decided to conduct a short series of additional 2" column tests with the Upper Freeport Seam Coal during the February and March time frame, to compare various frothers in the laboratory environment. Appendix C contains the series of test results for those 2" column tests performed with the Upper Freeport Seam Coal. Tables 18.C.1 through 18.C.6 compare the performance of various frothers using the laboratory sample and PTI's grinding system. Tables 18.C.8 through 18.C.12 compare the difference between PTI's laboratory grind and DOE PETC's finer plant grind for the Upper Freeport Seam Coal being tested at the plant, using only MIBC as a frother and No. 2 Fuel Oil as a collector.

The results in Appendix C are rather voluminous and difficult to quantify on a comparative basis. For the basis of comparison, Table 11 contains a summary of the optimum test results with the various frothers for the Upper Freeport Seam Coal. From the results, it can be observed that, as in the plant, the MIBC frother promoted high yields (76-83%) at lower reagent dosages (0.45 #/T) than the Betz M-150 and CM-670 frothers (0.60 #/T). The tailings ash contents of approximately 82% for the MIBC frother were also much higher than the 64-67% levels obtained with the Betz frothers. Therefore, these results seem to verify that PTI made a sound choice in switching to the MIBC frother in the plant tests.

Table 12 contains a comparison of the optimum 2" column laboratory results obtained with PTI's laboratory grind as well as PETC's plant grind. In all cases, MIBC was used as the frother and No. 2 Fuel Oil as the collector. For coal approximately of the same feed ash content (25-26%), yields approximately 10% higher (80% vs. 70%) could be obtained at 12-13% product ash content for the PTI's laboratory ground coal, as compared to the coal ground at PETC's CPPRF. The finer CPPRF grind apparently caused separation efficiency problems, as well as causing the solids content of the froth to be much lower than the coarser PTI laboratory grind (21% vs. 36-44%). This explains the reason PTI was experiencing difficulties obtaining yields above 75% in the plant testing being done at PETC's CPPRF. A more detailed discussion of the impacts of the size analyses is contained later in Section 11.

Table 11
OPTIMUM 2" LAB COLUMN RESULTS
PTI LABORATORY DRY GRIND
(Upper Freeport Seam Raw Coal)

Batch Number	Test Number	Appendix C Table Number	Frother Dosage		Collector Dosage		Sample	Actual Solids Content (Wt%)	Total Flow Rate (g/min)	Solids Flow Rate (g/min)	Column Performance (Dry Basis)			
			Type	#/T	Type	#/T					Yield (Wt%)	Ash (Wt%)	Sulfur (Wt%)	Pyr. Sulfur (Wt%)
1	3	18.C.2	M-150	0.60	Fuel Oil	0.60	Recon. Feed	5.76	819	47.2	100.0	23.70	1.93	—
							Product	24.39	148	36.9	78.1	12.41	1.98	—
							Tailings	1.18	871	10.3	21.9	63.98	1.76	—
5	4	18.C.6	CM-670	0.60	Fuel Oil	0.60	Recon. Feed	5.74	843	47.9	100.0	25.84	2.12	—
							Product	40.11	92	36.9	77.0	13.44	2.25	1.40
							Tailings	1.17	942	11.0	23.0	67.34	1.70	—
4	3	18.C.5	MIBC	0.45	Fuel Oil	0.60	Recon. Feed	5.69	832	47.3	100.0	23.78	2.02	—
							Product	28.69	137	39.3	83.1	11.92	2.12	1.34
							Tailings	0.89	895	8.0	16.9	82.07	1.52	—
4	5	18.C.5	MIBC	0.45	Fuel Oil	0.60	Recon. Feed	5.73	866	49.6	100.0	29.54	2.35	1.83
							Product	33.45	113	37.8	76.2	12.93	2.41	1.73
							Tailings	1.24	953	11.8	23.8	82.70	2.18	2.17

Notes: - All tests performed in 2" diameter by 6' high column, with nominal 100M grind feed coal.

- All tests done with 200 ml/min. froth wash, 14" froth thickness, and 1.5-2.0 CFM air rate @ 40 PSI.

Table 12
OPTIMUM 2" LAB COLUMN RESULTS
PTI LABORATORY GRIND VERSUS PETC/CPPRF PLANT GRIND
(Upper Freeport Seam Raw Coal, PETC/CPPRF Lot #3 and #5)

Batch Number	Test Number	Appendix C Table Number	Grind Method	Frother Dosage		Collector Dosage		Sample	Actual Solids Content (Wt%)	Total Flow Rate (g/min)	Solids Flow Rate (g/min)	Column Performance (Dry Basis)			
				Type	#/T	Type	#/T					Yield (Wt%)	Ash (Wt%)	Sulfur (Wt%)	Pyr. Sulfur (Wt%)
1	4	18.C.8	PTI's Lab	MIBC	0.45	Fuel Oil	0.60	Recon. Feed	5.35	822	44.0	100.0	26.20	--	--
								Product	44.18	79	34.9	79.3	12.41	--	--
								Tailings	0.97	943	9.1	20.7	79.05	--	--
1	5	18.C.8	PTI's Lab	MIBC	0.45	Fuel Oil	0.60	Recon. Feed	5.76	772	46.2	100.0	25.10	2.12	1.60
								Product	36.47	102	37.2	80.6	12.00	2.30	1.55
								Tailings	1.03	870	9.0	19.4	79.70	1.24	--
2	4	18.C.11	PETC/CPPRF	MIBC	0.30	Fuel Oil	0.50	Recon. Feed	6.20	836	51.8	100.0	26.04		
								Product	21.07	169	35.6	68.7	12.08		
								Tailings	1.68	967	16.2	31.3	56.67		
2	5	18.C.11	PETC/CPPRF	MIBC	0.30	Fuel Oil	0.50	Recon. Feed	6.46	835	53.9	100.0	26.48		
								Product	20.64	188	38.8	72.0	12.90		
								Tailings	1.78	847	15.1	28.0	61.39		

Notes: - All tests performed in 2" diameter by 6' high column, with nominal 100M grind feed coal.

- All tests done with 200 ml/min. froth wash, 14" froth thickness, and 1.5-2.0 CFM air rate @ 40 PSI.

Section 11.2 - 2" Column Laboratory Test Results (Pittsburgh No. 8 Seam Raw Coal)

Appendix D contains the laboratory 2" column tests that were performed during February and March with the Pittsburgh No. 8 Seam Coal. As with the Upper Freeport Seam Coal, the main focus was to determine the anticipated reagent addition dosages and product qualities that could be obtained for this coal at a nominal 100M topsize grind. In addition to these main testing goals, secondary goals were to evaluate the comparative performance of three frothers (MIBC, Betz M-150 and Betz CM-670) and determine whether the polyacrylic acid depressant had any impact on improving pyritic sulfur removal in the laboratory application.

As with Appendix C, the results in Appendix D are very voluminous and difficult to decipher. Because of this, certain optimum data has been transferred to Table 13 for the basis of comparison. The first three rows of data in Table 13 compares some of the optimum separations for the three frothers, with frother dosages of 0.45 #/T and fuel oil dosages of 0.60 #/T. For the Pittsburgh No. Seam Coal, the M-150 and MIBC performed very similarly, giving yields in the range of 76-78% and product qualities of 10.92% for feeds ranging from 25-26% ash. The CM-670 frother was less selective, giving a higher product ash content (14.32%) while only promoting the same tailings ash content as the other two frothers. One small advantage of the MIBC frother over the Betz M-150 frother is the higher solids content, which should lead to less froth washing requirements in the plant. PTI still must run sulfur and pyritic sulfur on the product to determine the efficiency of removal. However, if the results are similar, PTI will continue to use MIBC for the plant testing with the Pittsburgh No. 8 Seam Coal, due to higher solids content of the concentrate.

The lower part of Table 13 contains tests performed with the polyacrylic acid for both the MIBC and M-150 frother. The results indicate that the yields and product qualities are fairly comparable. PTI plans to also perform sulfur and pyritic sulfur analyses on these products. If the polyacrylic acid promotes lower sulfur and pyritic sulfur content for the tests in the lower portion of Table 13 as compared to the tests in the upper portion of Table 13, it will be tested during the plant trials. If not, the polyacrylic acid depressant addition will be dropped from the test matrix for the Pittsburgh No. 8 Seam Coal, and other variables will tested during the 80-test matrix planned for the one-month primary multivariable testing program for the Pittsburgh No. 8 Seam Coal.

Section 11.3 - QA/QC Results

There are a number of specific tests that were performed during the commissioning, preliminary and primary multivariable testing as part of a Quality Assurance/Quality Control (QA/QC) Program instituted by PTI at DOE's request. One of the first issues in the QA/QC was to collect a series of feed samples to get a feeling of the feed variability over a half hour time period. This feed variability QA/QC was first conducted during the commissioning testing on February 11, 1993. The table below shows feed samples collected from PTI's Multiplexer Sampling System on five minute time increments. A 6% solids target was desired during the testing. The results showed that the solids feed rate and the slurry feed rate were fairly accurate yielding solids contents ranging from approximately 6-7%. The results also illustrated that the feed ash content varied slightly from 26% to 27.3% over the half hour time period.

Table 13
OPTIMUM 2" LAB COLUMN RESULTS
PTI LABORATORY DRY GRIND
(Pittsburgh No. 8 Seam Raw Coal)

Batch Number	Test Number	Appendix C Table Number	Frother Dosage		Collector Dosage		Poly Acid Dosage Type	Poly Acid Dosage #/T	Sample	Actual Solids Content (Wt%)	Total Flow Rate (g/min)	Solids Flow Rate (g/min)	Column Performance (Dry Basis)			
			Type	#/T	Type	#/T							Yield (Wt%)	Ash (Wt%)	Sulfur (Wt%)	Pyr. Sulfur (Wt%)
7	3	18.D.8	MIBC	0.45	Fuel Oil	0.60	---	---	Recon. Feed	5.95	800	47.6	100.0	25.12		
									Product	42.39	88	37.3	78.4	10.92		
									Tailings	1.13	912	10.3	21.6	76.65		
11	3	18.D.12	M-150	0.45	Fuel Oil	0.60	---	---	Recon. Feed	6.26	836	52.3	100.0	26.19		
									Product	32.89	121	39.8	76.1	10.92		
									Tailings	1.37	915	12.5	23.9	74.80		
13	3	18.D.14	CM-670	0.45	Fuel Oil	0.60	---	---	Recon. Feed	6.10	816	49.8	100.0	25.29		
									Product	19.95	205	40.9	82.1	14.32		
									Tailings	1.10	811	8.9	17.9	75.58		
8	3	18.D.9	MIBC	0.45	Fuel Oil	0.60	Pure	0.80	Recon. Feed	6.00	793	47.6	100.0	25.48		
									Product	43.45	84	36.5	76.7	11.39		
									Tailings	1.22	909	11.1	23.3	71.86		
12	3	18.D.13	M-150	0.45	Fuel Oil	0.60	Pure	0.80	Recon. Feed	6.15	806	49.6	100.0	24.82		
									Product	35.09	112	39.3	79.2	11.66		
									Tailings	1.15	894	10.3	20.8	74.94		

Notes: - All tests performed in 2" diameter by 6' high column, with nominal 100M grind feed coal.

- All tests done with 200 ml/min. froth wash, 14" froth thickness, and 1.5-2.0 CFM air rate @ 40 PSI.

Feed Variability QA/QC Test Results Conducted February 11, 1993

<u>Samples (5 Minutes Apart)</u>	<u>Solids (Wt%)</u>	<u>Ash (Wt%)</u>
Feed #1	6.42	25.94
Feed #2	6.16	26.72
Feed #3	6.46	26.89
Feed #4	6.98	27.28
Feed #5	6.13	27.33
Feed #6	5.87	26.50

The exercise was again repeated during the second round of commissioning tests on February 23, 1993. The results from the second round of commissioning tests are shown below. Once again, the solids content held fairly tightly to the 6% target, but the ash content again ranged approximately 1.8%, from 28% to 29.8%. It is also interesting to note that the ash content for this later testing, that was done with the second lot of feed coal, was considerably higher than the ash content in the earlier tests that were done with the first lot of feed coal.

Feed Variability QA/QC Test Results Conducted February 23, 1993

<u>Samples (5 Minutes Apart)</u>	<u>Solids (Wt%)</u>	<u>Ash (Wt%)</u>
Feed #1	6.04	28.88
Feed #2	6.23	27.96
Feed #3	6.25	28.46
Feed #4	6.21	29.79
Feed #5	6.28	29.17

Based on these results and the variability that was observed in feed composition from test to test, PTI and DOE staff became very concerned with better blending of the coal to reduce the variability caused by the feed systems within the plant. Table 14 contains the feed lot sample composition for the five feed lots of Upper Freeport Seam Coal that have been fed through the plant. The feed lot analyses is the results from the head sample collected over the entire period when the 6-ton 1/4" x 0" lots were fed into the CPPRF system. The "individual test feedsample" results are the average from the test samples in Appendix A, as well as the minimums and maximums.

It can be observed that Feed Lot #2 was considerably higher ash content (29.23%) than the other feed lots, but the other feed lots generally range $\pm 1\%$ of 26.5% ash. The major concern is the extreme range of ash content for the individual test samples, as witnessed by the range of 24-36% ash that was obtained for Feed Lot #4 and 24-37.5% ash that was obtained in Feed Lot #5. These uncontrollable feed variations made evaluation of the impact of test variables extremely difficult, especially since the performance of the column, particularly the column product quality, is so dependent on the column feed quality. The PETC and Gilbert Commonwealth staff are working on improving the blending and mixing system that feeds slurry to PTI's agitated feed sump to try to reduce the variability of the test feed samples for the control testing portion of the project, as well as the upcoming Pittsburgh No. 8 Seam Coal testing, so that more sensitivity can be obtained in the data evaluation.

Table 14
 FEED LOT SAMPLE COMPARISON
 AND TEST SAMPLE VARIABILITY
 Upper Freeport Seam Raw Coal
 (Results Are Dry Basis)

	Feed Lot Analysis	Individual Average Analysis	Test Feed Minimum Analysis	Samples Maximum Analysis
<u>Feed Lot #1</u>				
Ash (Wt%)	25.94	26.85	25.77	29.90
Sulfur (Wt%)	2.49	---	---	---
Pyritic Sulfur (Wt%)	1.90	---	---	---
Heating Value (Btu/lb.)	11292	---	---	---
MAF Heating Value (Btu/lb.)	15248	---	---	---
<u>Feed Lot #2</u>				
Ash (Wt%)	29.23	29.40	26.74	32.58
Sulfur (Wt%)	2.68	---	---	---
Pyritic Sulfur (Wt%)	2.04	---	---	-
Heating Value (Btu/lb.)	10745	---	---	---
MAF Heating Value (Btu/lb.)	15182	---	---	---
<u>Feed Lot #3</u>				
Ash (Wt%)	27.21	27.64	24.97	30.94
Sulfur (Wt%)	2.57	2.55	2.45	2.63
Pyritic Sulfur (Wt%)	2.03	2.07	1.96	2.21
Heating Value (Btu/lb.)	11118	---	---	---
MAF Heating Value (Btu/lb.)	15274	---	---	---
<u>Feed Lot #4</u>				
Ash (Wt%)	26.88	28.37	24.10	36.25
Sulfur (Wt%)	2.56	2.52	2.00	2.81
Pyritic Sulfur (Wt%)	1.97	1.99	1.50	2.35
Heating Value (Btu/lb.)	11160	---	---	---
MAF Heating Value (Btu/lb.)	15282	---	---	---
<u>Feed Lot #5</u>				
Ash (Wt%)	26.57	27.76	24.37	37.53
Sulfur (Wt%)	2.54	2.64	2.38	3.40
Pyritic Sulfur (Wt%)	1.92	2.13	1.85	2.86
Heating Value (Btu/lb.)	11207	---	---	---
MAF Heating Value (Btu/lb.)	15262	---	---	---

Another area of the QA/QC testing was to determine the stabilization period required for the circuit to stabilize and be prepared for sampling after a circuit change. The table below shows the results from samples of concentrates and tailings that were taken at 10 minute increments during the commissioning testing. It can be observed that the yield and product quality stabilized at about 45% $\pm 1\%$ and 11.7% $\pm 2\%$ after a 15 to 25 minute period.

<u>Time After Feed Sample And Reagent Adjustment</u>	<u>Yield (Wt%)</u>	<u>Concentrate</u>		<u>Tailings</u>	
		<u>Solids (Wt%)</u>	<u>Ash (Wt%)</u>	<u>Solids (Wt%)</u>	<u>Ash (Wt%)</u>
5 Minutes	41.6	4.49	11.72	3.39	37.96
15 Minutes	43.3	4.38	11.57	3.37	38.85
25 Minutes	45.8	4.20	11.83	3.43	39.91
35 Minutes	43.8	4.32	11.67	3.42	39.00
45 Minutes	45.2	4.35	11.89	3.37	39.55
55 Minutes	44.5	4.28	11.76	3.41	39.23

Notes: - Yield Assumes 27.04 Wt% Feed Ash Content
 - Reagent Levels Were Unknown

The stabilization testing was also repeated during the later stages of the commissioning testing conducted on February 23, 1993. The table below again shows the results from concentrate and tailings samples that were taken at 10 minute increments after a change in circuit operations. Once again the circuit yield and concentrate quality seemed to stabilize after approximately 15 to 25 minutes. For this reason, PTI set a stabilization period of 25 minutes for all multivariable tests that were conducted during the preliminary and primary multivariable testing (PT#1 through PT#33 and FT#1 through FT#87 in Appendix A).

<u>Time After Feed Sample And Reagent Adjustment</u>	<u>Yield (Wt%)</u>	<u>Solids (Wt%)</u>	<u>Ash (Wt%)</u>	<u>Solids (Wt%)</u>	<u>Ash (Wt%)</u>
5 Minutes	11.9	2.88	10.56	4.03	30.84
15 Minutes	9.4	3.10	11.21	3.88	30.22
25 Minutes	11.6	3.20	11.34	3.92	30.67
35 Minutes	10.3	3.13	11.40	4.02	30.39
45 Minutes	11.1	3.05	11.60	4.00	30.54

Notes: - Yield Assumes 28.43 Wt% Feed Ash Content
 - Reagent Changed from 0.6 #/T M-150 and 0.8 #/T No. 2 Fuel Oil to 0.8 #/T M-150 and 1.0 #/T No. 2 Fuel Oil at time zero.

Another aspect of QA/QC testing was to check the back-to-back sample repeatability and back-to-back test repeatability of the circuit to observe the stability and reproducibility of the results. Table 15 contains the results from the back-to-back sample repeatability testing where back-to-back samples of concentrate, tails and feeds were taken for given test conditions. Table 15 illustrates that the results were fairly consistent when the feed composition does not vary significantly (CT#5), but when the feed ash content varies the yields and qualities for the back-to-back samples are prone to varying to a greater degree (DT#4).

In a similar fashion, the back-to-back test repeatability results in Table 16 represent duplicate tests run at exactly the same test conditions back-to-back. As with the back-to-back sample repeatability, tests in which the feed did not change dramatically (particularly PT#23 vs. PT#24 and FT#33 vs. FT#34) the yields and product qualities matched fairly well for the back-to-back tests. However, as the feed composition varied more from test to test, the yields and product qualities also varied more from test to test. This can be witnessed by comparison of FT#23 and FT#24 where feed ash content varied by 6% (26% to 32%) which caused the yield difference to be 9% (62% vs. 53%) and the product quality to be greater than 1% (11.69% vs. 13.42%). This data illustrates that it is difficult to draw conclusions for impacts of process variables unless the feed composition for the comparative tests is similar.

The final area of QA/QC testing was to assess the repeatability and reproducibility of PTI's laboratory analyses. Table 17 shows results from compositional analyses done on test samples from two tests occurring during the preliminary multivariable testing. The table includes a comparison of ash analyses results for the circuit samples done by DOE's LECO furnace and PTI's Calumet laboratories. The ash composition comparisons were all within ASTM range of reproducibility. Table 17 also contains a comparison of duplicate aliquots that were analyzed for sulfur and pyritic sulfur at PTI's Calumet laboratories. The pyritic sulfur analyses for the concentrate samples had slightly higher variabilities than desired, but all analyses were within ASTM guidelines for reproducibility.

The last aspect of the laboratory QA/QC, involved sending duplicate splits of feed and concentrate samples to other laboratories to compare to PTI's analyses results. Table 18 shows the results from eight samples that were sent to Standard Laboratories and Geochemicals, as well as analyzed by PTI's Calumet laboratories. These samples included two aliquots of FT#10 feed and FT#14 feed, which were approximately 25% and 28% ash, respectively, and two aliquots of FT#12 and FT#10 concentrate that were approximately 11.7% and 14.5% ash respectively. PTI not only analyzed both of the duplicate aliquots, but also duplicates of all analyses for each aliquot. From the results in Table 18 it can be observed that PTI's repeatability for the analyses of a given aliquot, and repeatability within aliquots, is well within ASTM standards. PTI's analyses also closely matched Standard Laboratories' and Geochemicals' results for moisture, ash and sulfur to a level well within ASTM reproducibility. The only concern was the differences in pyritic sulfur between PTI's results and Standard Laboratories results. However, PTI's pyritic sulfurs did closely match Geochemicals' analyses so it is assumed that our results are acceptable. Further QA/QC on laboratory analyses, particularly pyritic sulfur will be performed if DOE requires any further verification.

Table 15
BACK-TO-BACK SAMPLE REPEATABILITY RESULTS
Upper Freeport Seam Coal
(Dry Basis, Except Solids Content)

Test Number	Date	Time	Feed Sample				Concentrate Sample				Tailings Sample				
			Solids (Wt%)	Ash (Wt%)	Sulfur (Wt%)	Pyr. S. (Wt%)	A B Yield (Wt%)	Solids (Wt%)	Ash (Wt%)	Sulfur (Wt%)	Pyr. S. (Wt%)	Solids (Wt%)	Ash (Wt%)	Sulfur (Wt%)	Pyr. S. (Wt%)
CT#5	2/11	1740	6.13	26.76	2.52	---	43.5	4.18	13.10	2.12	1.40	3.65	37.26	---	---
	2/11	1740	5.68	26.37	2.50	--	45.1	4.15	13.40	2.20	1.48	3.71	37.02	---	---
DT#4	2/23	1357	6.12	33.99	2.65	2.25	12.1	2.99	13.90	2.00	1.32	4.20	36.76	---	---
	2/23	1357	5.98	32.37	2.59	2.20	19.1	2.86	14.21	2.02	1.38	4.11	36.67	---	---

Table 16
BACK-TO-BACK TEST REPEATABILITY
NO COLUMN SLEEVE
Upper Freeport Seam Coal
(Dry Basis, Except Solids Content)

Test Number	Date	Time	Feed Sample				Concentrate Sample				Tailings Sample				
			Solids (Wt%)	Ash (Wt%)	Sulfur (Wt%)	Pyr. S. (Wt%)	A.B. Yield (Wt%)	Solids (Wt%)	Ash (Wt%)	Sulfur (Wt%)	Pyr. S. (Wt%)	Solids (Wt%)	Ash (Wt%)	Sulfur (Wt%)	Pyr. S. (Wt%)
PT#23	3/04	1105	7.88	28.82	2.63	2.11	53.6	3.62	13.06	2.03	1.39	3.80	47.04	3.14	2.57
PT#24	3/04	1151	7.32	28.13	2.63	2.21	56.4	3.69	12.69	2.02	1.30	3.40	48.08	---	---
FT#23	3/16	1213	8.77	26.03	2.56	1.96	62.0	4.40	11.69	1.99	1.37	3.45	49.45	---	---
FT#24	3/16	1311	8.67	32.32	2.73	2.35	53.1	4.32	13.42	2.11	1.48	3.36	53.74	---	---
FT#33	3/17	1350	8.01	27.36	2.54	---	60.5	4.14	14.02	2.12	---	3.43	47.79	---	---
FT#34	3/17	1435	8.69	28.40	2.81	---	58.6	4.02	15.16	2.13	---	3.59	47.14	---	---
FT#43	3/18	1648	8.24	26.13	---	---	70.3	4.40	12.95	2.12	1.42	3.14	57.39	---	---
FT#44	3/18	1733	7.76	24.28	2.20	1.75	74.4	4.49	12.16	2.12	1.37	2.87	59.56	---	---
FT#60	3/23	1440	7.84	26.03	2.43	1.98	76.9	4.88	14.66	2.27	1.60	2.64	63.78	---	---
FT#61	3/23	1520	7.81	26.00	2.47	1.93	72.8	4.87	15.28	2.29	1.56	2.78	54.68	---	---
FT#62	3/23	1625	8.39	28.28	---	---	62.4	4.56	16.87	2.08	---	3.34	47.25	---	---
FT#63	3/23	1715	7.86	30.46	2.70	2.11	61.6	4.60	17.92	2.26	---	3.50	50.55	---	---

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DOE'S LECO FURNACE vs PTI'S CALUMET LAB
Including Separate Aliquots, Pulverized and Unpulverized
(Dry Basis)

Test Number	Laboratory	Aliquot	A.B.			Feed			Concentrate			Tailings	
			Yield (Wt%)	Ash (Wt%)	Sulfur (Wt%)	Pyr. Sulfur (Wt%)	Ash (Wt%)	Sulfur (Wt%)	Pyr. Sulfur (Wt%)	Ash (Wt%)	Sulfur (Wt%)	Ash (Wt%)	Sulfur (Wt%)
PT#9	DOE LECO	Main Sample	58.1	25.19	—	—	25.19	—	—	11.72	—	43.83	—
PT#9	PTI Calumet	Main Sample	57.7	25.40	2.54	—	25.40	1.98	—	11.67	1.98	44.11	—
PT#9	PTI Calumet	Dup #1 (Unpulv.)	56.7	25.27	2.53	—	25.27	1.97	—	11.35	1.97	43.50	—
PT#9	PTI Calumet	Dup #2 (Pulv.)	56.2	25.38	2.53	—	25.38	2.02	—	11.25	2.02	43.52	—
PT#24	DOE LECO	Main Sample	56.4	28.13	—	—	28.13	—	—	12.69	—	48.08	—
PT#24	PTI Calumet	Main Sample	55.3	28.63	2.63	2.21	28.63	2.02	1.30	12.90	2.02	48.12	1.30
PT#24	PTI Calumet	Dup #1 (Unpulv.)	55.8	28.54	2.67	2.23	28.54	2.04	1.34	12.81	2.04	48.42	1.34
PT#24	PTI Calumet	Dup #2 (Pulv.)	55.2	28.30	2.71	2.27	28.30	2.05	1.47	12.84	2.05	47.38	1.47

Notes: - Main sample of tailings and feed were pulverized before analysis. Main sample of concentrate was analyzed unpulverized.

Table 18
QA/QC ON COAL LABORATORY ANALYSES
PTI vs. STANDARD LABS AND GEOCHEMICALS
Upper Freeport Seam Coal
(Dry Basis, Except Moisture)

Sample Number	Description	PTI		PTI		PTI		PTI		PTI		Standard Labs		Geochemical	
		Moisture (Wt%)	Ash (Wt%)	Sulfur (Wt%)	Pyr. S. (Wt%)	Ash (Wt%)	Sulfur (Wt%)	H ₂ O (Wt%)	Pyr. S. (Wt%)	Ash (Wt%)	Sulfur (Wt%)	H ₂ O (Wt%)	Pyr. S. (Wt%)	Ash (Wt%)	Sulfur (Wt%)
1	FT#10, Feed A	0.66/0.55	24.86/24.85	2.24/2.34	1.80/1.79	24.86/24.85	2.24/2.34	0.85	1.80	24.45	2.33	0.68	1.53	24.40	2.42
2	FT#10, Feed B	0.57/0.56	24.71/24.77	2.30/2.26	1.79/1.80	24.71/24.77	2.30/2.26	0.79	1.80	24.42	2.30	0.71	1.50	24.63	2.31
3	FT#14, Feed A	0.41/0.43	28.26/28.21	2.54/2.53	2.08/2.10	28.26/28.21	2.54/2.53	0.87	2.10	27.85	2.53	0.72	1.70	27.63	2.55
4	FT#14, Feed B	0.63/0.75	27.98/28.12	2.52/2.52	2.12/2.17	27.98/28.12	2.52/2.52	0.96	2.14	28.00	2.53	0.66	1.71	27.24	2.52
5	FT#12, Conc. A	0.72/0.66	11.69/11.65	1.95/1.96	1.37/1.35	11.69/11.65	1.95/1.96	0.88	1.36	11.52	1.93	0.66	1.19	11.49	1.96
6	FT#12, Conc. B	0.69/0.69	11.62/11.62	1.97/1.97	1.32/1.37	11.62/11.62	1.97/1.97	0.82	1.35	11.50	1.93	0.64	1.16	11.42	1.94
7	FT#10, Conc. B	0.55/0.59	14.50/14.55	2.08/2.07	1.58/1.48	14.50/14.55	2.08/2.07	0.82	1.53	14.40	2.03	0.63	1.21	14.18	2.06
8	FT#10, Conc. B	0.59/0.51	14.56/14.47	2.02/2.05	1.48/1.56	14.56/14.47	2.02/2.05	0.87	1.52	14.43	2.05	0.68	1.22	14.34	2.03

Notes: - Ind. - Individual Analysis

Section 11.4 - Impact of Process Variables

Due to the fact that the feed composition varied randomly, and sometimes very severely, from test to test it is impossible to do an impact evaluation of various levels of process variables based on the results in Appendix A from any type of mathematical modeling approach. However, PTI feels it is worthwhile to present some of the test results individually where impacts of process variables can be compared from test to tests (i.e., where feed composition remained fairly constant for two tests).

The first variable of interest was comparing the use of unrecirculated city water to process water that had been recirculated through DOE's thickener and had residual flocculant and reagent remaining from the clarification system. The table below contains the results from a comparative test that was performed during the primary multivariable testing (PT#4 and PT#5) on February 26, 1993. Note for identical test conditions, the process water caused much higher concentrate ash content (26.7% vs. 14.1%) and considerably lower tailings ash content (33.1% vs. 37.4%) than the city water. The process water problem was more pronounced than anticipated in an operating plant, due to the fact that the CPPRF thickener is a high rate thickener and requires a much higher flocculant dosage than a normal thickener, which likely results in more flocculant being recirculated. The decision was therefore made to conduct all remaining testing with city water, and have a once pass through system where the clarified water discharges to outdoor water treatment facilities at PETC.

City Water Versus Process Water Comparison

Test Number	Feed Rate (#/hr)	Water Type	Yield (Wt%)	Feed		Concentrates		Tailings	
				Solids (Wt%)	Ash (Wt%)	Solids (Wt%)	Ash (Wt%)	Solids (Wt%)	Ash (Wt%)
PT#4	300	Process	30.0	7.25	31.19	5.47	26.73	5.85	33.10
PT#5	300	City	23.2	7.80	32.00	4.87	14.12	5.89	37.39

As witnessed by the low yields of 30% and 23%, shown in the table above, PTI was struggling early in the program to obtain higher yields and better product qualities for the testing circuit. During the process water testing, PTI decided to compare MIBC frother performance to the Betz M-150, which was the initial frother selected for the testing. Although the separation efficiencies were rather poor due to the fact that recirculated process water was being used, the results did show that a higher yield was being obtained with the MIBC frother (47% vs. 30% for the M-150) at a better product quality (21.6% ash vs. 26.7% ash) for the same reagent dosages. This coupled with the improved results in the laboratory 2" column separation, caused PTI to switch to the MIBC frother for the remainder of the Upper Freeport Seam Coal testing.

MIBC Frother vs. Betz M-150 Frother Comparison

Test Number	Feed Rate (#/hr)	Frother	Yield (Wt%)	Feed		Concentrates		Tailings	
				Solids (Wt%)	Ash (Wt%)	Solids (Wt%)	Ash (Wt%)	Solids (Wt%)	Ash (Wt%)
PT#4	300	M-150	30.0	7.25	31.19	5.47	26.73	5.85	33.10
PT#5	300	MIBC	47.4	7.65	32.32	5.50	21.57	5.83	42.01

One additional test variable that was evaluated during the project was the use of a dual-cylinder sleeve that PTI had invented and tested in an earlier laboratory column environment. Various dual-cylinder column sleeves were tested during the later stages of the primary multivariable testing (see FT#64 through FT#87 in Appendix A). In all cases, the dual-cylinder caused lower yields and poorer product qualities than were obtained for the conventional column without the sleeve. For this reason, the dual-cylinder sleeves will not be used in the control testing. Based on the fact that the testing matrix will need be condensed, due to the tight testing schedule for the Pittsburgh No. 8 Seam Coal, the dual-cylinder column approach will also not be utilized for the Pittsburgh No. 8 Seam testing.

Another research aspect that was evaluated was the use of a polyacrylic acid as a pyrite depressant. The results in Appendix A proved inconclusive in terms of any improvements in sulfur and pyritic sulfur removal occurring due to the polyacrylic acid addition. This was also the case for the 2" laboratory tests conducted with the Upper Freeport Seam Coal and discussed earlier. Due to the lack of any significant or noticeable impact of the polyacrylic acid on circuit performance, it will not be utilized during the control testing portion of the Upper Freeport Seam Coal testing. It will only be tested during the Pittsburgh No. 8 Seam Testing, if the results from the 2" column laboratory tests (see Table 13) prove that it causes a significant improvement in pyritic sulfur and total sulfur removal at that scale of testing.

In terms of the control testing plan, there are a number of key variables that impact performance of the column to a greater or lesser extent. One of the more important is quantity of froth wash. PTI intends to target a product quality of approximately 13% ash in the control testing portion of the project. The testing proved that this product composition can be obtained at relatively high yields (70-75%) when the feed is in the range of 24% to 26% ash, regardless of the froth wash quantity. However, as the feed ash content increases, as witnessed in the table below, a higher amount of froth wash is required to clean up the product and give the desired ash content range. For this reason, PTI has decided to use a feed rate of approximately 5.5 GPM during the control testing and froth wash at 3.5 GPM to ensure that the froth is adequately cleaned for the situation where the feed ash content increases above 27%.

Froth Wash Impact

Test Number	Feed Rate (#/hr)	Feed Rate (GPM)	Froth Wash (GPM)	Yield (Wt%)	Feed		Concentrates		Tailings	
					Solids (Wt%)	Ash (Wt%)	Solids (Wt%)	Ash (Wt%)	Solids (Wt%)	Ash (Wt%)
FT#41	250	8.1	1.0	70.2	6.20	27.95	4.73	15.44	2.76	57.35
FT#42	250	6.1	3.0	68.0	8.33	27.50	4.35	12.44	3.06	59.44

Note: - Both tests run with 0.90 #/T MIBC, and 2.00 #/T No. 2 Fuel Oil, with 1.5 CFM air rate, 36" froth height, and 3.5 GPM launder water.

The main operating variable that had a consistent impact on yield and product quality during the Upper Freeport Coal preliminary and primary multivariable testing was air rate to the column aspirator. This will be the primary control variable in the control testing. It will be varied to target yields and product qualities for various feed conditions occurring randomly, and by design, in the control testing. The table below illustrates some of the more representative results, which occurred for two back-to-back tests that have similar feed ash content and different air rates. In general, a higher air

rate promoted a higher yield and a slightly poorer product quality. This will be the primary control loop to attempt to control product ash content and maximize product yield. During the control testing, the air rate will be adjusted to between 1.0 and 2.0 CFM at 50 PSI. If adjustments within this range are not adequate to control the circuit the secondary and tertiary control variables (froth height and reagent dosage) will be implemented.

Air Rate Impact

Test Number	Air Rate 50 PSI (CFM)	Yield (Wt%)	Feed		Concentrates		Tailings	
			Solids (Wt%)	Ash (Wt%)	Solids (Wt%)	Ash (Wt%)	Solids (Wt%)	Ash (Wt%)
PT#14	2.0	59.7	8.30	28.82	4.25	12.67	3.11	52.76
PT#15	1.5	55.6	8.25	28.51	4.17	11.42	3.34	49.94

Note: - Both tests were fed at 250 #/hr., 7.5% Wt% solids, and 6.5 GPM, using 1.00 #/T MIBC and 2.00 #/T No. 2 Fuel Oil, with 36" froth height, 3.0 GPM froth wash and 3.5 GPM launder water.

As mentioned, a secondary control variable within the control testing will be froth height. In general, the impact of froth height was not as consistent and recognizable as the impact of air rate on circuit performance. However, increasing the froth height did seem to slightly improve the product quality, at the expense of product yield, as witnessed by some of the back-to-back test data shown below. PTI plans to set the froth height at approximately 32" during the control testing. If the primary control (air rate) is not adequate to obtain the desired yield and product quality, PTI will adjust froth height to between 26" and 38" to allow an additional yield and product quality compensation.

Froth Height Impact

Test Number	Froth Thickness	Yield (Wt%)	Feed		Concentrates		Tailings	
			Solids (Wt%)	Ash (Wt%)	Solids (Wt%)	Ash (Wt%)	Solids (Wt%)	Ash (Wt%)
PT#26	20	43.8	5.79	27.80	3.44	12.15	2.89	39.88
PT#27	28	39.7	5.07	28.55	3.34	11.98	3.19	39.44

The final (tertiary) control loop that will be implemented during control testing will be reagent dosage. As with froth height, the reagent dosage impact in the Appendix A test results is less consistent and of lower magnitude of the air rate impact. In general, the reagent dosage did not seem to have a major impact on yield and product quality when the feed was less than 28% ash content. However, as the feed ash content increased, it seemed that higher reagent dosage was required to obtain yields above 60%. The table shown below illustrates that situation for two tests that had varying reagent addition while all other circuit conditions remained the same, including a very similar feed ash content (30% to 31%). PTI plans on running the reagents at approximately 1.0 #/T MIBC and 2.0 #/T No. 2 Fuel Oil during the control testing, and only adjusting them if the air rate control loop and froth height control loop reach minimum or maximum end points beyond which the computer control

will not exceed. PTI plans to allow the reagent dosages to range from 0.75 and 1.25 #/T of frother with collector always being added at a 2:1 ratio as compared to frother.

Reagent Dosage Impact

Test Number	MIBC (#/T)	Fuel Oil (#/T)	Yield (Wt%)	Feed		Concentrates		Tailings	
				Solids (Wt%)	Ash (Wt%)	Solids (Wt%)	Ash (Wt%)	Solids (Wt%)	Ash (Wt%)
FT#26	1.20	2.00	69.4	8.04	29.94	4.41	14.76	3.04	64.44
FT#49	0.80	1.60	51.5	8.13	30.87	4.42	14.46	4.03	47.79

Notes: - Both tests were fed at 250 #/hr, 8.0% Wt% solids, and 6.1 GPM, using 1.5 CFM air rate, 24" froth height, 3.0 GPM froth wash, and 3.5 GPM launder water.

In summary, the control testing that PTI will perform will focus on comparing the performance of the circuit when it is merely set at optimum operating conditions for varying feed conditions, to the performance when it is controlled by the On-Line Monitor. The optimum setpoint operating conditions will be:

- 5.5 GPM Feed Rate
- 3.5 GPM Froth Wash
- 3.5 GPM Launder Water
- 1.5 CFM at 50 PSI Air Rate
- 32" Froth Thickness
- 1.0 #/T MIBC and 2.0 #/T No. 2 Fuel Oil, Assuming a 220 #/hr Feed Rate

Past operating experience indicates that there will be variations in feed composition and feed solids caused by the blending and feeding system of DOE's grinding circuit. PTI and DOE will also randomly change the solids feed rate between 190 and 250 #/hr, as well as the amount of precleaned coal blended into the feed coal, between 0% and 30% to further magnify the feed variations for certain portions of the testing.

PTI plans to operate in manual mode in the mornings, to establish baselines of how much the circuit varies for changing feed conditions at the optimum operating conditions, shown above. PTI then plans to run approximately four afternoons of testing using the control strategy to target certain product qualities and yield ranges. The control will focus on varying certain operating conditions, based on quality results obtained from the On-Line Monitor. The three levels of control include:

Level 1 - Air Rate Changes between 1.0 and 2.0 CFM

Level 2 - Froth Height Changes between 26" and 38"

Level 3 - Reagent Dosage Changes between 0.75 #/T and 1.25 #/T of MIBC with a constant 2:1 Collector-To-Frother Ratio

The goal of the testing will be to target a given product quality (probably 13% ash), while assuring the yield does not range beyond a desired range (60-80%).

Section 11.5 - Evaluation of Optimum Performance Results By Size (Plant Tests and Lab Tests)

Table 19 contains screen analyses and performance by size results for the feed, concentrate and tailings samples from two of the optimum tests performed during the preliminary multivariable testing with the Upper Freeport Seam Coal. When the feed was in the range of 25-27% the highest yields that were obtained were approximately 60-66% at 13% ash, as witness by the data for PT#8 and PT#32 in Table 19. The interesting observations in Table 19 are that the yields are very low in the coarse size fractions, and that the sulfur cleaning efficiency is fairly good with sulfur content dropping in all size fractions.

Later, during the primary multivariable testing PTI was better able to optimize the operating conditions so that at 26% feed ash, yields of approximately 70-75% could be obtained, while still targeting a 12-13% ash product. By contrast, when the feed was in the range of 27-29% ash the yields that could be obtained at 13% ash were only in the range of 65-70%. Table 20 contains the head analyses for two of the optimum tests (FT#45 and FT#47) that were obtained with both a 26% ash and a 28% feed. PTI has yet to obtain the screen analyses results from this testing, but the head results again illustrates that the sulfur content in the product is considerably lower than the feed sulfur content. Tailings ash contents in the range of 59-65% were obtained at the given yield levels.

For the basis of comparison, it is interesting to note the optimum screen analyses results in Table 21 for the 2" column laboratory tests, that PTI performed at their Calumet facilities. Note that much higher yields (approximately 80%) were obtained at 12% product ash for a 25% ash feed coal in the laboratory situation. Also note that the tailings ash content of approximately 80% was considerably higher than the levels obtained for the test FT#45 in Table 20.

One disadvantage of the 2" column testing was that the sulfur content in the concentrate increased above the levels in the feed. The reason for the differences between test FT#45 in Table 20 and the optimum 2" column results in Table 21 is probably due to the much finer grind resulting from PETC's plant grinding system as compared to the feed grinding system that PTI utilizes in the laboratory. PTI has completed a series of laboratory column tests using the PETC plant grind, and it appears that the optimum results do much more closely match the results in Table 20. The results from the optimum screening of the 2" column tests with the PETC lab grind will be added to the lower part of Table 21 at a later time.

As mentioned, PTI's laboratory grind, used to determine the initial anticipated performance of the plant circuit, turned out to be considerably coarser than the grind resulting from PETC's grinding system. Table 22 contains Microtrac results from two feed samples obtained from PETC's grinding system, and a feed sample obtained from PTI's grinding circuit. It can be noted that the PETC circuit feed coal has mean volume diameters (MVD's) in the range of 19 to 22 microns, whereas PTI laboratory dry grinding pulverizer has mean volume diameters approximately twice that size (39 to 41 microns). This would explain why higher reagent addition dosages are required in the plant circuit, and would also explain why lower yields have been obtained due to the impact of the additional slimes and fines on the column performance. It also explains why the sulfur removals are better for the PETC grind, as the pyritic sulfur is probably more liberated and more easily removed in the flotation separation.

Table 19
PRELIMINARY MULTIVARIABLE TEST MATRIX
OPTIMUM TESTS, SIZE ANALYSIS RESULTS
(Upper Freeport Seam Coal)

Test Number	Size Fraction USA Mesh	Reconstituted Feed			Actual Feed			Concentrate			Tailings			
		Weight (Wt%)	Ash (Wt%)	Sulfur (Wt%)	Weight (Wt%)	Ash (Wt%)	Sulfur (Wt%)	Yield (Wt%)	Weight (Wt%)	Ash (Wt%)	Sulfur (Wt%)	Weight (Wt%)	Ash (Wt%)	Sulfur (Wt%)
PT#8	Top x 30M	0.5	—	—	0.7	—	—	—	—	—	—	1.0	—	—
PT#8	30M x 50M	1.2	—	—	1.5	—	—	4.8	0.1	—	—	2.8	—	—
PT#8	50M x 100M	2.8	—	—	3.0	—	—	14.5	0.7	—	—	5.7	—	—
PT#8	100M x 200M	5.4	—	—	5.6	—	—	28.9	2.7	—	—	9.2	—	—
PT#8	Top x 200M	9.9	35.6	3.52	10.8	38.6	3.80	20.4	3.5	9.5	1.47	18.7	42.3	4.05
PT#8	200M x 400M	14.9	26.0	3.38	14.6	26.6	3.59	54.7	14.1	9.5	1.90	16.0	45.9	5.16
PT#8	400M x 0	75.2	26.6	2.35	74.6	26.0	2.36	63.3	82.4	14.1	2.13	65.3	48.2	2.73
PT#8	Total	100.0	27.4	2.62	100.0	27.4	2.70	57.8	100.0	13.3	2.07	100.0	46.7	3.37
PT#8	Heads	100.0	26.2	—	100.0	26.2	2.55	59.7	100.0	13.0	2.09	100.0	45.9	—
PT#32	Top x 30M	0.2	—	—	0.2	—	—	0.0	0.0	—	—	0.4	—	—
PT#32	30M x 50M	1.0	—	—	1.3	—	—	6.2	0.1	—	—	2.6	—	—
PT#32	50M x 100M	3.3	—	—	3.2	—	—	18.7	1.0	—	—	7.0	—	—
PT#32	100M x 200M	6.5	—	—	6.4	—	—	38.0	4.0	—	—	10.5	—	—
PT#32	Top x 200M	11.0	43.3	2.84	11.1	49.1	3.20	28.7	5.1	13.4	1.65	20.5	55.4	3.32
PT#32	200M x 400M	15.2	27.4	3.00	15.5	28.9	3.55	60.2	14.8	10.8	1.98	16.0	52.6	4.55
PT#32	400M x 0	73.8	24.8	2.16	73.4	23.7	2.22	67.1	80.1	13.6	2.04	63.5	47.7	2.39
PT#32	Total	100.0	27.3	2.36	100.0	27.3	2.53	61.8	100.0	13.2	2.01	100.0	50.1	2.93
PT#32	Heads	100.0	25.6	—	100.0	25.6	2.47	65.8	100.0	12.9	1.98	100.0	50.1	—

Table 20
PRIMARY MULTIVARIABLE TEST MATRIX
OPTIMUM TESTS, SIZE ANALYSIS RESULTS
(Upper Freeport Seam Coal)

Test Number	Size Fraction USA Mesh	Reconstituted Feed			Actual Feed			Yield (Wt%)	Concentrate			Tailings		
		Weight (Wt%)	Ash (Wt%)	Sulfur (Wt%)	Weight (Wt%)	Ash (Wt%)	Sulfur (Wt%)		Weight (Wt%)	Ash (Wt%)	Sulfur (Wt%)	Weight (Wt%)	Ash (Wt%)	Sulfur (Wt%)
PT#45	Top x 30M													
PT#45	30M x 50M													
PT#45	50M x 100M													
PT#45	100M x 200M													
PT#45	Top x 200M													
PT#45	200M x 400M													
PT#45	400M x 0													
PT#45	Total													
PT#45	Heads	100.0	26.1	2.37	100.0	26.1	2.38	73.4	100.0	12.1	2.12	100.0	64.8	3.05
PT#47	Top x 30M													
PT#47	30M x 50M													
PT#47	50M x 100M													
PT#47	100M x 200M													
PT#47	Top x 200M													
PT#47	200M x 400M													
PT#47	400M x 0													
PT#47	Total													
PT#47	Heads	100.0	28.2	2.68	100.0	28.2	2.75	67.7	100.0	13.5	2.21	100.0	58.8	3.65

Table 21
COMPOSITE 2" COLUMN TEST, SIZE ANALYSIS RESULTS
COMPARING PETC AND PTI LABORATORY DRY GRINDS
(Upper Freeport Seam Coal)

Feed Grind System	Size Fraction USA Mesh	Reconstituted Feed			Actual Feed			Concentrate			Tailings			
		Weight (Wt%)	Ash (Wt%)	Sulfur (Wt%)	Weight (Wt%)	Ash (Wt%)	Sulfur (Wt%)	Yield (Wt%)	Weight (Wt%)	Ash (Wt%)	Sulfur (Wt%)	Weight (Wt%)	Ash (Wt%)	Sulfur (Wt%)
PTI	Top x 30M	0.0	--	--	0.0	--	--	--	0.0	--	--	0.0	--	--
PTI	30M x 50M	0.1	--	--	0.1	--	--	100.0	0.1	--	--	0.0	--	--
PTI	50M x 100M	7.8	--	--	7.8	--	--	77.1	7.5	--	--	9.3	--	--
PTI	100M x 200M	21.5	--	--	21.7	--	--	83.9	22.5	--	--	17.3	--	--
PTI	Top x 200M	29.4	26.7	--	29.6	27.3	2.20	82.1	30.1	13.4	2.04	26.6	87.7	2.21
PTI	200M x 400M	24.6	19.0	--	24.6	20.1	2.75	90.3	27.7	11.7	2.77	12.1	87.0	1.44
PTI	400M x 0	46.0	28.7	--	45.8	27.8	2.05	73.6	42.2	12.4	2.36	61.3	74.0	0.93
PTI	Total	100.0	25.7	--	100.0	25.7	2.27	80.2	100.0	12.5	2.38	100.0	79.2	1.33
PTI	Heads	100.0	25.1	2.10	100.0	25.1	2.12	80.6	100.0	12.0	2.30	100.0	79.7	1.24
PETC	Top x 30M													
PETC	30M x 50M													
PETC	50M x 100M													
PETC	100M x 200M													
PETC	Top x 200M													
PETC	200M x 400M													
PETC	400M x 0													
PETC	Total													
PETC	Heads													

Table 22

47

Table 23
CONVENTIONAL WET SCREENING COMPARISON
PTI LABORATORY DRY GRIND AND PETC PLANT DRY GRIND
Upper Freeport Raw Coal
(Dry Basis)

Size Fraction (USA Mesh)	<u>Lot #3 PTI Lab Grind</u>		<u>Lot #5 PETC Plant Grind</u>	
	Direct (Wt%)	Cum. Passing (Wt%)	Direct (Wt%)	Cum. Passing (Wt%)
Top x 30M	0.0	100.0	0.2	99.8
30M x 50M	0.2	99.8	1.0	98.8
50M x 70M	3.1	96.7	1.0	97.8
70M x 100M	6.2	90.5	1.4	96.4
100M x 200M	22.1	68.4	6.3	90.1
200M x 400M	22.9	45.5	13.0	77.1
400M x 0	<u>45.5</u>	0.0	<u>77.1</u>	0.0
	100.0		100.0	

In addition to the Microtrac size results, Table 23 contains a conventional wet screening comparison of laboratory grind done with PTI's system for Lot #3 of the plant coal, as compared to PETC's plant grind of Lot #5 of the Upper Freeport Raw Coal. One disadvantage of the PETC grind is the much higher percentage of the 400M x 0 in the ground feed (77% vs. 46%). It is also a disadvantage that approximately 1.2% of the feed is +50M in PETC's plant grind as compared to only 0.2% in PTI's laboratory grind. This +50M size fraction is very difficult to recover in the column, especially when high froth wash must be utilized to clean up the large amount of slimes resulting from the fineness of the grind.

Over the last two weeks PETC has been altering the grinding circuit to try to increase the proportion of 100M x 400M in the feed coal resulting from PETC's plant grinding circuit. PETC and GC staff are also working on improving the blending and mixing systems within the plant to try to reduce the variability of the feed coal for PTI's Upper Freeport Seam Coal control testing. Of particular concern is the occasional surges of high ash content feed coal (greater than 30%) that make it very difficult to obtain acceptable yields (greater than 60%) while still maintaining reasonable product qualities (less than 14% product ash). Hopefully these situations will be improved, prior to PTI beginning the control testing on April 19, 1993.

Section 12

Task 1200 - Final Reporting

As mentioned, PTI plans to conduct the control testing for the Upper Freeport Seam Coal in the two-week time period from April 19 through April 30, 1993. PTI then plans to conduct the multivariable testing for the Pittsburgh No. 8 Seam Coal during the entire month of May. The control testing for the Pittsburgh No. 8 coal will then be conducted during the first two weeks of June, with the decommissioning of the plant occurring from June 14 through June 18, 1993.

PTI will be continuing with analytical work and data evaluation at least through the month of July. Therefore the efforts on the final reporting task will not occur until the beginning of August. It will continue for the two-month period from August 1 through September 30, 1993, at which time the Final Report should be completed in final form, allowing the contract to be closed out on schedule.

Appendix A
TEST CONDITIONS AND RESULTS
TO DATE AT PETC/CPPRF

Exhibit A.1: Target Test Conditions For Tests, By Feed Lot

Exhibit A.2: Actual Test Conditions For Tests, By Feed Lot

Exhibit A.3: Grinding Circuit Results For Tests, By Feed Lot

Exhibit A.4: Test Sample Results For Tests, By Feed Lot

Exhibit A.1

TARGET TEST CONDITIONS

(Upper Freeport Seam Raw Coal, Feed Lot #1)

Test	Date	Start Sampling Time	Feed Rate		Reagents (#/T)			Air Rate 50 Psi (CFM)	Froth Height (In.)	Water Additions		Water Type (P/C)	Inner Sleeve (In. O.D.)	
			#/Hr.	GPM	% Solids	M-150	No.2 F.O.			Poly. Acid	Laundry Water (GPM)			Froth Wash (GPM)
CT#2	2/11	1200	300	9.8	6.0	NA	NA	0.0	1.7	28	3.0	C	None	
CT#3	2/11	1338	300	9.8	6.0	NA	NA	0.0	1.7	28	3.0	C	None	
CT#4	2/11	1510	300	9.8	6.0	NA	NA	0.0	1.7	28	3.0	C	None	
CT#5	2/11	1740	300	9.8	6.0	NA	NA	0.0	1.7	28	3.0	C	None	
CT#6	2/12	1214	300	9.8	6.0	NA	NA	0.0	2.5	28	3.0	C	None	
CT#7	2/12	1319	300	9.8	6.0	NA	NA	0.0	2.5	28	3.0	C	None	

NA - Not Available, reagents were not checked and actual settings were unknown.

Exhibit A.1 (cont.)

TARGET TEST CONDITIONS

(Upper Freeport Seam Raw Coal, Feed Lot #2)

Test	Date	Start Sampling Time	Feed Rate		Reagents (#/T)			Air Rate 50 Psi (CFM)	Froth Height (In.)	Water Additions		Water Type (P/C)	Inner Sleeve (In. O.D.)	
			#/Hr.	GPM	% Solids	No.2 F.O. Poly. Acid				Laundry Water (GPM)	Froth Wash (GPM)			
						M-150	No.2 F.O.							Poly. Acid
DT#1	2/23	958	300	9.8	6.0	0.60	0.00	1.7	28	3.0	3.0	P	None	
DT#2	2/23	1055	300	9.8	6.0	0.80	1.00	0.00	1.7	28	3.0	P	None	
DT#4	2/23	1357	300	9.8	6.0	0.80	0.80	0.00	1.7	28	3.0	P	None	
DT#5	2/23	1515	300	9.8	6.0	0.60	0.60	0.00	2.5	28	3.0	P	None	
DT#6	2/23	1606	300	9.8	6.0	0.60	0.60	0.00	1.7	28	3.0	P	None	
PT#1	2/26	851	250	6.5	7.5	0.60	0.60	0.00	1.7	28	2.0	0.7	P	None
PT#2	2/26	936	250	6.5	7.5	0.60	0.60	0.00	1.7	28	2.0	0.7	C	None
PT#3	2/26	1035	250	6.5	7.5	0.70	0.70	0.00	2.5	20	2.0	0.0	P	None
PT#4	2/26	1121	300	7.8	7.5	0.60	0.60	0.00	1.7	20	2.0	0.7	P	None
PT#5	2/26	1200	300	7.8	7.5	0.60	0.60	0.00	1.7	20	2.0	0.7	C	None
PT#6	2/26	1313	300	7.8	7.5	0.60*	0.60	0.00	1.7	20	2.5	0.7	P	None

* MIBC for this test only, all others were with M-150 frother.

Exhibit A.1 (con't.)
TARGET TEST CONDITIONS
 (Upper Freeport Seam Raw Coal, Feed Lot #3)

Test	Date	Start Sampling Time	Feed Rate			Reagents (#/T)			Air Rate 50 Psi (CFM)	Froth Height (In.)	Water Additions			Water Type (P/C)	Inner Sleeve (In. O.D.)
			#/Hr.	GPM	% Solids	MIBC	No.2 F.O.	Poly. Acid			Laundry Water (GPM)	Froth Wash (GPM)			
PT#7	3/02	1242	250	6.5	7.5	0.80	1.00	0.00	3.0	20	3.5	2.5	C	None	
PT#8	3/02	1337	250	6.5	7.5	0.80	1.00	0.00	2.0	20	3.0	2.5	C	None	
PT#9	3/02	1440	250	6.5	7.5	0.80	1.00	0.00	2.0	20	3.0	3.5	C	None	
PT#10	3/02	1610	250	6.5	7.5	0.80	1.00	0.00	3.0	20	3.5	3.5	C	None	
PT#11	3/02	1655	250	6.5	7.5	0.80	1.00	0.00	2.0	28	3.5	1.5	C	None	
PT#12	3/02	1744	250	6.5	7.5	0.80	1.00	0.00	3.0	28	3.5	2.5	C	None	
PT#13	3/02	1830	250	6.5	7.5	0.80	1.00	0.00	2.0	28	3.0	3.0	C	None	
PT#14	3/02	1915	250	6.5	7.5	0.80	1.00	0.00	3.0	28	3.5	3.5	C	None	
PT#15	3/03	1321	250	6.5	7.5	0.80	0.80	0.00	2.0	20	3.5	2.0	C	None	
PT#16	3/03	1410	250	6.5	7.5	0.80	0.80	0.00	2.0	20	3.5	3.5	C	None	
PT#17	3/03	1500	250	6.5	7.5	0.80	0.80	0.00	3.0	20	3.5	2.5	C	None	
PT#18	3/03	1545	250	6.5	7.5	0.80	0.80	0.00	3.0	20	3.5	3.5	C	None	
PT#19	3/03	1630	250	6.5	7.5	0.80	0.80	0.00	2.0	28	3.5	1.5	C	None	
PT#20	3/03	1716	250	6.5	7.5	0.80	0.80	0.00	2.0	28	3.5	3.0	C	None	
PT#21	3/03	1800	250	6.5	7.5	0.80	0.80	0.00	3.0	28	3.5	2.5	C	None	
PT#22	3/03	1846	250	6.5	7.5	0.80	0.80	0.00	3.0	28	3.5	3.5	C	None	
PT#23	3/04	1105	250	6.5	7.5	0.60	0.90	0.00	2.5	20	3.5	3.5	C	None	
PT#24	3/04	1151	250	6.5	7.5	0.60	0.90	0.00	2.5	20	3.5	3.5	C	None	
PT#25	3/04	1253	250	6.5	7.5	0.60	0.90	0.00	2.5	28	3.0	3.0	C	None	
PT#26	3/04	1350	250	9.7	5.0	0.60	0.90	0.00	2.5	20	3.5	3.0	C	None	
PT#27	3/04	1436	250	9.7	5.0	0.60	0.90	0.00	2.5	28	3.5	3.0	C	None	
PT#28	3/05	930	250	6.5	7.5	0.80	1.00	0.00	3.0	20	3.5	3.5	C	11-3/8	
PT#29	3/05	1030	250	6.5	7.5	0.80	1.00	0.00	2.0	20	3.5	3.5	C	11-3/8	
PT#30	3/08	1010	250	6.5	7.5	0.80	1.00	0.00	3.0	28	3.5	2.5	C	11-3/8	
PT#31	3/08	1055	250	6.5	7.5	0.80	0.80	0.00	3.0	20	3.5	3.5	C	11-3/8	
PT#32	3/08	1140	250	6.5	7.5	0.80	0.80	0.00	3.0	28	3.5	2.5	C	11-3/8	
PT#33	3/08	1225	250	6.5	7.5	0.80	0.80	0.00	3.0	28	3.5	2.5	C	11-3/8	

Exhibit A.1

TARGET TEST CONDITIONS
(Upper Freeport Seam Raw Coal, Feed Lot #4)

Test	Date	Sampling Time	Feed Rate		Reagents (%T)			Air Rate 50 Psi (CFM)	Froth Height (In.)	Water Additions		Water Type (P/C)	Inner Sieve (In. O.D.)
			#/Hr.	GPM	% Solids	MIBC	No.2 F.O.	Poly. Acid		Laundry Water (GPM)	Froth Wash (GPM)		
FT#1	3/10	1052	250	6.5	7.5	0.90	1.10	0.00	1.5	3.5	3.0	C	None
FT#2	3/10	1145	250	8.1	6.0	0.95	1.15	0.00	1.5	3.5	3.0	C	None
FT#3	3/10	1250	200	6.5	6.0	1.00	1.20	0.00	1.5	3.5	3.0	C	None
FT#4	3/10	1335	200	6.5	6.0	1.00	1.20	0.00	1.5	3.5	0.8	C	None
FT#5	3/10	1425	200	7.8	5.0	1.05	1.30	0.00	1.5	3.5	3.0	C	None
FT#6	3/10	1510	200	6.5	6.0	1.00	1.20	0.00	1.5	3.5	3.0	P	None
FT#7	3/10	1555	250	6.5	7.5	0.90	1.10	0.00	1.5	3.5	3.0	P	None
FT#8	3/11	1230	250	7.5	6.5	1.00	1.80	0.00	1.2	3.5	0.8	C	None
FT#9	3/11	1310	250	7.5	6.5	1.00	1.80	0.00	1.2	3.5	0.8	C	None
FT#10	3/11	1356	250	7.5	6.5	1.00	1.80	0.00	1.7	3.5	0.8	C	None
FT#11	3/11	1430	250	7.5	6.5	1.00	1.80	0.00	1.0	3.5	0.8	C	None
FT#12	3/11	1506	250	6.5	7.5	1.00	2.00	0.00	1.5	3.5	3.5	C	None
FT#13	3/11	1540	250	6.5	7.5	1.00	2.00	0.00	2.0	3.5	4.0	C	None
FT#14	3/11	1620	250	6.5	7.5	1.00	2.00	0.00	2.0	3.5	3.5	C	None
FT#15	3/11	1642	250	6.5	7.5	1.00	2.00	0.00	1.5	3.5	3.5	C	None
FT#16	3/11	1720	200	5.2	7.5	1.00	2.00	0.00	1.5	3.5	3.0	C	None
FT#17	3/11	1753	200	5.2	7.5	1.00	2.00	0.00	1.5	3.5	3.5	C	None
FT#18	3/11	1825	200	5.2	7.5	0.70	1.40	0.00	1.5	3.5	3.5	C	None
FT#19	3/11	1855	200	7.8	5.2	0.70	1.40	0.00	1.5	3.5	0.8	C	None
FT#20	3/16	925	250	8.1	6.0	1.20	2.00	0.00	1.2	3.5	1.0	C	None
FT#21	3/16	1012	250	8.1	6.0	1.20	2.00	0.60	1.2	3.5	1.0	C	None
FT#22	3/16	1101	250	8.1	6.0	1.20	2.00	1.20	1.2	3.5	1.0	C	None
FT#23	3/16	1213	250	6.1	8.0	1.20	2.00	0.00	1.2	3.5	3.0	C	None
FT#24	3/16	1311	250	6.1	8.0	1.20	2.00	0.00	1.2	3.5	3.0	C	None
FT#25	3/16	1439	250	6.1	8.0	1.20	2.00	1.20	1.2	3.5	3.0	C	None
FT#26	3/16	1535	250	6.1	8.0	1.20	2.00	0.00	1.5	3.5	3.0	C	None
FT#27	3/16	1745	250	6.1	8.0	1.20	2.00	1.20	1.5	3.5	3.0	C	None
FT#28	3/16	1838	250	8.1	6.0	1.20	2.00	0.00	1.5	3.5	1.0	C	None
FT#29	3/16	1930	250	6.1	8.0	1.20	2.00	0.00	1.5	3.5	3.0	C	None

Note: - The solids feed rate for FT#27 through FT#29 was much lower than expected due to grinding circuit problems. Those 3 tests will need to be repeated.

Exhibit A.1
TARGET TEST CONDITIONS
(Upper Freeport Seam Raw Coal, Feed Lot #4)

Test	Date	Start Sampling Time	Feed Rate		Reagents (#/T)			Air Rate 50 Psi (CFM)	Froth Height (In.)	Water Additions		Water Type (P/C)	Inner Sleeve (In. O.D.)
			#/Hr.	GPM	% Solids	MIBC	No. 2 F.O.	Poly. Acid		Laundry Water (GPM)	Froth Wash (GPM)		
FT#30	3/17	1110	250	6.1	8.0	1.20	2.00	1.20	1.5	3.5	3.0	City	None
FT#31	3/17	1155	250	8.1	6.0	1.20	2.00	0.00	1.5	3.5	1.0	City	None
FT#32	3/17	1250	250	6.1	8.0	0.90	2.00	0.00	1.5	3.5	3.0	City	None
FT#33	3/17	1350	250	6.1	8.0	0.90	2.00	0.60	1.5	3.5	3.0	City	None
FT#34	3/17	1435	250	6.1	8.0	0.90	2.00	0.60	1.5	3.5	3.0	City	None
FT#35	3/17	1615	250	6.1	8.0	0.90	2.00	1.20	1.5	3.5	3.0	City	None
FT#36	3/17	1700	250	8.1	6.0	0.90	2.00	0.00	1.5	3.5	1.0	City	None
FT#37	3/17	1745	250	8.1	6.0	0.90	2.00	1.20	1.5	3.5	1.0	City	None
FT#38	3/17	1830	250	8.1	6.0	0.90	2.00	0.00	1.2	3.5	1.0	City	None
FT#39	3/17	1945	250	6.1	8.0	0.90	2.00	0.00	1.2	3.5	3.0	City	None
FT#40	3/18	1350	250	6.1	8.0	0.90	2.00	1.20	1.2	3.5	3.0	City	None
FT#41	3/18	1445	250	8.1	6.0	0.90	2.00	0.00	1.5	3.5	1.0	City	None
FT#42	3/18	1530	250	6.1	8.0	0.90	2.00	0.00	1.5	3.5	3.0	City	None
FT#43	3/18	1648	250	6.1	8.0	0.90	2.00	1.20	1.5	3.5	3.0	City	None
FT#44	3/18	1733	250	6.1	8.0	0.90	2.00	1.20	1.5	3.5	3.0	City	None
FT#45	3/18	1825	250	6.1	8.0	1.20	2.00	1.20	1.5	3.5	3.0	City	None
FT#46	3/18	1910	250	8.1	6.0	1.20	2.00	0.00	1.5	3.5	1.0	City	None

Exhibit A.1
TARGET TEST CONDITIONS
 (Upper Freeport Seam Raw Coal, Feed Lot #5)

Test	Date	Start Sampling Time	Feed Rate			Reagents (#/T)			Air Rate 50 Psi (CFM)	Froth Height (In.)	Water Additions		Water Type (P/C)	Inner Sleeve (In. O.D.)
			#/Hr.	GPM	% Solids	MIBC	No.2 F.O.	Poly. Acid			Laundry Water (GPM)	Froth Wash (GPM)		
FT#47	3/22	1245	250	6.1	8.0	1.20	2.00	0.00	1.5	36	3.5	3.0	City	None
FT#48	3/22	1340	250	6.1	8.0	0.80	1.60	0.00	1.5	24	3.5	3.0	City	None
FT#49	3/22	1430	250	6.1	8.0	0.80	1.60	1.00	1.5	24	3.5	3.0	City	None
FT#50	3/22	1535	250	6.1	8.0	0.80	1.60	0.00	2.0	24	3.5	3.0	City	None
FT#51	3/22	1635	190	6.1	6.0	1.05	2.10	0.00	1.5	24	3.5	3.0	City	None
FT#52	3/22	1735	190	6.1	6.0	1.05	2.10	1.32	1.5	24	3.5	3.0	City	None
FT#53	3/22	1830	190	6.1	6.0	1.05	2.10	0.00	2.0	24	3.5	3.0	City	None
FT#54	3/22	1915	190	6.1	6.0	1.05	2.10	0.00	1.5	36	3.5	3.0	City	None
FT#55	3/23	955	190	6.1	6.0	1.05	2.10	1.32	1.5	36	3.5	3.0	City	None
FT#56	3/23	1045	190	6.1	6.0	1.05	2.10	0.00	2.0	36	3.5	3.0	City	None
FT#57	3/23	1150	250	6.1	8.0	0.80	1.60	0.00	1.5	36	3.5	3.0	City	None
FT#58	3/23	1245	250	6.1	8.0	0.80	1.60	1.00	1.5	36	3.5	3.0	City	None
FT#59	3/23	1335	250	6.1	8.0	0.80	1.60	0.00	2.0	36	3.5	3.0	City	None
FT#60	3/23	1440	250	6.1	8.0	1.20	2.00	0.00	1.5	24	3.5	3.0	City	None
FT#61	3/23	1520	250	6.1	8.0	1.20	2.00	0.00	1.5	24	3.5	3.0	City	None
FT#62	3/23	1625	250	6.1	8.0	0.90	2.00	0.00	1.5	36	3.5	3.0	Process	None
FT#63	3/23	1715	250	6.1	8.0	0.90	2.00	0.00	1.5	36	3.5	3.0	Process	None
FT#64	3/25	1200	250	6.1	8.0	1.00	2.00	0.00	1.5	24	3.5	3.0	City	11-3/8
FT#65	3/25	1305	250	6.1	8.0	1.00	2.00	1.00	1.5	24	3.5	3.0	City	11-3/8
FT#66	3/25	1400	250	6.1	8.0	1.00	2.00	0.00	2.0	24	3.5	3.0	City	11-3/8
FT#67	3/25	1450	190	6.1	6.0	1.31	2.62	0.00	1.5	24	3.5	3.0	City	11-3/8
FT#68	3/25	1550	190	6.1	6.0	1.31	2.62	1.32	1.5	24	3.5	3.0	City	11-3/8
FT#69	3/25	1655	190	6.1	6.0	1.31	2.62	0.00	2.0	24	3.5	3.0	City	11-3/8
FT#70	3/25	1750	190	6.1	6.0	1.31	2.62	0.00	1.5	36	3.5	3.0	City	11-3/8
FT#71	3/25	1835	190	6.1	6.0	1.31	2.62	0.00	1.5	36	3.5	3.0	City	11-3/8
FT#72	3/25	1925	190	6.1	6.0	1.31	2.62	1.32	1.5	36	3.5	3.0	City	11-3/8
FT#73	3/25	2010	190	6.1	6.0	1.31	2.62	0.00	2.0	36	3.5	3.0	City	11-3/8

Exhibit A.1
TARGET TEST CONDITIONS
(Upper Freeport Seam Raw Coal, Feed Lot #5)

Test	Date	Start Sampling Time	Feed Rate		Reagents (#/T)			Air Rate 50 Psi (CFM)	Froth Height (In.)	Water Additions		Water Type (P/C)	Inner Sleeve (In. O.D.)
			#/Hr.	GPM	% Solids	MIBC	No.2 F.O.	Poly. Acid		Laundry Water (GPM)	Froth Wash (GPM)		
FT#74	3/26	815	250	6.1	8.0	1.00	2.00	0.00	1.5	3.5	3.0	City	11-3/8
FT#75	3/26	905	250	6.1	8.0	1.00	2.00	1.00	1.5	3.5	3.0	City	11-3/8
FT#76	3/26	1000	250	6.1	8.0	1.00	2.00	0.00	2.0	3.5	3.0	City	11-3/8
FT#77	3/26	1040	250	6.1	8.0	1.00	2.00	0.00	2.0	3.5	3.0	City	11-3/8
FT#78	3/26	1135	250	6.1	8.0	1.00	2.00	0.00	1.5	3.5	4.0	City	11-3/8
FT#79	3/26	1245	250	6.1	8.0	1.00	2.00	1.00	1.5	3.5	4.0	City	11-3/8
FT#80	3/26	1335	250	6.1	8.0	1.00	2.00	0.00	1.5	3.5	4.0	City	11-3/8
FT#81	3/26	1435	250	6.1	8.0	1.00	2.00	1.00	1.5	3.5	4.0	City	11-3/8
FT#82	3/30	1035	300	8.0	7.3	1.00	2.00	0.00	1.5	2.0	2.5	City	11-3/4
FT#83	3/30	1130	300	6.0	9.7	1.00	2.00	0.00	1.5	2.0	2.5	City	11-3/4
FT#84	3/30	1245	300	4.5	12.7	1.00	2.00	0.00	1.5	3.5	2.5	City	11-3/4
FT#85	3/30	1355	150	8.0	3.7	1.00	2.00	0.00	1.5	3.5	2.5	City	11-3/4
FT#86	3/30	1445	150	6.0	4.9	1.00	2.00	0.00	1.5	3.5	2.5	City	11-3/4
FT#87	3/30	1605	150	4.5	6.5	1.00	2.00	0.00	1.5	3.5	2.5	City	11-3/4

Exhibit A.2
ACTUAL TEST CONDITIONS
(Upper Freeport Seam Raw Coal, Feed Lot #1)

Test	Date	Start Sampling Time	Feed Rate		Reagents (#/T)			Air Rate 50 Psi (CFM)	Froth Height (In.)	Flow Balance Results					
			#/Hr.	GPM	% Solids	M-150	No.2 F.O.			Poly. Acid	Laundry Water (GPM)	Froth Wash (GPM)	Tails Flow (GPM)	Conc. Flow (GPM)	Diluted Conc. Flow (GPM)
CT#2	2/11	1200	323	9.8	6.4	NA	NA	0.00	1.7	28	3.0	3.0	11.5	1.3	4.3
CT#3	2/11	1338	320	9.7	6.4	NA	NA	0.00	1.7	28	3.0	3.0	11.2	1.5	4.5
CT#4	2/11	1510	323	9.8	6.4	NA	NA	0.00	1.7	28	3.0	3.0	11.1	1.7	4.7
CT#5	2/11	1740	298	9.8	5.9	NA	NA	0.00	1.7	28	3.0	3.0	11.6	1.2	4.2
CT#6	2/12	1214	318	9.8	6.3	NA	NA	0.00	2.5	28	3.0	3.0	10.9	1.9	4.9
CT#7	2/12	1319	313	9.8	6.2	NA	NA	0.00	2.5	28	3.0	3.0	10.9	1.9	4.9

NA - Not Available, reagents were not checked and actual settings were unknown.

Exhibit A.2 (con't.)
ACTUAL TEST CONDITIONS
(Upper Freeport Seam Raw Coal, Feed Lot #2)

Test	Date	Start Sampling Time	Feed Rate		Reagents (#/T)			Air Rate 50 Psi (CFM)	Froth Height (In.)	Flow Balance Results					
			#/Hr.	GPM	% Solids	M-150	No.2 F.O.			Poly. Acid	Launder Water (GPM)	Froth Wash (GPM)	Tails Flow (GPM)	Conc. Flow (GPM)	Diluted Conc. Flow (GPM)
DT#1	2/23	958	313	9.8	6.2	0.58	0.77	0.00	1.7	28	3.0	3.0	NA	NA	NA
DT#2	2/23	1055	313	9.8	6.2	0.76	0.98	0.00	1.7	28	3.0	3.0	NA	NA	NA
DT#4	2/23	1357	308	9.8	6.1	0.78	0.78	0.00	1.7	28	3.0	3.0	NA	NA	NA
DT#5	2/23	1515	293	9.8	5.8	0.60	0.60	0.00	2.5	28	3.0	3.0	NA	NA	NA
DT#6	2/23	1606	278	9.8	5.5	0.64	0.65	0.00	1.7	28	3.0	3.0	NA	NA	NA
PT#1	2/26	851	268	6.5	8.0	0.55	0.57	0.00	1.7	28	2.0	0.7	NA	NA	NA
PT#2	2/26	936	235	6.5	7.0	0.63	0.65	0.00	1.7	28	2.0	0.7	NA	NA	NA
PT#3	2/26	1035	201	6.5	6.0	0.90	0.91	0.00	2.5	20	2.0	0.0	NA	NA	NA
PT#4	2/26	1121	294	7.8	7.3	0.59	0.60	0.00	1.7	20	2.0	0.7	NA	NA	NA
PT#5	2/26	1200	314	7.8	7.8	0.57	0.58	0.00	1.7	20	2.0	0.7	NA	NA	NA
PT#6	2/26	1313	306	7.8	7.6	0.58*	0.60	0.00	1.7	20	2.5	0.7	NA	NA	NA

Note: * MIBC for this test only, all others were with M-150 frother.

- NA - Data logging program failed during these tests, so this data was unavailable.

Exhibit A.2 (con't.)
ACTUAL TEST CONDITIONS
(Upper Freeport Seam Raw Coal, Feed Lot #3)

Test	Date	Start Sampling Time	Feed Rate		Reagents (#/T)			Air Rate 50 Psi (CFM)	Froth Height (In.)	Flow Balance Results				
										Launder Water (GPM)	Froth Wash (GPM)	Tails Flow (GPM)	Conc. Flow (GPM)	Diluted Conc. Flow (GPM)
			#/Hr.	GPM	% Solids	MIBC	No.2 F.O.	Poly. Acid						
PT#7	3/02	1242	238	6.5	7.1	0.86	1.04	0.00	3.0	3.5	2.5	4.3	4.7	8.2
PT#8	3/02	1337	241	6.5	7.2	0.82	1.05	0.00	2.0	3.0	2.5	5.3	3.7	6.7
PT#9	3/02	1440	244	6.4	7.4	0.84	1.02	0.00	2.0	3.0	3.5	6.4	3.5	6.5
PT#10	3/02	1610	265	6.5	7.9	0.77	0.94	0.00	3.0	3.5	3.5	5.2	4.8	8.3
PT#11	3/02	1655	211	6.4	6.4	0.97	1.18	0.00	2.0	3.5	1.5	4.3	3.6	7.1
PT#12	3/02	1744	254	6.4	7.7	0.83	0.99	0.00	3.0	3.5	2.5	4.3	4.6	8.1
PT#13	3/02	1830	258	6.5	7.7	0.80	0.99	0.00	2.0	3.0	3.0	6.4	3.1	6.1
PT#14	3/02	1915	245	6.5	7.3	0.85	1.04	0.00	3.0	3.5	3.5	5.6	4.4	7.9
PT#15	3/03	1321	231	6.5	6.9	0.83	0.87	0.00	2.0	3.5	2.0	5.1	3.4	6.9
PT#16	3/03	1410	251	6.5	7.5	0.79	0.82	0.00	2.0	3.5	3.5	7.0	3.0	6.5
PT#17	3/03	1500	278	6.5	8.3	0.72	0.72	0.00	3.0	3.5	2.5	4.5	4.5	8.0
PT#18	3/03	1545	284	6.4	8.6	0.70	0.71	0.00	3.0	3.5	3.5	5.6	4.3	7.8
PT#19	3/03	1630	265	6.5	7.9	0.77	0.75	0.00	2.0	3.5	1.5	4.6	3.4	6.9
PT#20	3/03	1716	251	6.5	7.5	0.79	0.81	0.00	2.0	3.5	3.0	6.3	3.2	6.7
PT#21	3/03	1800	255	6.5	7.6	0.77	0.79	0.00	3.0	3.5	2.5	4.7	4.3	7.8
PT#22	3/03	1846	265	6.5	7.9	0.75	0.74	0.00	3.0	3.5	3.5	5.9	4.1	7.6
PT#23	3/04	1105	265	6.5	7.9	0.56	0.85	0.00	2.5	3.5	3.5	6.1	3.9	7.4
PT#24	3/04	1151	245	6.5	7.3	0.60	0.92	0.00	2.5	3.5	3.5	6.2	3.8	7.3
PT#25	3/04	1253	245	6.5	7.3	0.61	0.91	0.00	2.5	3.5	3.0	6.0	3.5	7.0
PT#26	3/04	1350	290	9.7	5.8	0.51	0.77	0.00	2.5	3.5	3.0	9.4	3.3	6.8
PT#27	3/04	1436	255	9.7	5.1	0.58	0.88	0.00	2.5	3.5	3.0	9.6	3.1	6.6
PT#28	3/05	930	287	6.4	8.7	0.71	0.87	0.00	3.0	3.5	3.5	5.5	4.4	7.9
PT#29	3/05	1030	257	6.4	7.8	0.80	0.97	0.00	2.0	3.5	3.5	6.9	3.0	6.5
PT#30	3/08	1010	244	6.4	7.4	0.83	1.00	0.00	3.0	3.5	2.5	4.7	4.2	7.7
PT#31	3/08	1055	244	6.4	7.4	0.83	0.82	0.00	3.0	3.5	3.5	5.6	4.3	7.8
PT#32	3/08	1140	241	6.4	7.3	0.83	0.81	0.00	3.0	3.5	2.5	4.9	4.0	7.5
PT#33	3/08	1225	268	6.5	8.0	0.75	0.74	0.00	3.0	3.5	2.5	4.9	4.1	7.6

Exhibit A.2
ACTUAL TEST CONDITIONS
(Upper Freeport Seam Raw Coal, Feed Lot #4)

Test	Date	Start Sampling Time	Feed Rate		Reagents (#/T)			Air Rate 50 Psi (CFM)	Froth Height (In.)	Flow Balance Results			
			#/Hr.	GPM	% Solids	MIBC	No.2 F.O.	Poly Acid		Laundry Water (GPM)	Froth Wash (GPM)	Tails Flow (GPM)	Conc. Flow (GPM)
FT#1	3/10	1052	258	6.5	7.7	0.89	1.10	0.00	1.5	3.5	3.0	5.9	3.6
FT#2	3/10	1145	252	8.0	6.1	0.94	1.12	0.00	1.5	3.5	3.0	7.5	3.5
FT#3	3/10	1250	194	6.5	5.8	1.01	1.24	0.00	1.5	3.5	3.0	6.5	3.0
FT#4	3/10	1335	204	6.5	6.1	0.96	1.19	0.00	1.5	3.5	0.8	4.2	3.1
FT#5	3/10	1425	193	7.8	4.8	1.07	1.34	0.00	1.5	3.5	3.0	8.0	2.8
FT#6	3/10	1510	204	6.5	6.1	0.98	1.19	0.00	1.5	3.5	3.0	6.4	3.1
FT#7	3/10	1555	257	6.4	7.8	0.86	1.08	0.00	1.5	3.5	3.0	5.7	3.7
FT#8	3/11	1230	232	7.5	6.1	1.08	1.96	0.00	1.2	3.5	0.8	4.9	3.4
FT#9	3/11	1310	224	7.5	5.8	1.10	2.01	0.00	1.2	3.5	0.7	5.2	3.0
FT#10	3/11	1356	240	7.4	6.3	1.05	1.91	0.00	1.7	3.5	0.7	4.2	3.9
FT#11	3/11	1430	255	7.5	6.6	0.97	1.77	0.00	1.0	3.5	0.7	5.0	3.2
FT#12	3/11	1506	257	6.4	7.8	0.96	1.96	0.00	1.5	3.5	3.5	6.1	3.8
FT#13	3/11	1540	268	6.5	8.0	0.93	1.90	0.00	2.0	3.5	4.0	6.1	4.4
FT#14	3/11	1620	278	6.5	8.3	0.91	1.82	0.00	2.0	3.5	3.5	5.7	4.3
FT#15	3/11	1642	271	6.4	8.2	0.93	1.86	0.00	1.5	3.5	3.5	6.2	3.7
FT#16	3/11	1720	223	5.2	8.3	0.90	1.81	0.00	1.5	3.5	3.0	4.9	3.3
FT#17	3/11	1753	223	5.2	8.3	0.90	1.81	0.00	1.5	3.5	3.5	5.3	3.4
FT#18	3/11	1825	206	5.2	7.7	0.65	1.39	0.00	1.5	3.5	3.5	6.0	2.7
FT#19	3/11	1855	193	7.5	5.0	0.72	1.48	0.00	1.5	3.5	1.0	5.7	2.8
FT#20	3/16	925	297	8.1	7.1	0.99	1.72	0.00	1.2	3.5	1.0	5.7	3.4
FT#21	3/16	1012	242	8.1	5.8	1.22	2.11	0.64	1.2	3.5	1.0	5.7	3.4
FT#22	3/16	1101	272	8.1	6.5	1.08	1.88	1.14	1.2	3.5	1.0	5.6	3.5
FT#23	3/16	1213	277	6.1	8.8	1.08	1.83	0.00	1.2	3.5	3.0	5.4	3.7
FT#24	3/16	1311	274	6.1	8.7	1.09	1.88	0.00	1.2	3.5	3.0	5.5	3.6
FT#25	3/16	1439	261	6.1	8.3	1.15	1.95	1.19	1.2	3.5	3.0	5.4	3.7
FT#26	3/16	1535	252	6.1	8.0	1.20	2.00	0.00	1.5	3.5	3.0	5.1	4.0
FT#27	3/16	1745	91	6.1	2.9	3.30	5.60	3.21	1.5	3.5	3.0	6.4	2.7
FT#28	3/16	1838	138	8.1	3.3	2.19	3.75	0.00	1.5	3.5	1.0	7.1	2.0
FT#29	3/16	1930	164	6.1	5.2	1.84	3.14	0.00	1.5	3.5	3.0	7.9	1.2

Exhibit A.2
ACTUAL TEST CONDITIONS
(Upper Freeport Seam Raw Coal, Feed Lot #4)

Test	Date	Start Sampling Time	Feed Rate		Reagents (#/T)			Air Rate 50 Psi (CFM)	Froth Height (In.)	Flow Balance Results					
			#/hr.	GPM	% Solids	MIBC	No.2 F.O.			Poly. Acid	Launder Water (GPM)	Froth Wash (GPM)	Tails Flow (GPM)	Conc. Flow (GPM)	Diluted Conc. Flow (GPM)
FT#30	3/17	1110	289	6.1	9.2	1.04	1.74	1.00	1.5	36	3.5	3.0	5.2	3.9	7.4
FT#31	3/17	1155	259	8.1	6.2	1.16	1.96	0.00	1.5	36	3.5	1.0	5.4	3.7	7.2
FT#32	3/17	1250	246	6.2	7.7	0.91	2.07	0.00	1.5	24	3.5	3.0	5.3	3.9	7.4
FT#33	3/17	1350	252	6.1	8.0	0.88	2.02	0.58	1.5	24	3.5	3.0	5.3	3.8	7.3
FT#34	3/17	1435	278	6.2	8.7	0.81	1.83	0.52	1.5	24	3.5	3.0	5.3	3.9	7.4
FT#35	3/17	1615	249	6.1	7.9	0.90	2.05	1.16	1.5	24	3.5	3.0	5.4	3.7	7.2
FT#36	3/17	1700	240	8.1	5.9	0.89	2.05	0.00	1.5	24	3.5	1.0	5.1	4.0	7.5
FT#37	3/17	1745	259	8.1	6.2	0.87	1.98	1.11	1.5	24	3.5	1.0	5.0	4.1	7.6
FT#38	3/17	1830	280	8.1	6.7	0.80	1.82	0.00	1.2	24	3.5	1.0	5.5	3.6	7.1
FT#39	3/17	1945	293	6.1	9.3	0.78	1.75	0.00	1.2	24	3.5	3.0	5.7	3.4	6.9
FT#40	3/18	1350	245	6.1	7.8	0.91	2.05	1.17	1.2	24	3.5	3.0	5.7	3.4	6.9
FT#41	3/18	1445	259	8.1	6.2	0.86	1.95	0.00	1.5	36	3.5	1.0	5.5	3.6	7.1
FT#42	3/18	1530	261	6.1	8.3	0.85	1.91	0.00	1.5	36	3.5	3.0	5.1	4.0	7.5
FT#43	3/18	1648	258	6.1	8.2	0.87	1.96	1.11	1.5	36	3.5	3.0	4.9	4.2	7.7
FT#44	3/18	1733	245	6.1	7.8	0.93	2.06	1.19	1.5	36	3.5	3.0	4.7	4.4	7.9
FT#45	3/18	1825	286	6.1	9.1	1.06	1.77	1.01	1.5	24	3.5	3.0	4.7	4.4	7.9
FT#46	3/18	1910	272	8.1	6.5	1.19	1.85	0.00	1.5	24	3.5	1.0	5.2	3.9	7.4

Exhibit A.2
ACTUAL TEST CONDITIONS
(Upper Freeport Seam Raw Coal, Feed Lot #5)

Test	Date	Start Sampling Time	Feed Rate		Reagents (#/T)			Air Rate 50 Psi (CFM)	Froth Height (In.)	Flow Balance Results				
			#/Hr.	GPM	% Solids	MIBC	No.2 F.O.	Poly. Acid		Launder Water (GPM)	Froth Wash (GPM)	Tails Flow (GPM)	Conc. Flow (GPM)	Diluted Conc. Flow (GPM)
FT#47	3/22	1245	280	6.1	8.9	1.08	1.84	0.00	1.5	3.5	3.0	5.1	4.0	7.5
FT#48	3/22	1340	264	6.1	8.4	0.76	1.51	0.00	1.5	3.5	3.0	5.5	3.6	7.1
FT#49	3/22	1430	255	6.1	8.1	0.76	1.57	0.96	1.5	3.5	3.0	5.9	3.2	6.7
FT#50	3/22	1535	261	6.1	8.3	0.74	1.50	0.00	2.0	3.5	3.0	5.3	3.8	7.3
FT#51	3/22	1635	204	6.1	6.5	0.97	1.91	0.00	1.5	3.5	3.0	6.2	2.9	6.4
FT#52	3/22	1735	201	6.2	6.3	0.99	1.99	1.25	1.5	3.5	3.0	6.2	3.0	6.5
FT#53	3/22	1830	195	6.1	6.2	1.03	2.04	0.00	2.0	3.5	3.0	6.0	3.1	6.6
FT#54	3/22	1915	189	6.2	5.9	1.07	2.10	0.00	1.5	3.5	3.0	6.5	2.7	6.2
FT#55	3/23	955	145	6.1	4.6	1.38	2.84	1.72	1.5	3.5	3.0	6.5	2.6	6.1
FT#56	3/23	1045	138	6.1	4.4	1.43	2.93	0.00	2.0	3.5	3.0	6.4	2.7	6.2
FT#57	3/23	1150	252	6.1	8.0	0.80	1.61	0.00	1.5	3.5	3.0	5.9	3.2	6.7
FT#58	3/23	1245	249	6.1	7.9	0.80	1.62	1.01	1.5	3.5	3.0	6.0	3.1	6.6
FT#59	3/23	1335	223	6.1	7.1	0.90	1.82	0.00	2.0	3.5	3.0	5.7	3.4	6.9
FT#60	3/23	1440	249	6.1	7.9	1.17	1.98	0.00	1.5	3.5	3.0	5.2	3.9	7.4
FT#61	3/23	1520	245	6.1	7.8	0.94	2.03	0.00	1.5	3.5	3.0	5.3	3.8	7.3
FT#62	3/23	1525	264	6.1	8.4	0.86	1.89	0.00	1.5	3.5	3.0	5.5	3.6	7.1
FT#63	3/23	1715	249	6.1	7.9	0.92	2.04	0.00	1.5	3.5	3.0	5.4	3.7	7.2
FT#64	3/25	1200	255	6.1	8.1	0.99	2.00	0.00	1.5	3.5	3.0	5.9	3.2	6.7
FT#65	3/25	1305	252	6.1	8.0	1.00	2.00	1.01	1.5	3.5	3.0	5.9	3.2	6.7
FT#66	3/25	1400	255	6.1	8.1	0.99	1.96	0.00	2.0	3.5	3.0	5.4	3.7	7.2
FT#67	3/25	1450	211	6.1	6.7	1.21	2.37	0.00	1.5	3.5	3.0	6.1	3.0	6.5
FT#68	3/25	1550	192	6.1	6.1	1.33	2.63	1.32	1.5	3.5	3.0	6.0	3.1	6.6
FT#69	3/25	1655	214	6.1	6.8	1.19	2.38	0.00	2.0	3.5	3.0	5.9	3.2	6.7
FT#70	3/25	1750	198	6.1	6.3	1.26	2.56	0.00	1.5	3.5	3.0	6.5	2.6	6.1
FT#71	3/25	1835	182	6.1	5.8	1.40	2.78	0.00	1.5	3.5	3.0	6.5	2.6	6.1
FT#72	3/25	1925	192	6.1	6.1	1.33	2.62	1.29	1.5	3.5	3.0	6.4	2.7	6.2
FT#73	3/25	2010	205	6.2	6.4	1.24	2.47	0.00	2.0	3.5	3.0	6.4	2.8	6.3

Exhibit A.2
ACTUAL TEST CONDITIONS
(Upper Freeport Seam Raw Coal, Feed Lot #5)

Test	Date	Start Sampling Time	Feed Rate				Reagents (#/T)			Air Rate 50 Psi (CFM)	Froth Height (In.)	Flow Balance Results					
			#/Hr.	GPM	% Solids	MIBC	No.2 F.O.	Poly. Acid	Launder Water (GPM)			Froth Wash (GPM)	Tails Flow (GPM)	Conc. Flow (GPM)	Diluted Conc. Flow (GPM)		
FT#74	3/26	815	242	6.1	7.7	1.04	2.08	0.00	1.5	36	3.5	3.0	6.0	3.1	6.6		
FT#75	3/26	905	267	6.1	8.5	0.95	1.92	0.94	1.5	36	3.5	3.0	6.1	3.0	6.5		
FT#76	3/26	1000	267	6.1	8.5	0.95	1.87	0.00	2.0	36	3.5	3.0	5.8	3.3	6.8		
FT#77	3/26	1040	264	6.1	8.4	0.94	1.90	0.00	2.0	36	3.5	3.0	5.6	3.5	7.0		
FT#78	3/26	1135	248	5.4	8.9	1.04	1.99	0.00	1.5	24	3.5	4.0	6.2	3.2	6.7		
FT#79	3/26	1245	259	5.4	9.3	0.98	1.96	0.96	1.5	36	3.5	4.0	7.3	2.1	5.6		
FT#80	3/26	1335	317	5.4	9.6	0.80	1.59	0.00	1.5	24	3.5	4.0	6.3	3.1	6.6		
FT#81	3/26	1435	259	5.4	9.3	0.98	1.93	0.96	1.5	36	3.5	4.0	7.3	2.1	5.6		
FT#82	3/30	1035	314	8.0	7.6	0.96	1.97	0.00	1.5	24	2.0	2.5	6.2	4.3	6.3		
FT#83	3/30	1130	300	6.0	9.7	1.01	2.04	0.00	1.5	24	2.0	2.5	4.5	4.0	6.0		
FT#84	3/30	1245	306	4.5	13.2	0.99	2.00	0.00	1.5	24	3.5	2.5	2.8	4.2	7.7		
FT#85	3/30	1355	173	8.0	4.2	0.84	1.72	0.00	1.5	24	3.5	2.5	8.4	2.1	5.6		
FT#86	3/30	1445	195	6.0	6.3	0.74	1.50	0.00	1.5	24	3.5	2.5	6.5	2.0	5.5		
FT#87	3/30	1605	161	4.6	6.8	0.89	1.87	0.00	1.5	24	3.5	2.5	4.8	2.3	5.8		

Exhibit A.3
GRINDING CIRCUIT RESULTS
(Upper Freeport Seam Raw Coal, Feed Lot #1)

Test	Date	Start Sampling Time	Feed Rate		Feed Sump Water (GPM)	Hammer Mill Screen (In.)	Dry Screening Results				Wet Screening Results			
			#/Hr.	GPM			% Solids	+30M (Wt%)	+50M (Wt%)	+100M (Wt%)	+30M (Wt%)	+50M (Wt%)	+100M (Wt%)	-400M (Wt%)
CT#2	2/11	1200	323	9.8			6.4							
CT#3	2/11	1338	320	9.7			6.4							
CT#4	2/11	1510	323	9.8			6.4							
CT#5	2/11	1740	298	9.8			5.9							
CT#6	2/12	1214	318	9.8			6.3							
CT#7	2/12	1319	313	9.8			6.2							

** No Data Available **

Exhibit A.3
GRINDING CIRCUIT RESULTS
(Upper Freeport Seam Raw Coal, Feed Lot # 2)

Test	Date	Start Sampling Time	Hammer Mill Screen	Feed Rate		Feed Sump Water (GPM)	Feed Sump Level (%)	Dry Sample Results				Slurry Sample Results					
				#/Hr.	GPM			% Solids	+30M (Wt%)	+50M (Wt%)	+100M (Wt%)	Ash (Wt% Dry)	+30M (Wt%)	+50M (Wt%)	+100M (Wt%)	-400M (Wt%)	Ash (Wt% Dry)
DT#1	2/23	958	1/16	313	9.8	NA	NA	6.2	NA	0.8	2.7	NA	NA	NA	NA	NA	NA
DT#2	2/23	1055	1/16	313	9.8	NA	NA	6.2	NA	0.5	4.8	NA	NA	NA	NA	NA	NA
DT#4	2/23	1357	1/16	308	9.8	NA	NA	6.1	NA	3.7	7.4	NA	NA	NA	NA	NA	NA
DT#5	2/23	1515	1/16	293	9.9	NA	NA	5.8	NA	4.0	8.8	NA	NA	NA	NA	NA	NA
DT#8	2/23	1606	1/16	278	9.8	NA	NA	5.5	NA	6.1	11.6	NA	NA	NA	NA	NA	NA
PT#1	2/26	851	3/16	268	6.5	NA	NA	8.0	NA	1.2	4.5	NA	NA	1.1	3.3	83.8	NA
PT#2	2/26	936	3/16	235	6.5	NA	NA	7.0	NA	1.2	5.0	NA	NA	1.1	3.3	83.8	NA
PT#3	2/26	1035	3/16	201	6.5	NA	NA	6.0	NA	1.7	5.1	NA	NA	1.1	3.3	83.8	NA
PT#4	2/26	1121	3/16	294	7.8	NA	NA	7.3	NA	1.3	4.4	NA	NA	1.1	3.3	83.8	NA
PT#5	2/26	1200	3/16	314	7.8	NA	NA	7.8	NA	1.7	6.1	NA	NA	0.5	2.4	81.2	NA
PT#6	2/26	1313	3/16	306	7.8	NA	NA	7.6	NA	1.7	6.1	NA	NA	0.5	2.4	81.2	NA

Note: - NA - Not Available
- Hammermill Screen broke between DT#2 and DT#4 on 2/23/93.

Exhibit A.3
GRINDING CIRCUIT RESULTS
 (Upper Freeport Seam Raw Coal, Feed Lot # 3)

Test	Date	Start Sampling Time	Hammer Mill Screen	Feed Sump Water (GPM)	Feed Sump Level (%)	Feed Rate				Dry Sample Results				Slurry Sample Results				Ash (Wt%_Dry)
						#/Hr.	GPM	% Solids	+30M (Wt%)	+50M (Wt%)	+100M (Wt%)	Ash (Wt%_Dry)	+30M (Wt%)	+50M (Wt%)	+100M (Wt%)	-325M (Wt%)		
PT#7	3/02	1242	3/16	4.7	52.8	238	6.5	7.1	NA	3.0	6.3	NA	NA	2.1	3.8	81.1	26.36	
PT#8	3/02	1337	3/16	4.6	50.7	241	6.5	7.2	NA	3.0	6.3	NA	NA	2.1	3.8	81.1	26.36	
PT#9	3/02	1440	3/16	4.7	51.3	244	6.4	7.4	0.9	2.6	5.9	NA	NA	2.1	3.8	81.1	26.36	
PT#10	3/02	1610	3/16	4.5	53.5	265	6.5	7.9	0.9	2.6	5.9	NA	NA	2.1	3.8	81.1	25.14	
PT#11	3/02	1655	3/16	4.5	49.8	211	6.4	6.4	0.9	2.6	5.9	NA	1.0	2.4	4.7	76.5	25.14	
PT#12	3/02	1744	3/16	4.6	50.0	254	6.4	7.7	1.5	3.5	7.8	NA	1.0	2.4	4.7	76.5	26.57	
PT#13	3/02	1830	3/16	4.6	54.4	258	6.5	7.7	1.5	3.5	7.8	NA	1.0	2.4	4.7	76.5	26.57	
PT#14	3/02	1915	3/16	4.8	51.3	245	6.5	7.3	1.5	3.5	7.8	NA	1.0	2.4	4.7	76.5	26.57	
PT#15	3/03	1321	3/16	4.7	51.3	231	6.5	6.9	0.2	0.8	3.7	NA	0.1	0.9	3.4	75.7	29.06	
PT#16	3/03	1410	3/16	4.6	51.4	251	6.5	7.5	0.2	0.8	3.7	NA	0.1	0.9	3.4	75.7	29.06	
PT#17	3/03	1500	3/16	4.3	50.1	278	6.5	8.3	0.2	0.8	3.7	NA	0.1	0.9	3.4	75.7	28.59	
PT#18	3/03	1545	3/16	4.5	51.3	284	6.4	8.6	0.7	1.8	4.5	NA	0.1	0.9	3.4	75.7	28.59	
PT#19	3/03	1630	3/16	4.6	51.2	265	6.5	7.9	0.7	1.8	4.5	NA	0.2	1.0	3.3	83.0	29.41	
PT#20	3/03	1716	3/16	4.7	50.2	251	6.5	7.5	0.3	1.4	4.4	NA	0.2	1.0	3.3	83.0	29.41	
PT#21	3/03	1800	3/16	4.6	52.6	255	6.5	7.6	0.3	1.4	4.4	NA	0.2	1.0	3.3	83.0	30.47	
PT#22	3/03	1846	3/16	4.6	52.3	265	6.5	7.9	0.3	1.4	4.4	NA	0.2	1.0	3.3	83.0	30.47	
PT#23	3/04	1105	1/8	4.6	51.4	265	6.5	7.9	0.2	1.1	3.6	NA	0.1	0.4	1.8	85.8	27.73	
PT#24	3/04	1151	1/8	4.7	51.4	245	6.5	7.3	0.2	1.1	3.6	NA	0.1	0.4	1.8	85.8	27.73	
PT#25	3/04	1253	1/8	4.8	51.0	245	6.5	7.3	0.3	1.1	3.3	NA	0.1	0.4	1.8	85.8	27.73	
PT#26	3/04	1350	1/8	7.9	50.4	290	9.7	5.8	0.3	1.1	3.3	NA	0.1	0.4	1.8	85.8	27.43	
PT#27	3/04	1436	1/8	7.8	51.1	255	9.7	5.1	0.2	1.1	3.2	NA	0.1	0.4	1.8	85.8	27.43	
PT#28	3/05	930	1/8	4.7	51.6	287	6.4	8.7	0.8	2.5	6.7	NA	0.3	1.4	4.7	79.2	31.64	
PT#29	3/05	1030	1/8	4.6	51.1	257	6.4	7.8	0.8	2.5	6.7	NA	0.3	1.4	4.7	79.2	31.64	
PT#30	3/08	1010	1/8	4.4	51.0	244	6.4	7.4	0.4	1.7	5.2	NA	0.1	1.6	5.2	80.1	NA	
PT#31	3/08	1055	1/8	4.5	51.6	244	6.4	7.4	0.4	1.7	5.2	NA	0.1	1.6	5.2	80.1	NA	
PT#32	3/08	1140	1/8	4.3	52.1	241	6.4	7.3	0.5	1.9	7.7	NA	0.1	1.6	5.2	80.1	NA	
PT#33	3/08	1225	1/8	4.6	51.5	268	6.5	8.0	0.5	1.9	7.7	NA	0.1	1.6	5.2	80.1	NA	

Note: - Hammer Mill Screen had a hole in it for PT#7 through PT#14.

Exhibit A.3
GRINDING CIRCUIT RESULTS
 (Upper Freeport Seam Raw Coal, Feed Lot # 4)

Test	Date	Start Sampling Time	Hammer Mill Screen (In.)	Feed Rate		Feed Water (GPM)	Feed Sump Level (%)	Dry Sample Results			Slurry Sample Results				Ash (Wt%, Dry)
				#/Hr.	GPM			+30M (Wt%)	+50M (Wt%)	+100M (Wt%)	+30M (Wt%)	+50M (Wt%)	+100M (Wt%)	+325M (Wt%)	
					% Solids										
FT#1	3/10	1052	1/8	258	6.5	7.7	25.6	0.1	1.3	4.7	0.1	1.0	3.7	81.6	26.31
FT#2	3/10	1145	1/8	252	8.0	6.1	25.0	0.1	1.3	4.7	0.1	1.0	3.7	81.6	26.31
FT#3	3/10	1250	1/8	194	6.5	5.8	24.7	0.1	1.3	4.7	0.1	1.0	3.7	81.6	35.78
FT#4	3/10	1335	1/8	204	6.5	6.1	25.0	0.4	2.2	NA	0.1	1.0	3.7	81.6	35.78
FT#5	3/10	1425	1/8	193	7.8	4.8	25.4	0.4	2.2	NA	0.1	1.2	4.4	82.0	36.04
FT#6	3/10	1510	1/8	204	6.5	6.1	24.9	0.4	1.6	4.6	0.1	1.2	4.4	82.0	36.04
FT#7	3/10	1555	1/8	257	6.4	7.8	24.8	0.4	1.6	4.6	0.1	1.2	4.4	82.0	36.04
FT#8	3/11	1230	1/8	232	7.5	6.1	24.8	0.3	1.5	5.0	0.8	1.9	4.8	80.1	25.51
FT#9	3/11	1310	1/8	224	7.5	5.8	25.1	0.3	1.5	5.0	0.8	1.9	4.8	80.1	25.51
FT#10	3/11	1356	1/8	240	7.4	6.3	24.9	0.2	1.5	4.8	0.8	1.9	4.8	80.1	25.51
FT#11	3/11	1430	1/8	255	7.5	6.6	25.0	0.2	1.5	4.8	0.4	1.8	4.8	80.7	25.28
FT#12	3/11	1506	1/8	257	6.4	7.8	24.9	0.7	2.4	5.8	0.4	1.8	4.8	80.7	25.28
FT#13	3/11	1540	1/8	268	6.5	8.0	24.9	0.7	2.4	5.8	0.4	1.8	4.8	80.7	24.90
FT#14	3/11	1620	1/8	278	6.5	8.3	24.9	0.6	2.3	5.9	0.4	1.8	4.8	80.7	28.65
FT#15	3/11	1642	1/8	271	6.4	8.2	24.9	0.6	2.3	5.9	0.4	1.8	4.8	80.7	28.65
FT#16	3/11	1720	1/8	223	5.2	8.3	25.1	0.6	2.3	5.9	0.4	1.8	4.8	80.7	28.65
FT#17	3/11	1753	1/8	223	5.2	8.3	25.0	0.6	2.3	5.9	0.4	1.8	4.8	80.7	34.36
FT#18	3/11	1825	1/8	206	5.2	7.7	24.9	0.6	2.3	5.9	0.4	1.8	4.8	80.7	34.36
FT#19	3/11	1855	1/8	193	7.5	5.0	24.9	0.6	2.3	5.9	0.4	1.8	4.8	80.7	34.36
FT#20	3/16	925	1/8	297	8.1	7.1	36.0	0.4	1.7	5.2	0.1	1.3	4.5	79.0	NA
FT#21	3/16	1012	1/8	242	8.1	5.8	35.7	0.4	1.7	5.2	0.1	1.3	4.5	79.0	NA
FT#22	3/16	1101	1/8	272	8.1	6.5	32.9	0.4	1.7	5.2	0.1	1.3	4.5	79.0	NA
FT#23	3/16	1213	1/8	277	6.1	8.8	35.5	0.4	1.7	5.2	0.1	1.3	4.5	79.0	NA
FT#24	3/16	1311	1/8	274	6.1	8.7	34.2	0.5	2.2	6.5	0.1	1.3	4.5	79.0	NA
FT#25	3/16	1439	1/8	261	6.1	8.3	35.9	0.5	2.2	6.5	0.1	1.3	4.5	79.0	NA
FT#26	3/16	1535	1/8	252	6.1	8.0	34.6	0.5	2.2	6.5	0.1	1.3	4.5	79.0	NA
FT#27	3/16	1745	1/8	91	6.1	2.9	34.5	1.3	3.8	8.3	0.1	1.3	4.5	79.0	NA
FT#28	3/16	1838	1/8	138	8.1	3.3	32.8	1.3	3.8	8.3	0.1	1.3	4.5	79.0	NA
FT#29	3/16	1930	1/8	164	6.1	5.2	40.3	1.3	3.8	8.3	0.1	1.3	4.5	79.0	NA

Exhibit A.3
GRINDING CIRCUIT RESULTS
(Upper Freeport Seam Raw Coal, Feed Lot # 4)

Test	Date	Start Sampling Time	Hammer Mill Screen (in.)	#/Hr.	Feed Rate		Feed Sump Water (GPM)	Feed Sump Level (%)	Dry Sample Results				Slurry Sample Results				Ash (Wt%, Dry)
					GPM	% Solids			+30M (Wt%)	+50M (Wt%)	+100M (Wt%)	Ash (Wt%, Dry)	+30M (Wt%)	+50M (Wt%)	+100M (Wt%)	-325M (Wt%)	
FT#30	3/17	1110	1/16	289	6.1	9.2	4.0	35.1	0.3	1.0	3.4	NA	0.1	0.6	2.9	81.0	NA
FT#31	3/17	1155	1/16	259	8.1	6.2	6.1	35.0	0.3	1.0	3.4	NA	0.1	0.6	2.9	81.0	NA
FT#32	3/17	1250	1/16	246	6.2	7.7	4.2	34.9	0.3	1.0	3.4	NA	0.1	0.6	2.9	81.0	NA
FT#33	3/17	1350	1/16	252	6.1	8.0	4.2	35.1	0.3	1.0	3.4	NA	0.1	0.6	2.9	81.0	NA
FT#34	3/17	1435	1/16	278	6.2	8.7	4.2	35.0	0.0	0.4	2.0	NA	0.1	0.6	2.9	81.0	NA
FT#35	3/17	1615	1/16	249	6.1	7.9	4.6	33.9	0.0	0.4	2.0	NA	0.1	0.6	2.9	81.0	NA
FT#36	3/17	1700	1/16	246	8.1	5.9	6.0	35.4	0.0	0.4	2.0	NA	0.1	0.6	2.9	81.0	NA
FT#37	3/17	1745	1/16	259	8.1	6.2	5.9	33.1	0.4	1.6	5.4	NA	0.1	0.6	2.9	81.0	NA
FT#38	3/17	1830	1/16	280	8.1	6.7	5.8	34.8	0.4	1.6	5.4	NA	0.1	0.6	2.9	81.0	NA
FT#39	3/17	1945	1/16	293	6.1	9.3	4.0	35.6	0.4	1.6	5.4	NA	0.1	0.6	2.9	81.0	NA
FT#40	3/18	1350	1/16	289	6.1	7.8	4.0	35.3	0.1	0.7	2.6	NA	0.0	0.2	2.4	83.8	NA
FT#41	3/18	1445	1/16	259	8.1	6.2	6.0	36.1	0.1	0.7	2.6	NA	0.0	0.2	2.4	83.8	NA
FT#42	3/18	1530	1/16	261	6.1	8.3	3.9	35.3	0.1	0.7	2.6	NA	0.0	0.2	2.4	83.8	NA
FT#43	3/18	1648	1/16	258	6.1	8.2	3.9	34.8	0.1	0.7	2.6	NA	0.0	0.2	2.4	83.8	NA
FT#44	3/18	1733	1/16	245	6.1	7.8	3.7	32.8	0.1	0.7	2.6	NA	0.0	0.2	2.4	83.8	NA
FT#45	3/18	1825	1/16	286	6.1	9.1	4.3	35.2	0.1	1.3	5.7	NA	0.0	0.2	2.4	83.8	NA
FT#46	3/18	1910	1/16	272	8.1	6.5	5.9	37.3	0.1	1.3	5.7	NA	0.0	0.2	2.4	83.8	NA

Exhibit A.3
GRINDING CIRCUIT RESULTS
(Upper Freeport Seam Raw Coal, Feed Lot # 5)

Test	Date	Start Sampling Time	Hammer Mill Screen	Feed Rate		Feed Sump Water (GPM)	Feed Sump Level (%)	Dry Sample Results				Slurry Sample Results				
				#/Hr.	GPM			+30M (Wt%)	+50M (Wt%)	+100M (Wt%)	Ash (Wt% Dry)	+30M (Wt%)	+50M (Wt%)	+100M (Wt%)	-325M (Wt%)	Ash (Wt% Dry)
FT#47	3/22	1245	1/16	280	6.1	3.9	34.7	0.9	3.7	8.9	NA	0.6	2.3	6.2	79.3	NA
FT#48	3/22	1340	1/16	264	6.1	3.9	34.9	0.9	3.7	8.9	NA	0.6	2.3	6.2	79.3	NA
FT#49	3/22	1430	1/16	255	6.1	3.9	34.9	0.9	3.7	8.9	NA	0.6	2.3	6.2	79.3	NA
FT#50	3/22	1535	1/16	261	6.1	3.9	35.1	0.9	3.0	8.9	NA	0.6	2.3	6.2	79.3	NA
FT#51	3/22	1635	1/16	204	6.1	4.4	34.9	0.9	3.0	8.9	NA	0.6	2.3	6.2	79.3	NA
FT#52	3/22	1735	1/16	201	6.2	4.4	34.9	0.9	3.0	8.9	NA	0.6	2.3	6.2	79.3	NA
FT#53	3/22	1830	1/16	195	6.1	4.4	34.3	0.0	1.2	4.4	NA	0.6	2.3	6.2	79.3	NA
FT#54	3/22	1915	1/16	189	6.2	4.3	35.2	0.0	1.2	4.4	NA	0.6	2.3	6.2	79.3	NA
FT#55	3/23	955	1/16	145	6.1	5.0	34.6	0.3	0.6	3.3	NA	0.7	2.1	5.1	81.5	NA
FT#56	3/23	1045	1/16	138	6.1	5.0	34.9	0.3	0.6	3.3	NA	0.7	2.1	5.1	81.5	NA
FT#57	3/23	1150	1/16	252	6.1	4.2	34.9	0.3	0.6	3.3	NA	0.7	2.1	5.1	81.5	NA
FT#58	3/23	1245	1/16	249	6.1	4.1	34.7	0.3	0.6	3.3	NA	0.7	2.1	5.1	81.5	NA
FT#59	3/23	1335	1/16	223	6.1	4.3	34.2	0.3	1.3	4.6	NA	0.7	2.1	5.1	81.5	NA
FT#60	3/23	1440	1/16	249	6.1	4.2	33.5	0.3	1.3	4.6	NA	0.7	2.1	5.1	81.5	NA
FT#61	3/23	1520	1/16	245	6.1	4.3	34.0	0.3	1.3	4.6	NA	0.7	2.1	5.1	81.5	NA
FT#62	3/23	1625	1/16	264	6.1	4.2	33.2	0.4	1.6	4.4	NA	0.7	2.1	5.1	81.5	NA
FT#63	3/23	1715	1/16	249	6.1	3.8	36.7	0.4	1.6	4.4	NA	0.7	2.1	5.1	81.5	NA
FT#64	3/25	1200	1/16	255	6.1	4.2	36.5	0.6	2.7	7.5	NA	0.6	2.4	6.2	77.4	NA
FT#65	3/25	1305	1/16	252	6.1	4.2	34.8	0.6	2.7	7.5	NA	0.6	2.4	6.2	77.4	NA
FT#66	3/25	1400	1/16	255	6.1	4.3	34.2	0.6	2.7	7.5	NA	0.6	2.4	6.2	77.4	NA
FT#67	3/25	1450	1/16	211	6.1	4.5	35.3	0.6	2.7	7.5	NA	0.6	2.4	6.2	77.4	NA
FT#68	3/25	1550	1/16	192	6.1	4.6	36.0	0.4	1.7	5.0	NA	0.6	2.4	6.2	77.4	NA
FT#69	3/25	1655	1/16	214	6.1	4.4	36.2	0.4	1.7	5.0	NA	0.6	2.4	6.2	77.4	NA
FT#70	3/25	1750	1/16	198	6.1	4.4	34.7	0.4	1.7	5.0	NA	0.6	2.4	6.2	77.4	NA
FT#71	3/25	1835	1/16	182	6.1	4.5	35.5	0.2	1.8	4.8	NA	0.6	2.4	6.2	77.4	NA
FT#72	3/25	1925	1/16	192	6.1	4.4	34.5	0.2	1.8	4.8	NA	0.6	2.4	6.2	77.4	NA
FT#73	3/25	2010	1/16	205	6.2	4.6	37.7	0.2	1.8	4.8	NA	0.6	2.4	6.2	77.4	NA

Exhibit A.3
GRINDING CIRCUIT RESULTS
(Upper Freeport Seam Raw Coal, Feed Lot # 5)

Test	Date	Start Sampling Time	Hammer Mill Screen (In.)	Feed Rate			Feed Sump Water (GPM)	Feed Sump Level (%)	Dry Sample Results				Slurry Sample Results				
				#/Hr.	GPM	% Solids			+30M (Wt%)	+50M (Wt%)	+100M (Wt%)	Ash (Wt%, Dry)	+30M (Wt%)	+50M (Wt%)	+100M (Wt%)	-325M (Wt%)	Ash (Wt%, Dry)
FT#74	3/26	815	1/16	242	6.1	7.7	4.1	34.5	0.4	1.7	5.0	NA	0.1	1.2	3.5	85.0	NA
FT#75	3/26	905	1/16	267	6.1	8.5	4.0	35.0	0.4	1.7	5.0	NA	0.1	1.2	3.5	85.0	NA
FT#76	3/26	1000	1/16	267	6.1	8.5	4.1	35.8	0.4	1.7	5.0	NA	0.1	1.2	3.5	85.0	NA
FT#77	3/26	1040	1/16	264	6.1	8.4	4.1	34.3	0.4	1.4	3.8	NA	0.1	1.2	3.5	85.0	NA
FT#78	3/26	1135	1/16	248	5.4	8.9	3.5	35.3	0.4	1.4	3.8	NA	0.1	0.6	2.2	86.8	NA
FT#79	3/26	1245	1/16	259	5.4	9.3	3.3	35.4	0.4	1.4	3.8	NA	0.1	0.6	2.2	86.8	NA
FT#80	3/26	1335	1/16	317	5.4	9.6	3.4	34.2	0.5	1.7	4.3	NA	0.1	0.6	2.2	86.8	NA
FT#81	3/26	1435	1/16	259	5.4	9.3	3.3	36.7	0.5	1.7	4.3	NA	0.1	0.6	2.2	86.8	NA
FT#82	3/30	1035	1/16	314	8.0	7.6	5.7	34.9	0.2	1.1	3.9	NA	0.1	1.1	3.6	79.0	NA
FT#83	3/30	1130	1/16	300	6.0	9.7	3.7	34.9	0.2	1.1	3.9	NA	0.1	1.1	3.6	79.0	NA
FT#84	3/30	1245	1/16	306	4.5	13.2	2.2	35.0	0.2	1.1	3.9	NA	0.1	1.1	3.6	79.0	NA
FT#85	3/30	1355	1/16	173	8.0	4.2	6.7	34.9	0.1	0.5	2.1	NA	0.1	0.7	2.0	83.6	NA
FT#86	3/30	1445	1/16	195	6.0	6.3	4.7	35.1	0.1	0.5	2.1	NA	0.1	0.7	2.0	83.6	NA
FT#87	3/30	1605	1/16	161	4.6	6.8	3.2	35.4	0.1	0.5	2.1	NA	0.1	0.7	2.0	83.6	NA

Exhibit A.4

TEST SAMPLE RESULTS

(Upper Freeport Seam Raw Coal, Feed Lot #1)

Test Lot#1	Date Head	Start Sampling Time	Feed				Concentrate (Diluted)				Tailings			
			Solids (Wt%)	Ash (Wt%)	Sulfur (Wt%)	Pyr. Sulfur (Wt%)	Yield (Wt%)	Solids (Wt%)	Ash (Wt%)	Sulfur (Wt%)	Pyr. Sulfur (Wt%)	Solids (Wt%)	Ash (Wt%)	
		--	--	25.94	2.49	1.90	--	--	--	--	--	--	--	
CT#2	2/11	1200	6.45	27.01	--	--	44.6	4.28	11.76	--	--	3.41	39.28	
CT#3	2/11	1338	6.45	27.01	--	--	35.5	4.36	10.92	--	--	3.73	35.85	
CT#4	2/11	1510	6.44	29.90	--	--	44.3	4.24	12.82	--	--	3.63	43.46	
CT#5	2/11	1740	5.90	26.57	2.51	--	42.5	4.17	13.25	2.11	1.44	3.68	37.14	
CT#6	2/12	1214	6.32	25.77	--	--	56.7	3.72	11.65	--	--	3.11	44.28	
CT#7	2/12	1319	6.19	25.85	--	--	53.3	5.01	11.04	--	--	2.99	42.74	

Exhibit A.4 (con't.)

TEST SAMPLE RESULTS

(Upper Freeport Seam Raw Coal, Feed Lot #2)

Test Lot#2	Date Head	Start Sampling Time	Feed				Concentrate (Diluted)				Tailings		
			Solids (Wt%)	Ash (Wt%)	Sulfur (Wt%)	Pyr. Sulfur (Wt%)	Yield (Wt%)	Solids (Wt%)	Ash (Wt%)	Sulfur (Wt%)	Pyr. Sulfur (Wt%)	Solids (Wt%)	Ash (Wt%)
			—	29.23	2.68	2.04	—	—	—	—	—	—	—
DT#1	2/23	958	6.17	28.43	—	—	17.5	2.86	10.74	—	—	4.03	32.18
DT#2	2/23	1055	6.17	28.43	—	—	11.3	3.05	11.80	—	—	4.00	30.54
DT#4	2/23	1357	6.05	33.18	2.62	2.22	15.6	2.93	14.06	2.01	1.35	4.16	36.72
DT#5	2/23	1515	5.76	27.64	—	—	35.3	3.59	12.64	—	—	3.56	35.83
DT#6	2/23	1606	5.53	32.59	—	—	10.1	3.11	11.11	—	—	3.89	34.99
PT#1	2/26	851	7.97	30.00	—	—	31.2	4.86	11.71	—	—	5.83	38.31
PT#2	2/26	936	6.97	30.22	—	—	27.8	4.68	11.44	—	—	5.39	37.44
PT#3	2/26	1035	5.50	30.35	—	—	52.2	5.84	21.86	—	—	5.96	39.62
PT#4	2/26	1121	7.25	31.19	—	—	30.0	5.47	26.73	—	—	5.85	33.10
PT#5	2/26	1200	7.80	32.00	—	—	23.2	4.87	14.12	—	—	5.89	37.39
PT#6	2/26	1313	7.65	32.32	—	—	47.4	5.50	21.57	—	—	5.83	42.01

Notes: - Yields and Qualities are for -28M portion of feed, as there was a screen problem, and considerable undesirable +28M was present in the feed.

Exhibit A.4 (con't.)
TEST SAMPLE RESULTS
(Upper Freeport Seam Raw Coal, Feed Lot #3)

Test Lot#3	Date Head	Start Sampling Time	Feed				Concentrate (Diluted)				Tailings		
			Solids (WT%)	Ash (WT%)	Sulfur (WT%)	Pyr. Sulfur (WT%)	Yield (WT%)	Solids (WT%)	Ash (WT%)	Sulfur (WT%)	Pyr. Sulfur (WT%)	Solids (WT%)	Ash (WT%)
PT#7	3/02	1242	7.08	27.23	—	—	74.4	4.29	16.36	—	—	2.86	58.89
PT#8	3/02	1337	7.26	26.20	2.55	2.11	59.7	4.42	12.95	2.09	1.33	3.46	45.85
PT#9	3/02	1440	7.39	25.19	2.54	—	58.6	4.12	11.72	1.98	—	2.92	44.28
PT#10	3/02	1610	7.92	24.97	—	—	67.3	4.16	15.52	—	—	2.99	44.42
PT#11	3/02	1655	6.42	26.72	—	—	56.5	4.20	15.08	—	—	4.38	41.82
PT#12	3/02	1744	7.69	25.26	—	—	70.0	3.95	15.53	—	—	3.63	47.93
PT#13	3/02	1830	7.73	25.67	—	—	47.6	3.63	11.27	—	—	3.75	38.73
PT#14	3/02	1915	7.30	25.76	—	—	60.9	3.54	14.41	—	—	3.38	43.44
PT#15	3/03	1321	6.86	28.94	—	—	53.8	3.83	14.14	—	—	4.11	46.15
PT#16	3/03	1410	7.51	29.70	—	—	45.5	3.57	11.84	—	—	3.58	44.59
PT#17	3/03	1500	8.35	27.81	—	—	67.5	4.00	16.24	—	—	3.76	51.80
PT#18	3/03	1545	8.61	28.02	—	—	60.0	3.77	14.43	—	—	3.37	48.40
PT#19	3/03	1630	7.93	29.67	—	—	52.5	4.01	14.94	—	—	4.63	45.97
PT#20	3/03	1716	7.52	30.71	—	—	44.0	3.47	12.46	—	—	4.42	45.03
PT#21	3/03	1800	7.60	30.49	—	—	62.0	4.01	16.68	—	—	3.87	53.06
PT#22	3/03	1846	7.92	30.03	—	—	57.4	3.80	14.84	—	—	3.69	50.50
PT#23	3/04	1105	7.88	28.82	2.63	2.11	53.6	3.62	13.06	2.03	1.39	3.80	47.04
PT#24	3/04	1151	7.32	28.13	2.63	2.21	56.4	3.69	12.69	2.02	1.30	3.40	48.08
PT#25	3/04	1253	7.34	27.62	—	—	54.5	3.73	13.10	—	—	3.57	44.99
PT#26	3/04	1350	5.79	27.80	—	—	43.8	3.44	12.15	—	—	2.89	39.98
PT#27	3/04	1436	5.07	28.55	—	—	39.7	3.34	11.98	—	—	3.19	39.44
PT#28	3/05	930	8.74	30.57	—	—	61.6	3.99	17.91	—	—	3.67	50.91
PT#29	3/05	1030	7.84	30.94	—	—	49.9	3.57	13.62	—	—	3.91	48.17
PT#30	3/08	1010	7.44	25.44	—	—	67.2	4.06	13.71	—	—	3.46	49.46
PT#31	3/08	1055	7.43	25.67	—	—	61.9	3.87	12.31	—	—	3.08	47.33
PT#32	3/08	1140	7.27	25.61	2.47	1.98	65.8	3.91	12.92	1.98	1.25	3.14	50.06
PT#33	3/08	1225	8.02	25.91	2.45	1.96	66.4	4.04	13.78	2.05	1.38	3.93	49.92

Note: - Yields and qualities are for 28M x 0 size fraction, for cases where pulverizer screen broke.

Exhibit A.4
TEST SAMPLE RESULTS
(Upper Freeport Seam Raw Coal, Feed Lot # 4)

Test Lot #4	Date Head	Start Sampling Time	Balance Method	Feed				Concentrate (Diluted)						Tailings			
				Flow (GPM)	Solids (WT%)	Ash (WT%)	Sulfur (WT%)	Pyr Sulfur (WT%)	F B Yield (WT%)	A B Yield (WT%)	Solids (WT%)	Ash (WT%)	Sulfur (WT%)	Pyr Sulfur (WT%)	Flow (GPM)	Solids (WT%)	Ash (WT%)
				---	---	26.88	2.56	1.97	---	---	---	---	---	---	---	---	---
FT#1	3/10	1052	ASTM	6.5	7.65	26.63	2.53	2.00	57.5	53.9	3.76	10.94	1.95	1.19	5.9	3.58	44.96
FT#2	3/10	1145	ASTM	8.0	6.09	27.42	---	---	52.0	48.3	3.50	10.92	---	---	7.5	3.12	42.83
FT#3	3/10	1250	ASTM	6.5	5.77	33.55	---	---	53.2	49.3	3.87	13.21	2.03	---	6.5	2.70	53.30
FT#4	3/10	1335	ASTM	6.5	6.05	36.28	2.71	2.27	63.2	60.2	3.91	18.47	2.44	1.87	4.2	3.45	63.22
FT#5	3/10	1425	ASTM	7.8	4.80	32.83	---	---	51.3	53.3	3.29	12.45	---	---	8.0	2.28	56.06
FT#6	3/10	1510	ASTM	6.5	6.06	30.86	---	---	63.4	63.2	3.55	14.19	2.24	---	6.4	2.25	59.44
FT#7	3/10	1555	ASTM	6.4	7.80	33.36	2.76	2.25	65.1	56.2	3.55	13.91	2.33	1.63	5.7	3.06	58.30
FT#8	3/11	1230	ASTM	7.5	6.13	28.49	---	---	69.6	59.2	4.65	14.48	---	---	4.9	2.85	60.01
FT#9	3/11	1310	ASTM	7.5	5.82	24.40	2.55	1.94	69.7	75.1	4.93	12.91	2.36	1.65	5.2	2.54	59.10
FT#10	3/11	1356	ASTM	7.4	6.32	25.05	---	---	77.8	75.7	4.67	14.51	2.08	---	4.2	2.47	57.86
FT#11	3/11	1430	ASTM	7.5	6.61	25.38	2.53	1.94	68.8	67.4	5.16	12.90	1.99	1.24	5.0	3.09	51.24
FT#12	3/11	1506	ASTM	6.4	7.83	25.87	---	---	66.5	62.7	4.25	11.58	---	---	6.1	2.75	49.91
FT#13	3/11	1540	ASTM	6.5	8.00	26.58	---	---	68.0	65.2	4.22	12.56	2.05	---	6.1	2.73	52.95
FT#14	3/11	1620	ASTM	6.5	8.30	28.82	---	---	67.1	59.7	4.25	12.67	---	---	5.7	3.11	52.76
FT#15	3/11	1642	ASTM	6.4	8.25	28.51	---	---	60.8	55.6	4.17	11.42	---	---	6.2	3.34	49.94
FT#16	3/11	1720	ASTM	5.2	8.30	28.63	2.54	1.91	69.3	64.3	4.02	12.84	2.09	1.40	4.9	2.70	57.08
FT#17	3/11	1753	ASTM	5.2	8.26	33.50	---	---	64.6	59.8	4.09	14.42	---	---	5.3	2.87	61.94
FT#18	3/11	1825	ASTM	5.2	7.72	34.77	---	---	54.7	50.5	3.65	13.02	2.27	---	6.0	3.03	56.96
FT#19	3/11	1855	ASTM	7.5	5.03	33.18	2.56	2.09	59.5	58.6	3.73	17.24	2.34	1.57	5.7	2.68	55.76
FT#20	3/16	925	ASTM	8.1	7.08	24.10	2.32	1.76	75.1	71.1	4.74	11.76	2.03	1.35	5.7	2.51	54.51
FT#21	3/16	1012	ASTM	8.1	5.77	24.56	---	---	69.4	67.7	4.71	11.87	---	---	5.7	2.51	51.18
FT#22	3/16	1101	ASTM	8.1	6.49	24.71	---	---	61.9	60.0	4.43	11.84	---	---	5.6	3.58	43.98
FT#23	3/16	1213	ASTM	6.1	8.77	26.03	2.56	1.96	65.2	62.0	4.40	11.69	1.99	1.37	5.4	3.45	49.45
FT#24	3/16	1311	ASTM	6.1	8.67	32.32	2.73	2.35	65.1	53.1	4.32	13.42	2.11	1.48	5.5	3.36	53.74
FT#25	3/16	1439	ASTM	6.1	8.32	31.76	---	---	62.0	60.5	4.08	14.69	---	---	5.4	3.57	57.91
FT#26	3/16	1535	ASTM	6.1	8.04	29.94	2.51	---	68.4	69.4	4.41	14.76	2.36	1.66	5.1	3.04	64.44
FT#27	3/16	1745	ASTM	6.1	2.86	25.75	---	---	64.0	76.7	3.98	13.35	---	---	6.4	0.98	66.55
FT#28	3/16	1838	ASTM	8.1	3.27	23.46	2.00	1.50	83.4	72.2	3.17	11.64	1.97	---	7.1	0.62	54.15
FT#29	3/16	1930	ASTM	6.1	5.17	25.29	---	---	85.0	65.9	2.30	10.28	2.01	1.36	7.9	0.60	54.33

Exhibit A.4
TEST SAMPLE RESULTS
(Upper Freeport Seam Raw Coal, Feed Lot # 4)

Test	Date	Start Sampling Time	Feed			Concentrate (Diluted)						Tailings					
			Balance Method	Flow (GPM)	Solids (Wt%)	Ash (Wt%)	Sulfur (Wt%)	Pyr. Sulfur (Wt%)	F. B. Yield (Wt%)	A. B. Yield (Wt%)	Solids (Wt%)	Ash (Wt%)	Sulfur (Wt%)	Pyr. Sulfur (Wt%)	Flow (GPM)	Solids (Wt%)	Ash (Wt%)
FT#30	3/17	1110	ASTM	6.1	9.24	27.24	—	—	56.1	52.3	4.16	10.83	1.86	1.20	5.2	4.76	45.26
FT#31	3/17	1155	ASTM	8.1	6.21	26.03	—	—	69.5	69.8	5.14	14.35	—	—	5.4	2.84	53.08
FT#32	3/17	1250	ASTM	6.2	7.72	26.02	—	—	67.8	66.9	4.17	13.64	—	—	5.3	2.91	51.09
FT#33	3/17	1350	ASTM	6.1	8.01	27.36	2.54	—	62.8	60.5	4.14	14.02	2.12	—	5.3	3.43	47.79
FT#34	3/17	1435	ASTM	6.2	8.69	28.40	2.81	—	64.7	58.6	4.02	15.16	2.13	—	5.3	3.59	47.14
FT#35	3/17	1615	ASTM	6.1	7.93	28.84	—	—	59.7	60.5	3.93	14.66	—	—	5.4	3.61	50.53
FT#36	3/17	1700	ASTM	8.1	5.88	28.55	—	—	61.9	67.5	4.78	16.37	2.19	—	5.1	3.56	53.83
FT#37	3/17	1745	ASTM	8.1	6.15	28.50	—	—	61.8	62.0	4.52	15.79	—	—	5.0	3.81	49.21
FT#38	3/17	1830	ASTM	8.1	6.70	29.28	2.49	2.05	68.7	63.7	4.75	16.02	2.20	1.61	5.5	3.09	52.50
FT#39	3/17	1945	ASTM	6.1	9.27	33.47	—	—	63.7	52.0	4.34	14.07	—	—	5.7	3.60	54.48
FT#40	3/18	1350	ASTM	6.1	7.76	31.30	—	—	60.9	62.8	4.08	14.30	—	—	5.7	3.25	59.96
FT#41	3/18	1445	ASTM	8.1	6.20	27.95	—	—	69.8	70.2	4.73	15.44	—	—	5.5	2.76	57.35
FT#42	3/18	1530	ASTM	6.1	8.33	27.50	—	—	69.3	68.0	4.35	12.44	—	—	5.1	3.06	59.44
FT#43	3/18	1648	ASTM	6.1	8.24	26.13	—	—	69.4	70.3	4.40	12.95	2.12	1.42	4.9	3.14	57.39
FT#44	3/18	1733	ASTM	6.1	7.76	24.28	2.20	1.75	71.5	74.4	4.49	12.16	2.12	1.37	4.7	2.87	59.56
FT#45	3/18	1825	ASTM	6.1	9.14	26.11	2.38	2.07	78.3	73.4	4.68	12.09	2.12	1.51	4.7	2.57	64.82
FT#46	3/18	1910	ASTM	8.1	6.48	25.93	—	—	77.2	75.5	5.29	14.28	—	—	5.2	2.30	61.80

Exhibit A.4
TEST SAMPLE RESULTS
(Upper Freeport Seam Raw Coal, Feed Lot # 5)

Test Lot #5	Date Head	Start Sampling Time	Balance Method	Feed			Concentrate (Diluted)						Tailings				
				Flow (GPM)	Solids (Wt%)	Ash (Wt%)	Sulfur (Wt%)	Pyr. Sulfur (Wt%)	F.B. Yield (Wt%)	A.B. Yield (Wt%)	Solids (Wt%)	Ash (Wt%)	Sulfur (Wt%)	Pyr. Sulfur (Wt%)	Flow (GPM)	Solids (Wt%)	Ash (Wt%)
				---	---	26.57	2.54	1.92	---	---	---	---	---	---	---	---	---
FT#47	3/22	1245	ASTM	6.1	8.89	28.15	2.75	2.39	69.2	67.7	4.65	13.52	2.21	1.68	5.1	3.28	58.76
FT#48	3/22	1340	ASTM	6.1	8.36	31.58	---	---	59.7	59.9	4.35	15.19	---	---	5.5	3.74	56.10
FT#49	3/22	1430	ASTM	6.1	8.13	30.87	---	---	52.1	51.5	4.42	14.46	---	---	5.9	4.03	47.79
FT#50	3/22	1535	ASTM	6.1	8.31	34.38	2.72	2.28	54.7	54.5	3.85	18.98	2.40	1.80	5.3	4.33	52.82
FT#51	3/22	1635	ASTM	6.1	6.49	29.39	---	---	68.5	71.8	4.37	15.44	---	---	6.2	2.01	64.84
FT#52	3/22	1735	ASTM	6.2	6.34	25.48	---	---	68.6	70.6	3.98	12.36	2.13	1.50	6.2	1.99	56.92
FT#53	3/22	1830	ASTM	6.1	6.15	25.00	---	---	68.8	69.4	3.90	12.61	---	---	6.0	1.95	53.16
FT#54	3/22	1915	ASTM	6.2	5.94	26.85	2.60	1.98	69.1	70.7	4.32	13.01	2.17	1.53	6.5	1.75	60.23
FT#55	3/23	955	ASTM	6.1	4.58	25.89	---	---	75.1	73.3	3.34	11.92	---	---	6.5	1.07	64.20
FT#56	3/23	1045	ASTM	6.1	4.41	24.86	---	---	68.8	72.2	3.45	11.80	---	---	6.4	1.31	58.86
FT#57	3/23	1150	ASTM	6.1	7.99	26.45	---	---	70.5	64.7	4.38	11.67	---	---	5.9	2.44	53.52
FT#58	3/23	1245	ASTM	6.1	7.85	26.44	---	---	56.9	56.7	4.08	11.20	---	---	6.0	3.44	46.38
FT#59	3/23	1335	ASTM	6.1	7.14	26.87	---	---	64.9	63.9	4.27	12.86	2.16	1.54	5.7	2.68	51.67
FT#60	3/23	1440	ASTM	6.1	7.94	26.03	2.43	1.98	78.1	76.9	4.88	14.66	2.27	1.60	5.2	2.04	63.78
FT#61	3/23	1520	ASTM	6.1	7.81	26.00	2.47	1.93	69.1	72.8	4.87	15.28	2.29	1.56	5.3	2.78	54.68
FT#62	3/23	1625	ASTM	6.1	8.39	28.28	---	---	64.1	62.4	4.56	16.87	2.08	---	5.5	3.34	47.25
FT#63	3/23	1715	ASTM	6.1	7.86	30.46	2.70	2.11	60.6	61.6	4.60	17.92	2.26	---	5.4	3.50	50.55
FT#64	3/25	1200	ASTM	6.1	8.07	31.35	2.65	---	60.7	62.3	4.45	15.61	2.32	---	5.9	3.28	57.35
FT#65	3/25	1305	ASTM	6.1	7.99	30.95	---	---	59.0	57.5	4.05	16.25	---	---	5.9	3.39	50.94
FT#66	3/25	1400	ASTM	6.1	8.13	27.63	---	---	63.0	64.7	4.03	16.63	---	---	5.4	3.40	47.83
FT#67	3/25	1450	ASTM	6.1	6.72	25.81	---	---	67.7	68.3	4.12	16.13	---	---	6.1	2.17	46.67
FT#68	3/25	1550	ASTM	6.1	6.06	26.10	---	---	60.2	64.4	3.69	15.44	---	---	6.0	2.45	45.37
FT#69	3/25	1655	ASTM	6.1	6.83	26.36	---	---	68.7	63.7	3.58	15.93	---	---	5.9	2.21	44.67
FT#70	3/25	1750	ASTM	6.1	6.25	25.66	2.38	1.85	64.4	64.2	3.88	14.47	2.21	1.60	6.5	2.09	45.69
FT#71	3/25	1835	ASTM	6.1	5.84	26.30	---	---	63.0	62.2	3.90	14.53	---	---	6.5	2.03	45.70
FT#72	3/25	1925	ASTM	6.1	6.13	26.86	---	---	62.7	57.5	3.62	14.09	---	---	6.4	2.18	44.13
FT#73	3/25	2010	ASTM	6.2	6.39	26.95	---	---	59.5	60.7	3.41	15.19	---	---	6.4	2.51	45.08

Exhibit A.4
TEST SAMPLE RESULTS
(Upper Freeport Seam Raw Coal, Feed Lot # 5)

Test	Date	Start Sampling Time	Balance Method	Feed				Concentrate (Diluted)				Tailings					
				Flow (GPM)	Solids (Wt%)	Ash (Wt%)	Sulfur (Wt%)	Pyr. Sulfur (Wt%)	F. B. Yield (Wt%)	A. B. Yield (Wt%)	Solids (Wt%)	Ash (Wt%)	Sulfur (Wt%)	Pyr. Sulfur (Wt%)	Flow (GPM)	Solids (Wt%)	Ash (Wt%)
FT#74	3/26	815	ASTM	6.1	7.72	31.95	---	---	56.7	46.8	3.84	15.85	---	---	6.0	3.40	46.12
FT#75	3/26	905	ASTM	6.1	8.47	37.53	3.40	2.86	50.8	44.1	3.62	21.31	2.60	2.18	5.8	4.17	50.33
FT#76	3/26	1000	ASTM	6.1	8.53	32.36	---	---	51.4	56.3	3.44	20.98	---	---	5.8	4.36	47.03
FT#77	3/26	1040	ASTM	6.1	8.36	27.20	---	---	50.0	62.0	3.56	18.88	---	---	5.6	4.55	40.75
FT#78	3/26	1135	ASTM	5.4	8.93	26.51	---	---	47.3	48.3	3.58	14.27	---	---	6.2	4.10	37.96
FT#79	3/26	1245	ASTM	5.4	9.30	26.40	2.49	1.98	40.1	36.5	3.08	10.62	1.94	1.33	7.3	4.12	35.47
FT#80	3/26	1335	ASTM	5.4	9.57	26.92	---	---	52.6	51.0	3.72	13.97	---	---	6.3	3.89	40.42
FT#81	3/26	1435	ASTM	5.4	9.28	27.30	---	---	36.3	32.9	2.95	11.26	---	---	7.3	4.37	35.18
FT#82	3/30	1035	ASTM	8.0	7.59	24.37	2.42	1.97	63.8	64.9	4.66	12.97	1.91	1.35	6.2	3.55	45.46
FT#83	3/30	1130	ASTM	6.0	9.68	24.93	---	---	65.1	66.7	4.98	13.67	---	---	4.5	4.51	47.46
FT#84	3/30	1245	ASTM	4.5	13.23	26.63	---	---	66.4	62.6	4.62	15.28	---	---	2.8	7.15	45.61
FT#85	3/30	1355	ASTM	8.0	4.18	26.87	2.61	---	51.3	52.2	3.23	11.62	2.16	---	8.4	1.94	43.55
FT#86	3/30	1445	ASTM	6.0	6.33	25.53	---	---	65.3	58.4	3.27	13.04	---	---	6.5	2.03	43.08
FT#87	3/30	1605	ASTM	4.6	6.83	26.51	---	---	64.1	59.4	3.49	15.01	---	---	4.8	2.35	43.34

Appendix B

VERTICAL MOUNTED SKID MODULE DRAWINGS

Figure B.1 - Elevation 1116' Skid Components

Figure B.2 - Elevation 1106' Skid Module

Figure B.3 - Elevation 1096' Skid Module

Figure B.4 - Elevation 1086' Skid Module

Figure B.1
ELEVATION 1116'
SKID COMPONENTS

TECH
 PROCESS TECHNOLOGY, INC.
 1122 CALUMET AVENUE
 CALUMET, INDIAN 45913-1931
 (903) 337-0029
 FAX (903) 337-0023

PROJECT	11-11	DATE	01-08-00
DESIGNER	Kelly	DATE	11-12-92

1116 ELEVATION FLOOR PLAN

Figure B.2
ELEVATION 1106'
SKID MODULE

Figure B.3
ELEVATION 1096'
SKID MODULE

Figure B.4
ELEVATION 1086'
SKID MODULE

Appendix C

ADDITIONAL 2" LAB COLUMN TESTS UPPER FREEPORT SEAM RAW COAL

Table 18.C.1: Set #3 Head Analyses (Old Coal and PTI Grind)

Table 18.C.2: Set #1 Tests With 0.60 #/T M-150 (Site) and 0.60 #/T Fuel Oil

Table 18.C.3: Set #2 Tests With 0.60 #/T MIBC and 0.60 #/T Fuel Oil

Table 18.C.4: Set #3 Tests With 0.55 #/T MIBC and 0.55 #/T Fuel Oil

Table 18.C.5: Set #4 Tests With 0.45 #/T MIBC and 0.60 #/T Fuel Oil

Table 18.C.6: Set #5 Tests With 0.60 #/T CM-670 (Site) and 0.60 #/T Fuel Oil

Table 18.C.7: Set #4 Head Analysis Lot #3 (Lot #5 Plant Coal Ground at PETC)

Table 18.C.8: Batch #1 Tests With 0.45 #/T MIBC and 0.60 #/T Fuel Oil

Table 18.C.9: Set #5 Head Analysis (Lot #5 Plant Coal, and PTI Grind)

Table 18.C.10: Batch #1 Tests With 0.45 #/T MIBC and 0.60 #/T Fuel Oil

Table 18.C.11: Batch #2 Tests With 0.30 #/T MIBC and 0.50 #/T Fuel Oil

Table 18.C.12: Batch #3 Tests With 0.30 #/T MIBC and 0.50 #/T Fuel Oil

Table 18.C.1
 2" KEN-FLOTE™ COLUMN TESTS
 SET #3, FEED COMPOSITE, HEAD AND SCREEN ANALYSIS
 Upper Freeport Seam Raw Coal
 (Dried at 40° C and Pulverized)

I. Head Analysis: Set #3 Feed Composite

	<u>As-Determined</u>	<u>Dry Basis</u>
Moisture (Wt%)	0.77	---
Ash (Wt%)	26.30	26.50
Sulfur (Wt%)	2.33	2.35
Pyritic Sulfur (Wt%)	1.74	1.75

II. Screen Analysis (Dry Basis): Set #3 Composite

<u>Size Fraction</u> <u>(USA Mesh)</u>	<u>Direct</u> <u>(Wt%)</u>	<u>Cum. Passing</u> <u>(Wt%)</u>
Top x 30M	0.0	100.0
30M x 50M	0.2	99.8
50M x 70M	3.1	96.7
70M x 100M	6.2	90.5
100M x 200M	22.1	68.4
200M x 400M	22.9	45.5
400M x 0	<u>45.5</u>	0.0
	100.0	

Upper Freeport Seam Raw Coal

Batch Feed Solids = 6.0 Wt%
 Batch Frother Dosage = 0.60 #/T Betz M-150 Frother (Site)
 Batch Collector Dosages = 0.60 #/T No. 2 Fuel Oil
 Batch Pyrite Depressant Dosage = 0.00 #/T Polyacrylic Acid

Batch	Test	Feed Rate (g/min.)	Solids Feed Rate		Froth Height		Compressed Air Use (40 PSI)		Laundry Water		Froth Wash Water		Retention Time (min.)	
			g/min	#/hr. ft.2	inches	% height	CFM	CFM/ft.2	ml/min.	% prod. flow	ml/min.	% feed flow	rel. to feed	actual
1	1	784	44.1	265	10	14	.053	2.41	400	305	200	26	4.7	3.0
1	2	789	45.6	274	10	14	.070	3.18	400	258	200	25	4.7	3.0
1	3	819	47.2	283	14	19	.070	3.18	400	270	200	24	4.5	2.9
1	4	813	46.7	280	14	19	.053	2.41	400	367	200	25	4.6	2.9

Batch	Test	Air Rate (L/min.)	Froth		Froth Wash Water (ml/min.)	Laundry Water (ml/min.)	Sample Head	Diluted Solids Content (Wt%)	Actual Solids Content (Wt%)	Total Flow Rate (g/min.)	Solids Flow Rate (g/min.)	Column Performance (Dry Basis)		
			Height (inches)	Wash Depth (inches)								Yield (Wt%)	Ash (Wt%)	Sulfur (Wt%)
1	---	---	---	---	---	---	---	---	---	---	---	---	26.51	2.38
1	---	---	---	---	---	---	Start Feed	---	5.60	---	---	---	22.59	1.86
1	1	1.5	10	5	200	400	Recon. Feed Product Tailings	6.52	5.63	784	44.1	100.0	22.23	1.85
									26.41	131	34.6	78.5	12.49	1.93
									1.11	853	9.5	21.5	57.77	1.56
1	2	2.0	10	5	200	400	Recon. Feed Product Tailings	---	5.78	789	45.6	100.0	22.35	1.88
								6.68	23.94	155	37.1	81.4	13.02	1.96
								---	1.02	834	8.5	18.6	63.16	1.51
1	3	2.0	14	7	200	400	Recon. Feed Product Tailings	---	5.76	819	47.2	100.0	23.70	1.93
								6.73	24.93	148	36.9	78.1	12.41	1.98
								---	1.18	871	10.3	21.9	63.98	1.76
1	4	1.5	14	7	200	400	Recon. Feed Product Tailings	---	5.74	813	46.7	100.0	25.05	1.99
								6.48	30.28	109	33.0	70.7	10.94	1.93
								---	1.52	904	13.7	29.3	59.08	2.14
1	---	---	---	---	---	---	End Feed	---	5.90	---	---	---	25.91	2.08
														1.49

Notes: - Retention time "relative to feed" is total column volume divided by volume feed rate.
 - Retention time "actual" is 80% of total column volume divided by volume feed rate and froth wash water rate.
 - Diluted solids content includes laundry water addition for product samples.
 - Actual solids content reflects product sample prior to laundry water addition.

Upper Freeport Seam Raw Coal

Batch Feed Solids = 6.0 Wt%
 Batch Frother Dosage = 0.55 #/T MIBC Frother
 Batch Collector Dosages = 0.55 #/T No. 2 Fuel Oil
 Batch Pyrite Depressant Dosage = 0.00 #/T Polyacrylic Acid

Batch	Test	Feed Rate (g/min.)	Solids Feed Rate		Froth Height		Compressed Air Use (40 PSI)			Launder Water		Froth Wash Water		Retention Time (min.)	
			g/min	#/hr. ft.2	inches	% height	CFM	CFM/ft.2	CFM/TPH	ml/min.	% prod. flow	ml/min.	%feed flow	rel. to feed	actual
3	1	769	44.3	266	10	14	.053	2.41	18.1	400	296	200	26	4.8	3.1
3	2	760	41.9	251	10	14	.070	3.18	25.3	400	258	200	26	4.9	3.1
3	3	829	47.7	286	14	19	.070	3.18	22.3	400	315	200	24	4.5	2.9
3	4	906	48.1	289	14	19	.053	2.41	16.7	400	392	200	22	4.1	2.7

Batch	Test	Air Rate (L/min.)	Froth Height (inches)	Froth Wash Depth (inches)	Froth Wash Water (ml/min.)	Launder Water (ml/min.)	Diluted Solids Content (Wt%)	Actual Solids Content (Wt%)	Total Flow Rate (g/min.)	Solids Flow Rate (g/min.)	Column Performance (Dry Basis)				
											Yield (Wt%)	Ash (Wt%)	Sulfur (Wt%)	Pyr. Sulfur (Wt%)	
3	—	—	—	—	—	—	—	—	—	—	27.00	2.39	1.75	—	—
3	—	—	—	—	—	—	—	5.42	—	—	23.17	—	—	—	—
3	1	1.5	10	5	200	400	7.42	5.76	769	44.3	21.92	100.0	89.6	—	—
							—	29.41	135	39.7	14.88	89.6	10.4	—	—
							—	0.55	834	4.6	82.61	10.4	—	—	—
3	2	2.0	10	5	200	400	—	5.51	760	41.9	23.36	100.0	87.4	—	—
							6.59	23.61	155	36.6	14.64	87.4	12.6	—	—
							—	0.66	805	5.3	83.81	12.6	—	—	—
3	3	2.0	14	7	200	400	—	5.75	829	47.7	25.26	100.0	83.6	—	—
							7.57	31.42	127	39.9	13.63	83.6	16.4	—	—
							—	0.86	902	7.8	84.32	16.4	—	—	—
3	4	1.5	14	7	200	400	—	5.31	906	48.1	30.77	100.0	75.7	—	—
							7.25	35.68	102	36.4	14.01	75.7	24.3	—	—
							—	1.17	1004	11.7	83.00	24.3	—	—	—
							—	5.27	—	—	32.17	—	—	—	—

Notes: - Retention time "relative to feed" is total column volume divided by volume feed rate.
 - Retention time "actual" is 80% of total column volume divided by volume feed rate and froth wash water rate.
 - Diluted solids content includes launder water addition for product samples.
 - Actual solids content reflects product sample prior to launder water addition.

SET #3, BATCH #4, 2 REIN-LOTE COLUMN TESTS

Upper Freeport Seam Raw Coal

Batch Feed Solids = 6.0 Wt%
 Batch Frother Dosage = 0.45 #/T MIBC Frother
 Batch Collector Dosages = 0.60 #/T No. 2 Fuel Oil
 Batch Pyrite Depressant Dosage = 0.00 #/T Polyacrylic Acid

Batch	Test	Feed Rate		Solids Feed Rate		Froth Height		Compressed Air Use (40 PSI)		Launder Water		Froth Wash Water		Retention Time (min.)	
		(g/min.)	#/hr. ft.2	g/min	#/hr. ft.2	inches	% height	CFM	CFM/ft.2	CFM/TPH	ml/min.	% prod. flow	ml/min.	% feed flow	rel. to feed
4	1	753	270	45.0	270	10	14	.053	2.41	17.8	400	303	200	27	4.9
4	2	824	272	45.4	272	10	14	.070	3.18	23.4	400	260	200	24	4.5
4	3	832	284	47.3	284	14	19	.070	3.18	22.4	400	292	200	24	4.5
4	4	866	298	49.6	298	14	19	.053	2.41	16.2	400	354	200	23	4.3
Batch	Test	Air Rate (L/min.)	Froth Height (inches)	Froth Wash Depth (inches)	Froth Wash Water (ml/min.)	Launder Water (ml/min.)	Sample Head	Diluted Solids Content (Wt%)	Actual Solids Content (Wt%)	Total Flow Rate (g/min.)	Solids Flow Rate (g/min.)	Column Performance (Dry Basis)			
												Yield (Wt%)	Ash (Wt%)	Sulfur (Wt%)	Pyr. Sulfur (Wt%)
4	—	—	—	—	—	—	—	—	—	—	—	—	26.38	2.30	1.75
4	—	—	—	—	—	—	Start Feed	—	5.27	—	—	—	22.26	—	—
4	1	1.5	10	5	200	400	Recon. Feed Product Tailings	7.46	5.98	753	45.0	100.0	20.45	—	—
								—	30.08	132	39.7	88.2	12.52	—	—
								—	0.65	821	5.3	11.8	79.70	—	—
4	2	2.0	10	5	200	400	Recon. Feed Product Tailings	7.04	5.51	824	45.4	100.0	22.32	—	—
								—	25.32	154	39.0	85.9	12.57	—	—
								—	0.74	870	6.4	14.1	81.69	—	—
4	3	2.0	14	7	200	400	Recon. Feed Product Tailings	7.32	5.69	832	47.3	100.0	23.78	2.02	—
								—	28.69	137	39.3	83.1	11.92	2.12	1.34
								—	0.89	895	8.0	16.9	82.07	1.54	—
4	4	1.5	14	7	200	400	Recon. Feed Product Tailings	7.37	5.73	866	49.6	100.0	29.54	2.35	1.83
								—	33.45	113	37.8	76.2	12.93	2.41	1.73
								—	1.24	953	11.8	23.8	82.70	2.18	2.17
4	—	—	—	—	—	—	End Feed	—	5.08	—	—	—	32.00	2.58	—

Notes: - Retention time "relative to feed" is total column volume divided by volume feed rate.
 - Retention time "actual" is 80% of total column volume divided by volume feed rate and froth wash water rate.
 - Diluted solids content includes launder water addition for product samples.
 - Actual solids content reflects product sample prior to launder water addition.

Upper Freeport Seam Raw Coal

Batch Feed Solids = 6.0 Wt%
 Batch Frother Dosage = 0.60 #/T Betz CM-670 Frother
 Batch Collector Dosages = 0.60 #/T No. 2 Fuel Oil
 Batch Pyrite Depressant Dosage = 0.00 #/T Polyacrylic Acid

Batch	Test	Feed Rate		Solids Feed Rate		Froth Height		Compressed Air Use (40 PSI)		Lauder Water		Froth Wash Water		Retention Time (min.)	
		(g/min.)	(g/min)	#/hr.	ft.2	inches	% height	CFM	CFM/ft.2	CFM/TPH	ml/min.	% prod. flow	ml/min.	% feed flow	rel. to feed
5	1	761	45.4	272	10	14	14	.053	2.41	17.7	400	315	200	26	4.9
5	2	786	47.3	284	10	14	14	.070	3.18	22.4	400	231	200	25	4.7
5	3	848	47.3	284	14	19	19	.070	3.18	22.4	400	301	200	24	4.4
5	4	834	47.9	287	14	19	19	.053	2.41	16.8	400	435	200	24	4.5
Batch	Test	Air Rate (L/min.)	Froth Height (inches)	Froth Wash Depth (inches)	Froth Wash Water (ml/min.)	Lauder Water (ml/min.)	Diluted Solids Content (Wt%)	Actual Solids Content (Wt%)	Total Flow Rate (g/min.)	Solids Flow Rate (g/min.)	Column Performance (Dry Basis)				
											Yield (Wt%)	Ash (Wt%)	Sulfur (Wt%)	Pyr. Sulfur (Wt%)	actual
5	1	1.5	10	5	200	400	7.46	5.97	761	45.4	100.0	20.82	—	—	—
5	2	2.0	10	5	200	400	7.10	30.94	127	39.3	86.6	13.90	—	—	—
5	3	2.0	14	7	200	400	—	0.73	834	6.1	13.4	65.52	—	—	—
5	4	1.5	14	7	200	400	—	6.01	786	47.3	100.0	22.21	—	—	—
5	5	2.0	10	5	200	400	7.22	23.53	173	40.7	86.0	14.56	—	—	—
5	6	2.0	14	7	200	400	—	0.81	813	6.6	14.0	69.21	—	—	—
5	7	2.0	14	7	200	400	—	5.58	848	47.3	100.0	24.46	—	—	—
5	8	2.0	14	7	200	400	7.50	28.95	133	38.5	81.4	14.24	—	—	—
5	9	2.0	14	7	200	400	—	0.96	915	8.8	18.6	69.16	—	—	—
5	10	1.5	14	7	200	400	—	5.74	834	47.9	100.0	25.84	—	—	—
5	11	1.5	14	7	200	400	7.50	40.11	92	36.9	77.0	13.44	—	—	1.40
5	12	1.5	14	7	200	400	—	1.17	942	11.0	23.0	67.34	—	—	—
5	13	1.5	14	7	200	400	—	5.54	—	—	—	26.41	—	—	1.60

Notes: - Retention time "relative to feed" is total column volume divided by volume feed rate.
 - Retention time "actual" is 80% of total column volume divided by volume feed rate and froth wash water rate.
 - Diluted solids content includes lauder water addition for product samples.
 - Actual solids content reflects product sample prior to lauder water addition.

18.C.7
2" KEN-FLOTE™ COLUMN TESTS
SET #4, FEED COMPOSITE, HEAD AND SCREEN ANALYSIS
Upper Freeport Seam Raw Coal
(Dried at 40° C and Pulverized)

I. Head Analysis: Set #4 Feed Composite

	<u>As-Determined</u>	<u>Dry Basis</u>
Moisture (Wt%)	0.91	—
Ash (Wt%)	26.06	26.30
Sulfur (Wt%)	2.55	2.53
Pyritic Sulfur (Wt%)	1.99	2.01

SET #4, BATCH #1, 2 RE-FLUTE™ COLUMBIAN RESINS
Upper Freeport Seam Raw Coal

Batch Feed Solids = 6.0 Wt%
Batch Frother Dosage = 0.45 #/T MIBC Frother
Batch Collector Dosages = 0.60 #/T No. 2 Fuel Oil
Batch Pyrite Depressant Dosage = 0.00 #/T Polyacrylic Acid

Batch	Test	Feed Rate (g/min.)	Solids Feed Rate		Froth Height		Compressed Air Use (40 PSI)		Lauder Water		Froth Wash Water		Retention Time (min.)		
			g/min	#/hr. ft.2	inches	% height	CFM	CFM/ft.2	CFM/TPH	ml/min.	% prod. flow	ml/min.	%feed flow	rel. to feed	actual
1	1	760	44.0	264	10	14	.053	2.41	18.3	400	345	200	26	4.9	3.1
1	2	719	43.9	263	10	14	.070	3.18	24.2	400	370	200	28	5.2	3.2
1	3	787	46.1	277	14	19	.070	3.18	23.0	400	381	200	25	4.7	3.0
1	4	822	44.0	264	14	19	0.053	2.41	18.3	400	506	200	24	4.5	2.9

Batch	Test	Air Rate (L/min.)	Froth Height (inches)	Froth Wash Depth (inches)	Froth Wash Water (ml/min.)	Laundry Water (ml/min.)	Diluted Solids Content (Wt%)	Actual Solids Content (Wt%)	Total Flow Rate (g/min.)	Solids Flow Rate (g/min.)	Column Performance (Dry Basis)				
											Yield (Wt%)	Ash (Wt%)	Sulfur (Wt%)	Pyr. Sulfur (Wt%)	
1	—	—	—	—	—	—	—	—	—	—	—	—	26.30	2.58	2.01
1	—	—	—	—	—	—	—	5.31	—	—	—	—	22.69	1.95	1.38
1	1	1.5	10	5	200	400	7.31	5.79	760	44.0	100.0	100.0	22.02	—	—
							—	32.50	116	37.7	85.7	85.7	12.59	—	—
							—	0.75	844	6.3	14.3	14.3	78.55	—	—
1	2	2.0	10	5	200	400	7.42	6.11	719	43.9	100.0	100.0	21.37	—	—
							—	34.91	108	37.7	85.9	85.9	11.47	—	—
							—	0.76	811	6.2	14.1	14.1	81.65	—	—
1	3	2.0	14	7	200	400	7.64	5.86	787	46.1	100.0	100.0	22.92	—	—
							—	36.76	105	38.6	83.7	83.7	11.62	—	—
							—	0.85	882	7.5	16.3	16.3	80.94	—	—
1	4	1.5	14	7	200	400	7.29	5.35	822	44.0	100.0	100.0	26.20	—	—
							—	44.18	79	34.9	79.3	79.3	12.41	—	—
							—	0.97	943	9.1	20.7	20.7	79.05	—	—
1	—	—	—	—	—	—	—	—	—	—	—	—	27.43	2.29	1.77

Notes: - Retention time "relative to feed" is total column volume divided by volume feed rate.
- Retention time "actual" is 80% of total column volume divided by volume feed rate and froth wash water rate.
- Diluted solids content includes laundry water addition for product samples.
- Actual solids content reflects product sample prior to laundry water addition.

18.C.9
 2" KEN-FLOTE COLUMN TESTS
 SET #5, FEED COMPOSITE, HEAD AND SCREEN ANALYSIS
 Upper Freeport Seam Raw Coal
 (Pulverized at PETC)

I. Head Analysis: Set #5 Feed Composite (PETC Grind Lot #5)

	<u>As-Determined</u>	<u>Dry Basis</u>
Moisture (Wt%)	0.73	---
Ash (Wt%)	25.97	26.15
Sulfur (Wt%)	2.52	2.54
Pyritic Sulfur (Wt%)	1.88	1.89

II. Screen Analysis (Dry Basis):

<u>Size Fraction</u> <u>(USA Mesh)</u>	<u>Direct</u> <u>(Wt%)</u>	<u>Cum. Passing</u> <u>(Wt%)</u>
Top x 30M	0.2	99.8
30M x 50M	1.0	98.8
50M x 70M	1.0	97.8
70M x 100M	1.4	96.4
100M x 200M	6.3	90.1
200M x 400M	13.0	77.1
400M x 0	<u>77.1</u>	0.0
	100.0	

Upper Freeport Seam Raw Coal

Batch Feed Solids = 6.0 Wt%
 Batch Frother Dosage = 0.45 #/T MIBC Frother
 Batch Collector Dosages = 0.60 #/T No. 2 Fuel Oil
 Batch Pyrite Depressant Dosage = 0.00 #/T Polyacrylic Acid

Batch	Test	Feed Rate			Froth Height		Compressed Air Use (40 PSI)		Launder Water		Froth Wash Water		Retention Time (min.)	
		g/min	g/min	#/hr. ft.2	inches	% height	CFM	CFM/ft.2	CFM/TPH	ml/min.	% feed flow	ml/min.	rel. to feed	actual
1	1	795	45.4	272	10	14	.053	2.41	17.7	400	190	200	4.7	3.0
1	2	792	47.8	287	10	14	.070	3.18	22.2	400	163	200	4.7	3.0
1	3	781	48.9	293	10	14	.070	3.18	21.7	400	165	200	4.8	3.0
1	4	819	51.3	308	14	19	.053	2.41	15.7	400	181	200	4.5	2.9
1	5	836	49.2	295	10	14	.053	2.41	16.3	400	194	200	4.4	2.9

Batch	Test	Air Rate (L/min.)	Froth Height (inches)	Froth Wash Depth (inches)	Froth Wash Water (ml/min.)	Launder Water (ml/min.)	Sample Head	Diluted Solids Content (Wt%)	Actual Solids Content (Wt%)	Column Performance (Dry Basis)			
										Yield (Wt%)	Ash (Wt%)	Sulfur (Wt%)	Pyr. Sulfur (Wt%)
1	1	1.5	10	5	200	400	Recon. Feed Product Tailings	6.42	5.71	100.0	25.02	2.54	1.89
1	2	2.0	10	5	200	400	Recon. Feed Product Tailings	6.42	6.03	100.0	24.53	2.54	1.89
1	3	2.0	14	7	200	400	Recon. Feed Product Tailings	6.53	17.31	100.0	25.15	2.54	1.89
1	4	1.5	14	7	200	400	Recon. Feed Product Tailings	6.88	19.32	100.0	25.66	2.54	1.89
1	5	1.5	10	5	200	400	Recon. Feed Product Tailings	6.62	19.47	100.0	27.04	2.54	1.89
1	—	—	—	—	—	—	End Feed	—	5.93	—	27.63	—	—

Notes: - Retention time "relative to feed" is total column volume divided by volume feed rate.
 - Retention time "actual" is 80% of total column volume divided by volume feed rate and froth wash water rate.
 - Diluted solids content includes launder water addition for product samples.
 - Actual solids content reflects product sample prior to launder water addition.

Upper Freeport Seam Raw Coal

Batch Feed Solids = 6.0 Wt%
 Batch Frother Dosage = 0.30 #/T MIBC Frother
 Batch Collector Dosages = 0.50 #/T No. 2 Fuel Oil
 Batch Pyrite Depressant Dosage = 0.00 #/T Polyacrylic Acid

Batch	Test	Feed Rate (g/min)	Solids Feed Rate		Froth Height		Compressed Air Use (40 PSI)			Lauder Water		Froth Wash Water		Retention Time (min.)	
			g/min	#/hr. ft.2	inches	% height	CFM	CFM/ft.2	CFM/TPH	ml/min.	% prod. flow	ml/min.	% feed flow	rel. to feed	actual
2	1	802	60.6	364	14	19	.053	2.41	13.3	600	359	200	25	4.6	3.0
2	2	827	48.8	293	14	19	.035	1.59	10.9	600	566	200	24	4.5	2.9
2	3	825	49.9	299	14	19	.035	1.59	10.6	600	857	200	36	4.5	2.7
2	4	836	51.8	311	14	19	.053	2.41	15.5	600	355	200	36	4.4	2.6
2	5	835	53.9	323	14	19	.053	2.41	14.9	600	319	200	24	4.5	2.9

Batch	Test	Air Rate (L/min.)	Froth Height (inches)	Froth Wash Depth (inches)	Froth Wash Water (ml/min.)	Lauder Water (ml/min.)	Sample Head	Diluted Solids Content (Wt%)	Actual Solids Content (Wt%)	Column Performance (Dry Basis)					
										Total Flow Rate (g/min.)	Solids Flow Rate (g/min.)	Yield (Wt%)	Ash (Wt%)	Sulfur (Wt%)	Pyr. Sulfur (Wt%)
2	1	1.5	14	7	200	600	Recon. Feed Product Tailings	5.55	7.56	802	60.6	100.0	28.23	—	—
2	2	1.0	14	7	200	600	Recon. Feed Product Tailings	3.82	25.47	167	42.2	70.3	14.01	—	—
2	3	1.0	14	7	200	600	Recon. Feed Product Tailings	—	2.16	835	18.0	29.7	69.89	—	—
2	4	1.5	14	7	200	600	Recon. Feed Product Tailings	—	5.90	827	48.8	100.0	26.15	—	—
2	5	1.5	14	7	200	600	Recon. Feed Product Tailings	3.04	25.47	106	27.0	55.3	12.35	—	—
2	—	—	—	—	—	—	End Feed	—	2.37	921	21.8	44.7	43.23	—	—
2	—	—	—	—	—	—	End Feed	—	6.05	825	49.9	100.0	25.71	—	—
2	—	—	—	—	—	—	End Feed	—	29.14	70	20.4	40.9	10.94	—	—
2	—	—	—	—	—	—	End Feed	—	2.80	1055	29.5	59.1	35.93	—	—
2	—	—	—	—	—	—	End Feed	—	6.20	836	51.8	100.0	26.04	—	—
2	—	—	—	—	—	—	End Feed	—	21.07	169	35.6	68.7	12.08	—	—
2	—	—	—	—	—	—	End Feed	—	1.68	967	16.2	31.3	56.67	—	—
2	—	—	—	—	—	—	End Feed	—	6.49	835	53.9	100.0	26.48	—	—
2	—	—	—	—	—	—	End Feed	—	20.64	188	38.8	72.0	12.90	—	—
2	—	—	—	—	—	—	End Feed	—	1.78	847	15.1	28.0	61.39	—	—
2	—	—	—	—	—	—	End Feed	—	6.22	—	—	—	26.99	—	—

Notes: - Retention time "relative to feed" is total column volume divided by volume feed rate.
 - Retention time "actual" is 80% of total column volume divided by volume feed rate and froth wash water rate.
 - Diluted solids content includes lauder water addition for product samples.
 - Actual solids content reflects product sample prior to lauder water addition.

Upper Freeport Seam Raw Coal

Batch Feed Solids = 6.0 Wt%
 Batch Frother Dosage = 0.30 #/T MIBC Frother
 Batch Collector Dosages = 0.50 #/T No. 2 Fuel Oil
 Batch Pyrite Depressant Dosage = 0.00 #/T Polyacrylic Acid

Batch	Test	Feed Rate (g/min)	Solids Feed Rate		Froth Height		Compressed Air Use (40 PSI)			Lauder Water		Froth Wash Water		Retention Time (min.)	
			g/min	#/hr. ft.2	inches	% height	CFM	CFM/ft.2	CFM/TPH	ml/min.	% prod. flow	ml/min.	%feed flow	rel. to feed	actual
3	1	765	45.3	272	14	19	.040	1.82	13.4	600	373	200	26	5.0	3.1
3	2	784	46.8	281	10	14	.040	1.82	13.0	600	331	200	26	4.7	3.0
3	3	803	48.1	289	10	14	.053	2.41	16.7	600	305	200	25	4.6	3.0
3	4	750	48.3	290	14	19	.053	2.41	16.6	600	328	200	26	4.8	3.0

Batch	Test	Air Rate (L/min.)	Froth Height (inches)	Froth Wash Depth (inches)	Froth Wash Water (ml/min.)	Lauder Water (ml/min.)	Sample Head	Diluted Solids Content (Wt%)	Actual Solids Content (Wt%)	Column Performance (Dry Basis)					
										Total Flow Rate (g/min.)	Solids Flow Rate (g/min.)	Yield (Wt%)	Ash (Wt%)	Sulfur (Wt%)	Pyr. Sulfur (Wt%)
3	—	—	—	—	—	—	—	—	—	—	—	—	26.16	2.54	1.89
3	—	—	—	—	—	—	Start Feed	—	5.66	—	—	—	24.68	—	—
3	1	1.25	10	5	200	600	Recon. Feed Product Tailings	4.52	5.92	100.0	24.31	—	—	—	—
								—	21.37	75.9	13.69	—	—	—	—
								—	1.36	24.1	57.75	—	—	—	—
3	2	1.25	10	5	200	600	Recon. Feed Product Tailings	—	5.97	100.0	24.52	—	—	—	—
								4.51	19.45	75.2	13.77	—	—	—	—
								—	1.44	24.8	57.13	—	—	—	—
3	3	1.5	14	7	200	600	Recon. Feed Product Tailings	—	5.99	100.0	24.93	—	—	—	—
								4.62	18.68	76.5	13.82	—	—	—	—
								—	1.40	23.5	61.02	—	—	—	—
3	4	1.5	14	7	200	600	Recon. Feed Product Tailings	—	6.19	100.0	24.86	—	—	—	—
								4.53	19.40	73.5	12.88	—	—	—	—
								—	1.61	26.5	58.09	—	—	—	—
3	4B	1.5	14	7	200	600	Recon. Feed Product Tailings	—	—	100.0	25.94	—	—	—	—
								—	—	71.1	12.78	—	—	—	—
								—	—	28.9	58.30	—	—	—	—
3	—	—	—	—	—	—	End Feed	—	5.84	—	26.00	—	—	—	—

- Notes:
- Retention time "relative to feed" is total column volume divided by volume feed rate.
 - Retention time "actual" is 80% of total column volume divided by volume feed rate and froth wash water rate.
 - Diluted solids content includes lauder water addition for product samples.
 - Actual solids content reflects product sample prior to lauder water addition.

Appendix D
ALL 2" LAB COLUMN TESTS
PITTSBURGH NO. 8 SEAM RAW COAL

Table 18.D.1: Batch 1-13 Head Analysis (Old Coal and PTI Grind)

Table 18.D.2: Batch #1 Feed Sump Mixing Tests (12" Recirculator Depth)

Table 18.D.3: Batch #2 Feed Sump Mixing Tests (9" Recirculator Depth)

Table 18.D.4: Batch #3 Tests, 0.80 #/T M-150, 0.80 #/T Fuel Oil, 0.00 #/T Polyacrylic Acid

Table 18.D.5: Batch #4 Tests, 0.80 #/T M-150, 0.80 #/T Fuel Oil, 0.40 #/T Polyacrylic Acid

Table 18.D.6: Batch #5 Tests, 0.60 #/T M-150, 0.60 #/T Fuel Oil, 0.00 #/T Polyacrylic Acid

Table 18.D.7: Batch #6 Tests, 0.60 #/T M-150, 0.60 #/T Fuel Oil, 0.30 #/T Polyacrylic Acid

Table 18.D.8: Batch #7 Tests, 0.45 #/T MIBC, 0.60 #/T Fuel Oil, 0.00 #/T Polyacrylic Acid

Table 18.D.9: Batch #8 Tests, 0.45 #/T MIBC, 0.60 #/T Fuel Oil, 0.300 #/T Polyacrylic Acid

Table 18.D.10: Batch #9 Tests, 0.60 #/T CM-670, 0.60 #/T Fuel Oil, 0.00 #/T Polyacrylic Acid

Table 18.D.11: Batch #10 Tests, 0.60 #/T CM-670, 0.60 #/T Fuel Oil, 0.30 #/T Polyacrylic Acid

Table 18.D.12: Batch #11 Tests, 0.45 #/T M-150 (Site), 0.60 #/T Fuel Oil, 0.00 #/T Polyacrylic Acid

Table 18.D.13: Batch #12 Tests, 0.45 #/T M-150 (Site), 0.60 #/T Fuel Oil, 0.30 #/T Polyacrylic Acid

Table 18.D.14: Batch #13 Tests, 0.45 #/T CM-670, 0.60 #/T Fuel Oil, 0.00 #/T Polyacrylic Acid

Table 18.D.1
 2" KEN-FLOTE™ COLUMN TESTS
 BATCH 1-13, FEED COMPOSITE, HEAD AND SCREEN ANALYSIS
 Pittsburgh No. 8 Seam Raw Coal
 (Dried at 40° C and Pulverized)

I. Head Analysis: Batch 1-13 Feed Composite

	<u>As-Determined</u>	<u>Dry Basis</u>
Moisture (Wt%)	1.26	---
Ash (Wt%)	28.75	29.12
Sulfur (Wt%)	5.20	5.27
Pyritic Sulfur (Wt%)	2.86	2.90

II. Screen Analysis (Dry Basis): Batch 1-13 Composite

Size Fraction (USA Mesh)	Direct (Wt%)	Cum. Passing (Wt%)
Top x 30M	0.0	100.0
30M x 50M	0.4	99.6
50M x 70M	4.3	95.3
70M x 100M	11.1	84.2
100M x 200M	26.6	57.6
200M x 400M	21.2	36.4
400M x 0	<u>36.4</u>	0.0
	100.0	

Table 18.D.2
2" KEN-FLOTE™ LAB COLUMN
FEED SUMP MIXING TESTS
PITTSBURGH NO. 8 SEAM RAW COAL (Batch #1)
(Recirculator Discharging 12" Down into Sump)

Conditions: - 6.0 Wt% Feed Solids
- 0.80 #/Ton Betz M-150 Frother
- 0.80 #/Ton No. 2 Fuel Oil Collector
- Put 10 GPM Recirculator Pump on Bottom of Sump
- Moved Feed Suction Point 10" Up Into Sump Directly Under Agitator
- Feed At 800 ml/min. and Compared 10 Minute Feed Increments Over Entire Feed Period
- Head Split was 28.38 Wt% Dry Ash, and 5.26 Wt% Dry Sulfur.

Sample #	Description	Recirc. Pump (%scale)	Feed Pump (%scale)	Final Sump Level (in. down)	Feed Sample Composition				
					Slurry Weight (lbs.)	Solids Content (Wt%)	Dry Ash (Wt%)	Dry Sulfur (Wt%)	Filtrate pH
1	Time zero to 10 minutes	100	19	3.00	17.91	5.62	25.45	—	—
2	Time 10 to 20 minutes	100	18	3.50	17.28	5.69	25.27	4.31	7.94
3	Time 20 to 30 minutes	100	18	4.00	17.43	5.91	24.45	—	—
4	Time 30 to 40 minutes	100	18	5.00	16.79	5.98	24.59	4.55	7.87
5	Time 40 to 50 minutes	100	18	5.50	16.64	5.99	24.44	—	—
6	Time 50 to 60 minutes	100	18	6.50	17.37	6.00	26.02	4.54	8.00
7	Time 60 to 70 minutes	100	18	7.50	18.01	5.68	28.07	—	—
8	Time 70 to 80 minutes	100	18	8.50	17.95	5.46	30.69	4.79	8.03
9*	Time 80 to 90 minutes	100	18	10.00	18.05	5.43	31.83	—	—
10	Time 90 to 100 minutes	100	18	12.00	18.18	5.53	31.33	5.11	7.91
11	Time 100 to 110 minutes	70	18	13.50	18.27	5.38	33.72	—	—
12	Time 110 to 114 minutes	70	18	16.50	7.64	5.34	32.24	5.16	8.05
13	Leftover in Sump	—	—	19.00	13.62	9.43	27.10	—	—

Notes: - * Feed was fairly consistent through Sample #9. We have only 90 minutes (1 hour and 30 minutes) to complete all tests when we are doing batch testing.

Table 18.D.3
2" KEN-FLOTE™ LAB COLUMN
FEED SUMP MIXING TESTS
PITTSBURGH NO. 8 SEAM RAW COAL (Batch #2)
(Recirculator Discharging 9" Down into Sump)

Conditions: - 6.0 Wt% Feed Solids
 - 0.80 #/Ton Betz M-150 Frother
 - 0.80 #/Ton No. 2 Fuel Oil Collector
 - Put 10 GPM Recirculator Pump on Bottom of Sump
 - Moved Feed Suction Point 10" Up Into Sump Directly Under Agitator
 - Feed At 800 ml/min. and Compared 10 Minute Feed Increments Over Entire Feed Period
 - Head Split was 29.74 Wt% Dry Ash, and 5.22 Wt% Dry Sulfur.

Sample #	Description	Recirc. Pump (%scale)	Feed Pump (%scale)	Final Sump Level (in. down)	Feed Sample Composition				
					Slurry Weight (lbs.)	Solids Content (Wt%)	Dry Ash (Wt%)	Dry Sulfur (Wt%)	Filtrate pH
1	Time zero to 10 minutes	100	18	3.00	17.80	5.59	25.09	---	---
2	Time 10 to 20 minutes	100	18	3.50	17.93	5.69	25.36	4.43	7.94
3	Time 20 to 30 minutes	100	19	4.00	17.66	5.92	24.40	---	---
4	Time 30 to 40 minutes	100	19	5.00	17.92	6.11	24.41	4.48	7.93
5	Time 40 to 50 minutes	100	19	5.50	18.27	6.09	24.93	---	---
6	Time 50 to 60 minutes	100	19	6.50	18.60	5.91	26.92	4.63	7.84
7	Time 60 to 70 minutes	100	19	7.50	17.89	5.39	31.33	---	---
8	Time 70 to 80 minutes	100	18	9.00	18.45	5.19	32.75	5.20	7.98
9*	Time 80 to 90 minutes	70	18	10.00	18.36	5.40	32.77	---	---
10	Time 90 to 100 minutes	70	18	12.00	18.03	5.70	32.41	5.24	8.01
11	Time 100 to 110 minutes	70	18	13.50	18.10	5.37	36.84	---	---
12	Leftover in Sump	---	---	19.00	14.34	10.49	24.78	6.33	8.00

Notes: - * Feed was fairly consistent through Sample #9. We have only 90 minutes (1 hour and 30 minutes)
 to complete all tests when we are doing batch testing.

Pittsburgh No. 8 Seam Raw Coal

Batch Feed Solids = 6.0 Wt%
 Batch Frother Dosage = 0.8 #/T Betz M-150 Frother
 Batch Collector Dosages = 0.8 #/T No. 2 Fuel Oil
 Batch Pyrite Depressant Dosage = 0.0 #/T Polyacrylic Acid

Batch	Test	Feed Rate (g/min.)	Solids Feed Rate		Froth Height		Compressed Air Use (40 PSI)		Lauder Water		Froth Wash Water		Retention Time (min.)		
			g/min	#/hr. ft. 2	inches	% height	CFM	CFM/ft. 2	CFM/TPH	ml/min.	% prod. flow	ml/min.	%feed flow	rel. to feed	actual
3	1	799	49.2	295	10	14	.053	2.41	16.3	400	203	200	25	4.7	3.0
3	2	802	49.7	298	10	14	.070	3.18	21.3	400	120	200	25	4.6	3.0
3	3	819	47.5	285	14	19	.070	3.18	22.3	400	151	200	24	4.5	2.9
3	4	838	48.6	292	14	19	.053	2.41	16.5	400	360	200	24	4.4	2.9

Batch	Test	Air Rate (L/min.)	Froth Height (inches)	Froth Wash Depth (inches)	Froth Wash Water (ml/min.)	Lauder Water (ml/min.)	Sample Head	Diluted Solids Content (Wt%)	Actual Solids Content (Wt%)	Total Flow Rate (g/min.)	Solids Flow Rate (g/min.)	Column Performance (Dry Basis)			
												Yield (Wt%)	Ash (Wt%)	Sulfur (Wt%)	Pyr. Sulfur (Wt%)
3	—	—	—	—	—	—	—	—	—	—	—	—	29.26	5.31	2.90
3	—	—	—	—	—	—	Start Feed	—	5.81	—	—	—	24.52	4.31	2.40
3	1	1.5	10	5	200	400	Recon. Feed Product Tailings	6.83	6.16	799	49.20	100.00	23.46	4.49	2.40
								—	20.71	197	40.80	82.90	13.16	4.75	2.37
								—	1.05	802	8.40	17.10	73.40	3.21	2.52
3	2	2.0	10	5	200	400	Recon. Feed Product Tailings	—	6.20	802	49.70	100.00	24.07	—	—
								5.74	12.65	332	42.00	84.50	14.62	4.80	—
								—	1.15	670	7.70	15.50	75.60	—	—
3	3	2.0	14	7	200	400	Recon. Feed Product Tailings	—	5.80	819	47.50	100.00	27.77	—	—
								5.59	14.04	265	37.20	78.30	15.24	—	—
								—	1.37	754	10.30	21.70	75.10	—	—
3	4	1.5	14	7	200	400	Recon. Feed Product Tailings	—	5.80	838	48.60	100.00	28.35	4.84	—
								6.97	32.07	111	35.60	73.20	12.12	4.96	2.42
								—	1.40	927	13.00	26.80	72.66	4.53	—
3	—	—	—	—	—	—	End Feed	—	5.32	—	—	—	30.76	4.82	2.83

Notes: - Retention time "relative to feed" is total column volume divided by volume feed rate.
 - Retention time "actual" is 80% of total column volume divided by volume feed rate and froth wash water rate.
 - Diluted solids content includes lauder water addition for product samples.
 - Actual solids content reflects product sample prior to lauder water addition.

Pittsburgh No. 8 Seam Raw Coal

Batch Feed Solids = 6.0 Wt%
 Batch Frother Dosage = 0.8 #/T Betz M-150 Frother
 Batch Collector Dosages = 0.8 #/T No. 2 Fuel Oil
 Batch Pyrite Depressant Dosage = 0.4 #/T Polyacrylic Acid

Batch	Test	Feed Rate (g/min.)	Solids Feed Rate		Froth Height		Compressed Air Use (40 PSI)			Launder Water		Froth Wash Water		Retention Time (min.)	
			g/min	#/hr. ft.2	inches	% height	CFM	CFM/ft.2	CFM/TPH	ml/min.	% prod. flow	ml/min.	% feed flow	rel. to feed	actual
4	1	799	50.7	304	10	14	.053	2.41	15.8	400	190	200	25	4.7	3.0
4	2	832	50.4	302	10	14	.070	3.18	21.0	400	119	200	24	4.5	2.9
4	3	784	49.9	299	14	19	.070	3.18	21.3	400	127	200	26	4.7	3.0
4	4	856	48.8	293	14	19	.053	2.41	16.5	400	336	200	23	4.3	2.8

Batch	Test	Air Rate (l/min.)	Froth Height (inches)	Froth Wash Depth (inches)	Froth Wash Water (ml/min.)	Launder Water (ml/min.)	Sample Head	Diluted Solids Content (Wt%)	Actual Solids Content (Wt%)	Total Flow Rate (g/min.)	Solids Flow Rate (g/min.)	Column Performance (Dry Basis)			
												Yield (Wt%)	Ash (Wt%)	Sulfur (Wt%)	Pyr. Sulfur (Wt%)
4	—	—	—	—	—	—	—	—	—	—	—	—	—	—	2.90
4	—	—	—	—	—	—	Start Feed	—	5.65	—	—	—	24.69	4.41	2.90
4	1	1.5	10	5	200	400	Recon. Feed Product Tailings	7.15	6.35	799	50.70	100.00	22.67	—	—
								—	20.76	210	43.60	86.00	14.15	4.82	2.39
								—	0.90	789	7.10	14.00	75.03	—	—
4	2	2.0	10	5	200	400	Recon. Feed Product Tailings	—	6.06	832	50.40	100.00	24.08	—	—
								5.95	13.04	335	43.70	86.17	15.69	—	—
								—	0.96	697	6.70	13.30	78.81	—	—
4	3	2.0	14	7	200	400	Recon. Feed Product Tailings	—	6.36	784	49.90	100.00	24.84	—	—
								5.98	13.60	314	42.70	85.60	15.83	—	—
								—	1.07	670	7.20	14.40	78.43	—	—
4	4	1.5	14	7	200	400	Recon. Feed Product Tailings	—	5.70	856	48.8	100.00	28.97	4.90	3.03
								7.09	30.92	119	36.8	75.40	13.91	5.02	2.65
								—	1.28	937	12.0	24.60	75.12	4.55	4.20
4	—	—	—	—	—	—	End Feed	—	5.53	—	—	—	30.62	4.93	—

* After Test #2, We increased polyacrylic acid dosage for 0.4 #/T to approximately 1.0 #/T for Tests #3 and #4.
 Notes: - Retention time "relative to feed" is total column volume divided by volume feed rate.
 - Retention time "actual" is 80% of total column volume divided by volume feed rate and froth wash water rate.
 - Diluted solids content includes launder water addition for product samples.
 - Actual solids content reflects product sample prior to launder water addition.

Pittsburgh No. 8 Seam Raw Coal

Batch Feed Solids = 6.0 Wt%
 Batch Frother Dosage = 0.6 #/T Betz M-150 Frother
 Batch Collector Dosages = 0.6 #/T No. 2 Fuel Oil
 Batch Pyrite Depressant Dosage = 0.0 #/T Polyacrylic Acid

Batch	Test	Feed Rate (g/min.)	Solids Feed Rate		Froth Height		Compressed Air Use (40 PSI)			Launder Water		Froth Wash Water		Retention Time (min.)	
			g/min	#/hr. ft. 2	inches	% height	CFM	CFM/ft. 2	CFM/TPH	ml/min.	% prod. flow	ml/min.	%feed flow	rel. to feed	actual
5	1	801	44.0	264	10	14	.053	2.41	18.3	400	278	200	25	4.6	3.0
5	2	834	47.8	287	10	14	.070	3.18	22.2	400	161	200	24	4.5	2.9
5	3	825	46.4	278	14	19	.070	3.18	22.9	400	231	200	24	4.5	2.9
5	4	825	48.1	289	14	19	.053	2.41	16.7	400	377	200	24	4.5	2.9

Batch	Test	Air Rate (L/min.)	Froth Height (inches)	Froth Wash Depth (inches)	Froth Wash Water (ml/min.)	Launder Water (ml/min.)	Diluted Solids Content (Wt%)	Actual Solids Content (Wt%)	Total Flow Rate (g/min.)	Solids Flow Rate (g/min.)	Column Performance (Dry Basis)				
											Yield (Wt%)	Ash (Wt%)	Sulfur (Wt%)	Pyr. Sulfur (Wt%)	
5	—	—	—	—	—	—	—	—	—	—	—	—	—	—	2.90
5	—	—	—	—	—	—	—	5.22	—	—	—	—	26.08	—	—
5	1	1.5	10	5	200	400	6.36	5.49	801	44.0	—	100.0	24.56	—	—
								24.03	144	34.6	—	78.6	12.35	—	—
								1.10	857	9.4	—	21.4	69.40	—	—
5	2	2.0	10	5	200	400	—	5.73	834	47.8	—	100.0	24.20	—	—
								15.62	249	38.9	—	81.4	12.86	—	—
								1.13	785	8.9	—	18.6	73.85	—	—
5	3	2.0	14	7	200	400	—	5.62	825	46.4	—	100.0	26.34	—	—
								20.64	173	35.7	—	76.9	12.11	—	—
								1.26	852	10.7	—	23.1	73.70	—	—
5	4	1.5	14	7	200	400	—	5.83	825	48.1	—	100.0	27.79	—	—
								32.45	106	34.4	—	71.5	10.52	—	—
								1.49	919	13.7	—	28.5	71.10	—	—
5	—	—	—	—	—	—	—	5.56	—	—	—	—	26.92	—	—

Notes: - Retention time "relative to feed" is total column volume divided by volume feed rate.
 - Retention time "actual" is 80% of total column volume divided by volume feed rate and froth wash water rate.
 - Diluted solids content includes launder water addition for product samples.
 - Actual solids content reflects product sample prior to launder water addition.

Pittsburgh No. 8 Seam Raw Coal

Batch Feed Solids = 6.0 Wt%
 Batch Frother Dosage = 0.60 #/T Betz M-150 Frother
 Batch Collector Dosages = 0.60 #/T No. 2 Fuel Oil
 Batch Pyrite Depressant Dosage = 0.30 #/T Polyacrylic Acid at Start

Batch	Test	Feed Rate (g/min.)	Solids Feed Rate		Froth Height		Compressed Air Use (40 PSI)			Lauder Water		Froth Wash Water		Retention Time (min.)	
			g/min	#/hr. ft. 2	inches	% height	CFM	CFM/ft. 2	CFM/TPH	ml/min.	% prod. flow	ml/min.	%feed flow	rel. to feed	actual
6	1	767	42.6	256	10	14	.053	2.41	18.9	400	315	200	26	4.8	3.1
6	2	786	45.9	275	10	14	.070	3.18	23.1	400	192	200	25	4.7	3.0
6	3	794	48.9	293	14	19	.070	3.18	21.7	400	216	200	25	4.7	3.0
6	4	833	50.4	302	14	19	.053	2.41	15.9	400	408	200	24	4.5	2.9

Batch	Test	Air Rate (L/min.)	Froth Height (inches)	Froth Wash Depth (inches)	Froth Wash Water (ml/min.)	Lauder Water (ml/min.)	Sample Head	Diluted Solids Content (Wt%)	Actual Solids Content (Wt%)	Total Flow Rate (g/min.)	Solids Flow Rate (g/min.)	Column Performance (Dry Basis)				Pyr. Sulfur (Wt%)																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																											
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* After Test #2 we increased Polyacrylic Acid addition from 0.30 #/T to approximately 0.80 #/T for Tests #3 and #4.
 Notes: - Retention time "relative to feed" is total column volume divided by volume feed rate.
 - Retention time "actual" is 80% of total column volume divided by volume feed rate and froth wash water rate.
 - Diluted solids content includes lauder water addition for product samples.
 - Actual solids content reflects product sample prior to lauder water addition.

Pittsburgh No. 8 Seam Raw Coal

Batch Feed Solids = 6.0 Wt%
 Batch Frother Dosage = 0.45 #/T MIBC Frother
 Batch Collector Dosages = 0.60 #/T No. 2 Fuel Oil
 Batch Pyrite Depressant Dosage = 0.0 #/T Polyacrylic Acid

Batch	Test	Feed Rate		Solids Feed Rate		Froth Height		Compressed Air Use (40 PSI)		Lauder Water		Froth Wash Water		Retention Time (min.)	
		(g/min.)	(g/min.)	g/min	#/hr. ft.2	inches	% height	CFM	CFM/ft.2	CFM/TPH	ml/min.	% feed flow	ml/min.	rel. to feed	actual
7	1	771	42.7	256	10	14	2.41	.053	18.8	400	465	26	200	4.8	3.1
7	2	783	45.7	274	10	14	3.18	.070	23.2	400	357	26	200	4.7	3.0
7	3	800	47.6	286	14	19	3.18	.070	22.3	400	455	25	200	4.6	3.0
7	4	820	45.0	270	14	19	2.41	.053	17.8	400	588	24	200	4.5	2.9

Batch	Test	Air Rate (U/min.)	Froth Height (inches)	Froth Wash Depth (inches)	Froth Wash Water (ml/min.)	Lauder Water (ml/min.)	Sample Head	Diluted Solids Content (Wt%)	Actual Solids Content (Wt%)	Total Flow Rate (g/min.)	Solids Flow Rate (g/min.)	Column Performance (Dry Basis)			
												Yield (Wt%)	Ash (Wt%)	Sulfur (Wt%)	Pyr. Sulfur (Wt%)
7	—	—	—	—	—	—	—	—	—	—	—	—	28.99	5.10	2.90
7	—	—	—	—	—	—	Start Feed	—	5.12	—	—	—	26.62	4.32	2.31
7	1	1.5	10	5	200	400	Recon. Feed Product Tailings	7.14	5.54	771	42.7	100.0	25.48	—	—
								—	40.35	86	34.7	81.3	12.63	—	—
								—	0.90	885	8.0	18.7	81.34	—	—
7	2	2.0	10	5	200	400	Recon. Feed Product Tailings	7.29	5.84	783	45.7	100.0	24.26	—	—
								—	33.30	112	37.3	81.6	11.69	—	—
								—	0.96	871	8.4	18.4	79.98	—	—
7	3	2.0	14	7	200	400	Recon. Feed Product Tailings	7.64	5.95	800	47.6	100.0	25.12	4.45	2.49
								—	42.39	88	37.3	78.4	10.92	4.57	2.24
								—	1.13	912	10.3	21.6	76.65	4.02	3.40
7	4	1.5	14	7	200	400	Recon. Feed Product Tailings	6.94	5.49	820	45.0	100.0	28.18	4.46	—
								—	47.79	68	32.5	72.2	10.08	4.64	2.32
								—	131.00	952	12.5	27.8	75.20	3.99	—
7	—	—	—	—	—	—	End Feed	—	5.73	—	—	—	27.88	4.51	2.78

Notes: - Retention time "relative to feed" is total column volume divided by volume feed rate.
 - Retention time "actual" is 80% of total column volume divided by volume feed rate and froth wash water rate.
 - Diluted solids content includes lauder water addition for product samples.
 - Actual solids content reflects product sample prior to lauder water addition.

Pittsburgh No. 8 Seam Raw Coal

Batch Feed Solids = 6.0 Wt%
 Batch Frother Dosage = 0.45 #/T MIBC Frother
 Batch Collector Dosages = 0.60 #/T No. 2 Fuel Oil
 Batch Pyrite Depressant Dosage = 0.30 #/T Polyacrylic Acid at Start

Batch	Test	Feed Rate (g/min.)	Solids Feed Rate		Froth Height		Compressed Air Use (40 PSI)			Launder Water		Froth Wash Water		Retention Time (min.)	
			g/min	#/hr. ft.2	inches	% height	CFM	CFM/ft.2	CFM/TPH	ml/min.	% prod. flow	ml/min.	%feed flow	rel. to feed	actual
8	1	744	43.0	258	10	14	.053	2.41	18.7	400	513	200	27	5.0	3.1
8	2	775	45.4	272	10	14	.070	3.18	23.4	400	444	200	26	4.8	3.0
8	3	793	47.6	286	14	19	.070	3.18	22.3	400	476	200	25	4.7	3.0
8	4	820	46.3	278	14	19	.053	2.41	17.3	400	678	200	24		

Batch	Test	Air Rate (L/min.)	Froth Height (inches)	Froth Wash Depth (inches)	Froth Wash Water (ml/min.)	Launder Water	Sample Head	Diluted Solids Content (Wt%)	Actual Solids Content (Wt%)	Total Flow Rate (g/min.)	Solids Flow Rate (g/min.)	Column Performance (Dry Basis)			
												Yield (Wt%)	Ash (Wt%)	Sulfur (Wt%)	Pyr. Sulfur (Wt%)
8	—	—	—	—	—			—	—	—	—	—	28.28	5.23	2.90
8	—	—	—	—	—	Start Feed		—	5.25	—	—	—	26.57	—	—
8	1	1.5	10	5	200	400	Recon. Feed Product Tailings	7.49	5.78	744	43.0	100.0	24.27	—	—
								—	45.90	78	35.8	83.3	13.20	—	—
								—	0.83	866	7.2	16.7	79.49	—	—
8	2	2.0	10	5	200	400	Recon. Feed Product Tailings	7.55	5.86	775	45.4	100.0	24.65	—	—
								—	41.11	90	37.0	81.5	12.46	—	—
								—	0.95	885	8.4	18.5	78.37	—	—
8	3*	2.0	14	7	200	400	Recon. Feed Product Tailings	7.54	6.00	793	47.6	100.0	25.48	4.60	2.33
								—	43.45	84	36.5	76.7	11.39	4.67	
								—	1.22	909	11.1	23.3	71.86	4.36	
8	4	1.5	14	7	200	400	Recon. Feed Product Tailings	7.08	5.65	820	46.3	100.0	28.37		
								—	55.08	59	32.5	70.2	10.64	4.76	
								—	1.44	961	13.8	29.8	70.15		
8	—	—	—	—	—	End Feed		—	5.80	—	—	—	27.87	4.77	2.83

* After Test #2 we increased Polyacrylic Acid addition from 0.30 #/T to approximately 0.80 #/T for Tests #3 and #4.
 Notes: - Retention time "relative to feed" is total column volume divided by volume feed rate.
 - Retention time "actual" is 80% of total column volume divided by volume feed rate and froth wash water rate.
 - Diluted solids content includes launder water addition for product samples.
 - Actual solids content reflects product sample prior to launder water addition.

Pittsburgh No. 8 Seam Raw Coal

Batch Feed Solids = 6.0 Wt%
 Batch Frother Dosage = 0.60 #/T CM-670 Frother
 Batch Collector Dosages = 0.60 #/T No. 2 Fuel Oil
 Bat.h Pyrite Depressant Dosage = 0.0 #/T Polyacrylic Acid

Batch	Test	Feed Rate		Solids Feed Rate		Froth Height		Compressed Air Use (40 PSI)		Lauder Water		Froth Wash Water		Retention Time (min.)	
		(g/min.)	(g/min.)	g/min	#/hr. ft.2	inches	% height	CFM	CFM/ft.2	CFM/TPH	ml/min.	% prod. flow	ml/min.	rel. to feed	actual
9	1	768	45.6	274	14	10	14	.053	2.41	17.6	400	255	200	4.8	3.1
9	2	750	47.5	285	14	10	14	.070	3.18	22.3	400	119	200	5.0	3.1
9	3	772	47.9	287	14	14	19	.070	3.18	22.1	400	148	200	4.8	3.1
9	4	804	45.6	274	14	14	19	.053	2.41	17.6	400	417	200	4.6	3.0

Batch	Test	Air Rate (L/min.)	Froth Height (inches)	Froth Wash Depth (inches)	Froth Wash Water (ml/min.)	Lauder Water (ml/min.)	Diluted Solids Content (Wt%)	Actual Solids Content (Wt%)	Total Flow Rate (g/min.)	Solids Flow Rate (g/min.)	Column Performance (Dry Basis)			
											Yield (Wt%)	Ash (Wt%)	Sulfur (Wt%)	Pyr. Sulfur (Wt%)
9	—	—	—	—	—	—	—	—	—	—	—	28.87	5.23	2.90
9	—	—	—	—	—	—	—	5.28	—	—	—	26.43	—	—
9	1	1.5	10	5	200	400	6.91	5.94	768	45.6	100.0	24.04	—	—
								24.52	157	38.5	84.4	14.66	—	—
								0.88	811	7.1	15.6	74.78	—	—
9	2	2.0	10	5	200	400	—	6.33	750	47.5	100.0	23.86	—	—
							5.61	12.30	335	41.2	86.7	15.66	—	—
								1.02	615	6.3	13.3	77.32	—	—
9	3	2.0	14	10	200	400	—	6.20	772	47.9	100.0	25.18	—	—
							5.98	14.80	271	40.1	83.7	15.01	—	—
								1.11	701	7.8	16.3	77.39	—	—
9	4	1.5	14	10	200	400	—	5.67	804	45.6	100.0	28.28	—	—
							6.98	36.04	96	34.6	75.9	13.37	—	—
								1.21	908	11.0	24.1	75.24	—	—
9	—	—	—	—	—	—	—	5.59	—	—	—	29.69	—	—

Notes: - Retention time "relative to feed" is total column volume divided by volume feed rate.
 - Retention time "actual" is 80% of total column volume divided by volume feed rate and froth wash water rate.
 - Diluted solids content includes lauder water addition for product samples.
 - Actual solids content reflects product sample prior to lauder water addition.

Pittsburgh No. 8 Seam Raw Coal

Batch Feed Solids = 6.0 Wt%
 Batch Frother Dosage = 0.60 #/T Betz CM-670 Frother
 Batch Collector Dosages = 0.60 #/T No. 2 Fuel Oil
 Batch Pyrite Depressant Dosage = 0.30 #/T Polyacrylic Acid at Start

Batch	Test	Feed Rate (g/min.)	Solids Feed Rate		Froth Height		Compressed Air Use (40 PSI)		Launder Water		Froth Wash Water		Retention Time (min.)		
			g/min	#/hr. ft. 2	inches	% height	CFM	CFM/ft. 2	CFM/TPH	ml/min.	% prod. flow	ml/min.	%feed flow	rel. to feed	actual
10	1	803	47.5	285	10	14	.053	2.41	16.9	400	227	200	25	4.6	3.0
10	2	797	50.9	305	10	14	.070	3.18	20.8	400	114	200	25	4.7	3.0
10	3	833	48.2	289	14	19	.070	3.18	22.0	400	141	200	24	4.5	2.9
10	4	824	48.8	293	14	19	.053	2.41	16.5	400	348	200	24	4.5	2.9

Batch	Test	Air Rate (L/min.)	Froth Height (inches)	Froth Wash Depth (inches)	Froth Wash Water (ml/min.)	Launder Water (ml/min.)	Sample Head	Diluted Solids Content (Wt%)	Actual Solids Content (Wt%)	Total Flow Rate (g/min.)	Solids Flow Rate (g/min.)	Column Performance (Dry Basis)			
												Yield (Wt%)	Ash (Wt%)	Sulfur (Wt%)	Pyr. Sulfur (Wt%)
10	—	—	—	—	—	—	—	—	—	—	—	—	—	5.17	2.90
10	—	—	—	—	—	—	Start Feed	—	5.41	—	—	—	24.88	—	—
10	1	1.5	10	5	200	400	Recon. Feed Product Tailings	7.05	5.92	803	47.5	100.0	23.68	—	—
								—	23.07	176	40.6	85.5	14.85	—	—
								—	0.83	827	6.9	14.5	75.76	—	—
10	2	2.0	10	5	200	400	Recon. Feed Product Tailings	—	6.39	797	50.9	100.0	23.20	—	—
								5.97	12.76	352	44.9	88.2	15.76	—	—
								—	0.93	645	6.0	11.8	78.75	—	—
10	3*	2.0	14	7	200	400	Recon. Feed Product Tailings	—	5.79	833	48.2	100.0	25.98	—	—
								5.89	14.20	283	40.2	83.4	15.66	—	—
								—	1.07	750	8.0	16.6	77.83	—	—
10	4	1.5	14	7	200	400	Recon. Feed Product Tailings	—	5.92	824	48.8	100.0	26.92	—	—
								7.46	33.39	115	38.4	78.7	13.73	—	—
								—	1.14	909	10.4	21.3	75.64	—	—
10	—	—	—	—	—	—	End Feed	—	5.51	—	—	—	28.79	—	—

* After Test #2 we increased Polyacrylic Acid addition from 0.30 #/T to approximately 0.80 #/T for Tests #3 and #4.
 Notes: - Retention time "relative to feed" is total column volume divided by volume feed rate.
 - Retention time "actual" is 80% of total column volume divided by volume feed rate and froth wash water rate.
 - Diluted solids content includes launder water addition for product samples.
 - Actual solids content reflects product sample prior to launder water addition.

Pittsburgh No. 8 Seam Raw Coal

Batch Feed Solids = 6.0 Wt%
 Batch Frother Dosage = 0.45 #/T Betz M-150 Frother (Site)
 Batch Collector Dosages = 0.60 #/T No. 2 Fuel Oil
 Batch Pyrite Depressant Dosage = 0.0 #/T Polyacrylic Acid

Batch	Test	Feed Rate (g/min.)	Solids Feed Rate		Froth Height		Compressed Air Use (40 PSI)			Launder Water		Froth Wash Water		Retention Time (min.)	
			g/min	#/hr. ft.2	inches	% height	CFM	CFM/ft.2	CFM/TPH	ml/min.	% prod. flow	ml/min.	%feed flow	rel. to feed	actual
11	1	827	47.5	285	10	14	.053	2.41	16.9	400	404	200	24	4.5	2.9
11	2	835	50.3	302	10	14	.070	3.18	21.1	400	267	200	24	4.5	2.9
11	3	836	52.3	314	14	19	.070	3.18	20.3	400	331	200	24	4.5	2.9
11	4	805	50.7	304	14	19	.053	2.41	15.8	400	533	200	25	4.6	3.0

Batch	Test	Air Rate (L/min.)	Froth Height (inches)	Froth Wash Depth (inches)	Froth Wash Water (ml/min.)	Launder Water (ml/min.)	Column Performance (Dry Basis)								
							Total Flow Rate (g/min.)	Solids Flow Rate (g/min.)	Yield (Wt%)	Ash (Wt%)	Sulfur (Wt%)	Pyr. Sulfur (Wt%)			
11	1	1.5	10	5	200	400	827	47.5	37.17	100.0	24.57	—	—	—	—
							99	36.8	5.74	77.5	10.91	—	—	—	—
							928	10.7	1.15	22.5	71.36	—	—	—	—
11	2	2.0	10	5	200	400	835	50.3	6.02	100.0	25.56	—	—	—	—
							150	39.6	26.40	78.7	11.94	—	—	—	—
							885	10.7	1.21	21.3	75.89	—	—	—	—
11	3	2.0	14	7	200	400	836	52.3	6.26	100.0	26.19	—	4.53	—	—
							121	39.8	32.89	76.1	10.92	—	4.71	—	—
							915	12.5	1.37	23.9	74.80	—	3.96	—	—
11	4	1.5	14	7	200	400	805	50.7	6.30	100.0	27.18	—	—	—	—
							75	36.1	48.13	71.2	9.53	—	4.88	—	—
							930	14.6	1.57	28.8	70.83	—	—	—	—
11	—	—	—	—	—	—	—	—	6.03	—	28.79	—	—	4.67	—

Notes: - Retention time "relative to feed" is total column volume divided by volume feed rate.
 - Retention time "actual" is 80% of total column volume divided by volume feed rate and froth wash water rate.
 - Diluted solids content includes launder water addition for product samples.
 - Actual solids content reflects product sample prior to launder water addition.

Pittsburgh No. 8 Seam Raw Coal

Batch Feed Solids = 6.0 Wt%
 Batch Frother Dosage = 0.45 #/T Betz M-150 Frother (Site)
 Batch Collector Dosages = 0.60 #/T No. 2 Fuel Oil
 Batch Pyrite Depressant Dosage = 0.30 #/T Polyacrylic Acid at Start

Batch	Test	Feed Rate (g/min.)	Solids Feed Rate		Froth Height		Compressed Air Use (40 PSI)		Laundry Water		Froth Wash Water		Retention Time (min.)		
			g/min	#/hr. ft.2	inches	% height	CFM	CFM/ft.2	CFM/TPH	ml/min.	% prod. flow	ml/min.	% feed flow	rel. to feed	actual
12	1	777	44.9	269	10	14	.053	2.41	17.9	400	526	200	26	4.8	3.0
12	2	818	48.2	289	10	14	.070	3.18	22.0	400	303	200	24	4.5	2.9
12	3	806	49.6	298	14	19	.070	3.18	21.4	400	357	200	25	4.6	3.0
12	4	819	49.1	295	14	19	.053	2.41	16.4	400	625	200	24	4.5	2.9

Batch	Test	Air Rate (L/min.)	Froth Height (inches)	Froth Wash Depth (inches)	Froth Wash Water (ml/min.)	Laundry Water (ml/min.)	Diluted Solids Content (Wt%)	Actual Solids Content (Wt%)	Total Flow Rate (g/min.)	Solids Flow Rate (g/min.)	Column Performance (Dry Basis)				
											Yield (Wt%)	Ash (Wt%)	Sulfur (Wt%)	Pyr. Sulfur (Wt%)	
12	—	—	—	—	—	—	—	—	—	—	30.26	5.14	2.90		
12	—	—	—	—	—	—	—	5.26	—	—	26.27	—	—		
12	1	1.5	10	5	200	400	7.18	5.78	777	44.9	25.37	100.0	25.37	—	—
							—	45.00	76	34.2	11.72	76.2	11.72	—	—
							—	1.19	901	10.7	69.07	23.8	69.07	—	—
12	2	2.0	10	5	200	400	—	5.89	818	48.2	24.62	100.0	24.62	—	—
							7.24	29.17	132	38.5	12.20	79.9	12.20	—	—
							—	1.09	886	9.7	73.98	20.1	73.98	—	—
12	3*	2.0	14	7	200	400	—	6.15	806	49.6	24.82	100.0	24.82	4.52	—
							7.68	35.09	112	39.3	11.66	79.2	11.66	4.75	—
							—	1.15	894	10.3	74.94	20.8	74.94	3.63	—
12	4	1.5	14	7	200	400	—	6.00	819	49.1	27.01	100.0	27.01	4.72	—
							7.76	56.25	64	36.0	10.51	73.3	10.51	4.79	—
							—	1.37	955	13.1	72.31	26.7	72.31	4.52	—
12	—	—	—	—	—	—	—	5.73	—	—	28.55	—	28.55	4.92	—

* After Test #2 we increased Polyacrylic Acid addition from 0.30 #/T to approximately 0.80 #/T for Tests #3 and #4.

- Notes:
- Retention time "relative to feed" is total column volume divided by volume feed rate.
 - Retention time "actual" is 80% of total column volume divided by volume feed rate and froth wash water rate.
 - Diluted solids content includes laundry water addition for product samples.
 - Actual solids content reflects product sample prior to laundry water addition.

Pittsburgh No. 8 Seam Raw Coal

Batch Feed Solids = 6.0 Wt%
 Batch Frother Dosage = 0.45 #/T CM-670 Frother
 Batch Collector Dosages = 0.60 #/T No. 2 Fuel Oil
 Batch Pyrite Depressant Dosage = 0.0 #/T Polyacrylic Acid

Batch	Test	Feed Rate (g/min.)	Solids Feed Rate		Froth Height		Compressed Air Use (40 PSI)		Lauder Water		Froth Wash Water		Retention Time (min.)		
			g/min	#/hr. ft. 2	inches	% height	CFM	CFM/ft. 2	CFM/TPH	ml/min.	% prod. flow	ml/min.	% feed flow	rel. to feed	actual
13	1	781	44.8	269	10	14	.053	2.41	17.9	400	364	200	26	4.8	3.0
13	2	825	48.8	293	10	14	.070	3.18	21.7	400	159	200	24	4.5	2.9
13	3	816	49.8	299	14	19	.070	3.18	21.3	400	195	200	25	4.6	2.9
13	4	845	46.2	277	14	19	.053	2.41	17.4	400	533	200	24	4.4	2.8

Batch	Test	Air Rate (L/min.)	Froth Height (inches)	Froth Wash Depth (inches)	Froth Wash Water (ml/min.)	Lauder Water (ml/min.)	Diluted Solids Content (Wt%)	Actual Solids Content (Wt%)	Total Flow Rate (g/min.)	Solids Flow Rate (g/min.)	Column Performance (Dry Basis)				
											Yield (Wt%)	Ash (Wt%)	Sulfur (Wt%)	Pyr. Sulfur (Wt%)	
13	—	—	—	—	—	—	—	—	—	—	29.71	5.02	2.90	—	—
13	—	—	—	—	—	—	—	5.26	—	—	25.40	—	—	—	—
13	1	1.5	10	5	200	400	7.25	33.64	781	44.8	37.0	82.6	23.99	—	—
							—	0.90	871	7.8	7.7	17.4	12.08	—	—
							—	—	—	—	75.79	—	—	—	—
13	2	2.0	10	5	200	400	6.30	16.31	825	48.8	41.1	100.0	24.33	—	—
							—	1.00	773	7.7	7.7	15.8	14.25	—	—
							—	—	—	—	78.06	—	—	—	—
13	3	2.0	14	7	200	400	6.76	19.95	816	49.8	40.9	100.0	25.29	4.63	—
							—	1.10	205	8.9	8.9	82.1	14.32	4.93	—
							—	—	811	11.8	11.8	17.9	75.58	3.28	—
13	4	1.5	14	7	200	400	7.24	45.87	845	46.2	34.4	100.0	29.53	—	—
							—	1.22	75	11.8	11.8	74.5	13.45	—	—
							—	—	970	11.8	11.8	25.5	76.51	—	—
13	—	—	—	—	—	—	—	5.58	—	—	29.72	—	—	—	—

Notes: - Retention time "relative to feed" is total column volume divided by volume feed rate.
 - Retention time "actual" is 80% of total column volume divided by volume feed rate and froth wash water rate.
 - Diluted solids content includes lauder water addition for product samples.
 - Actual solids content reflects product sample prior to lauder water addition.

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