

**FIFTH QUARTERLY  
TECHNICAL PROGRESS REPORT  
(JULY, 1995 THROUGH SEPTEMBER, 1995)**

**BENCH-SCALE TESTING OF THE  
MICRONIZED MAGNETITE PROCESS**

**DOE Contract No. DE-AC22-93PC92206  
Custom Coals International Project No. 94002**

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Pittsburgh, PA 15236-0940

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**Submitted By:**

Custom Coals Corporation  
100 First Avenue, Suite 500  
Pittsburgh, PA 15222  
PH: (412) 642-2621  
FX: (412) 642-2643

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**FIFTH QUARTERLY TECHNICAL PROGRESS REPORT  
(July, 1995 Through September, 1995)**

**BENCH-SCALE TESTING OF THE  
MICRONIZED MAGNETITE PROCESS**

DOE Contract No. DE-AC22-93PC92206  
Custom Coals, Int. Project No. 94002

This document contains the Quarterly Technical Progress Report for the Micronized Magnetite Testing Project being performed at PETC's Process Research Facility (PRF). This fifth quarterly report covers the period from July, 1995 through September, 1995. The main accomplishments of Custom Coals and the project subcontractors, during this period, included:

- Continued purchasing small equipment and supplies for the circuit.
- Procured a 46-ton sample of Lower Kittanning "B" Seam coal.
- Completed eight primary integrated tests (PIT #1-#8) using the Pittsburgh No. 8 seam and the Grade-K and Grade-L magnetites.
- Completed classifying cyclone tests using the Pittsburgh No. 8 and Lower Kittanning seams using a larger (0.5 inch) apex.
- Completed data analysis on the four Grade-K magnetite "closed-loop" heavy-media cyclone tests.
- Obtained a finer third grade of magnetite (Grade-M) with a MVD of approximately 3 microns.
- Presented paper on the Micro-Mag project at the Coal Preparation, Utilization and Environmental Control Contractors Conference and a Poster Board Paper on the Micro-Mag Project at the Pittsburgh Coal Conference.
- Developed a method to modify all 5 Micro-Mag magnetic separators to approximately one third of their present size to better approximate commercial operation.

- Contract modifications were effected to:
  - Change the project manager from Pete Suardini to Ed Torak
  - Delete the circuit Decommissioning Task
  - Provide a no-cost time extension to January 31, 1996

This report contains a short discussion of the project description, objectives, budget, schedule, and teaming arrangement. It also includes a detailed discussion of the above mentioned project accomplishments and plans, organized by the various task series within the project work plan. The final section contains an outline of the specific project goals for the next quarterly reporting period.

## SECTION 1 - PROJECT DESCRIPTION

The major focus of the project, which is scheduled to occur through January 1996, will be to install and test a 500#/hr. fine-coal cleaning circuit at DOE's Process Research Facility (PRF), located at the Pittsburgh Energy Technology Center (PETC). The circuit will utilize an extremely fine, micron-sized magnetite media and small diameter cyclones to make efficient density separations on minus-28-Mesh coal.

Figure 1 contains a block-flow diagram of the test circuit, which was installed at the PRF. The circuit consists of three subcircuits:

- **Classification Circuit** - Which consists of a feed sump and pump, a 2" Krebs Classifying Cyclone, and a 2'x 3' Sizetec Inclined Desliming Screen. The Classifying Cyclone is equipped with various orifices to make cuts (i.e., D-50) at 200M to perhaps as fine as 500M. The Desliming Screen has layered screen panels ranging from 100M to 325M. The Classification Circuit is fed 28M x 0 coal slurry from the existing PRF grinding circuit, and will remove the majority of the slimes prior to the heavy-media cycloning circuit.
- **Dense-Medium Cycloning Circuit** - Which consists of a dense-medium cyclone feed, wing tank and feed pump, that overflows into a recirculating correct media sump and pump. Magnetite is added as required via a rotary air-lock feeder from a 0.5 ton magnetite bin. This subcircuit also consist of parallel-mounted Krebs 2" and 4" diameter Dense-Medium Cyclones. The 4" Cyclone products always recirculates back to the feed sump, and the 2" Cyclone products represents the feed to the Magnetite Recovery Circuit.
- **Magnetite Recovery Circuit** - Which consists of a 2'x3' Sizetec Inclined Desliming Screen (Drain Screen), and a 4'x 9' Sizetec Horizontal Dewatering Screen (Rinse Screen). These screens have screen panels



ranging from 100M to 325M. The magnetite recovery circuit contains four 36"x24" Eriez Conventional, Wet-Drum Magnetic Separators (CLIMAXX Models), as the Primary, Secondary, Tertiary, and Cleaner Magnetic Separators. There is also an Eriez High Gauss, Rare-Earth Magnetic Separator (Concurrent Flow), which is used as a Scavenger Magnetic Separator in the circuit. The final magnetic concentrates return to the Correct Medium Sump, and the final non-magnetics tailing reports to the Waste Sump and Pump, along with the Classifying Cyclone Overflow and Rinse Screen Oversize (see Figure 1). The Waste Sump discharge is dewatered using the Sharples Centrifuge and Thickener in the existing PRF process water clarification circuit.

The circuit is contained in a new permanent structure, that Custom Coals has installed in the PRF Emerging Technology (ET) Area. In addition to the equipment shown in Figure 1, the ET circuit contains a Clarified Water Head Tank and Pump to provide all water additions to the circuit. A closed-loop system is utilized in the circuit. A Motor Control Center (MCC) in the PRF motor control room, and Control Cabinet (CC) in the field provides the power distribution to the circuit.

The testing scope involves initial closed-loop testing of each subcircuit to optimize the performance of the equipment in each subcircuit (i.e., Component Testing), followed by open-circuit testing of the entire integrated circuit to optimize the process and quantify the process efficiency (i.e., Integrated Testing). All equipment can be run in closed-loop, with the exception of the 2" Krebs Dense-Medium Cyclone and the Drain and Rinse Screens (see Figure 1).

## SECTION 2 - PROJECT OBJECTIVES

The overall objectives of the project are to:

- Determine the effects of operating time on the characteristics of the recirculating medium in a continuous integrated processing circuit, and, subsequently, the sensitivity of cyclone separation performance to the quality of the recirculating medium.
- Determine the technical and economic feasibility of various unit operations and systems in optimizing the separation and recovery of the micronized magnetite from the coal products.

The specific technical objectives of the project are to:

- Establish the classifying circuit's operating conditions to make a separation at, or about 40 microns.



- Determine the effects of the magnetite particle size and medium purity on cyclone separation performance.
- Determine the effects of medium-to-coal ratio, medium density, feed pressure, and cyclone configuration on the separation efficiency of the cyclone. This testing is to verify whether cyclone separation performance equivalent to those produced in earlier research can be achieved and to determine the potential ranges of medium-to-coal ratios and medium densities expected for each cyclone product to help establish recovery circuit feed conditions.
- Quantify the amount and size of the magnetite not recovered by the individual and combined recovery circuit unit operations.
- Assess the technical and economic feasibility of various magnetite recovery circuits. Technically, the focus is on establishing the least complicated, easiest to operate circuit, that will provide the correct recirculating medium properties. Economically, determinations will be made looking at the trade offs between circuit capital and maintenance costs and overall system performance, including expected makeup magnetite requirements and cyclone separation efficiency.
- Determine the characteristics of the recirculating medium (purity and size distribution), and cyclone separation performance over time, during continuous, integrated testing of the entire circuit.

The Test, Sampling, and Analytical Plan was designed with these specific objectives in mind.

### SECTION 3 - PROJECT SCHEDULE AND BUDGET

Figure 2 contains the project schedule, by task series. The schedule in Figure 2, starts when Custom Coals began to actively work on the project (September 1994), and carries for a period of 17 months, until the scheduled completion in January 1996. The Major Milestone Tasks on the critical path contain asterisks. The project work scope and labor plan were discussed in detail in the Draft Work Plan, submitted in November, 1994.

Table 1 contains the revised Cost Plan estimate for the project. The upper part of the plan shows Custom Coals labor estimate, including markups. The plan incorporates Custom Coals' Project Manager, Ed Torak, working full-time on the project through January 1996. It also includes some time for other Custom Coal's personnel.





The lower part of the Cost Plan, in Table 1, shows the anticipated pass-through costs for subcontractors, as well as travel and equipment and supplies. A detailed description of the project subcontractors responsibilities and the items which have been purchased for the project are discussed in Sections 4 and 5 of this report. In summary, as of the time of submission of this report, the project accomplishments are approximately two months behind the original schedule (shown in Figure 2) due to expanding the scope of the project. However, cost to date are also under running the cost Plan in Table 1 by two months. At present, it is estimated that the project can be completed with the remaining budget.

#### SECTION 4 - PROJECT TEAM ORGANIZATION

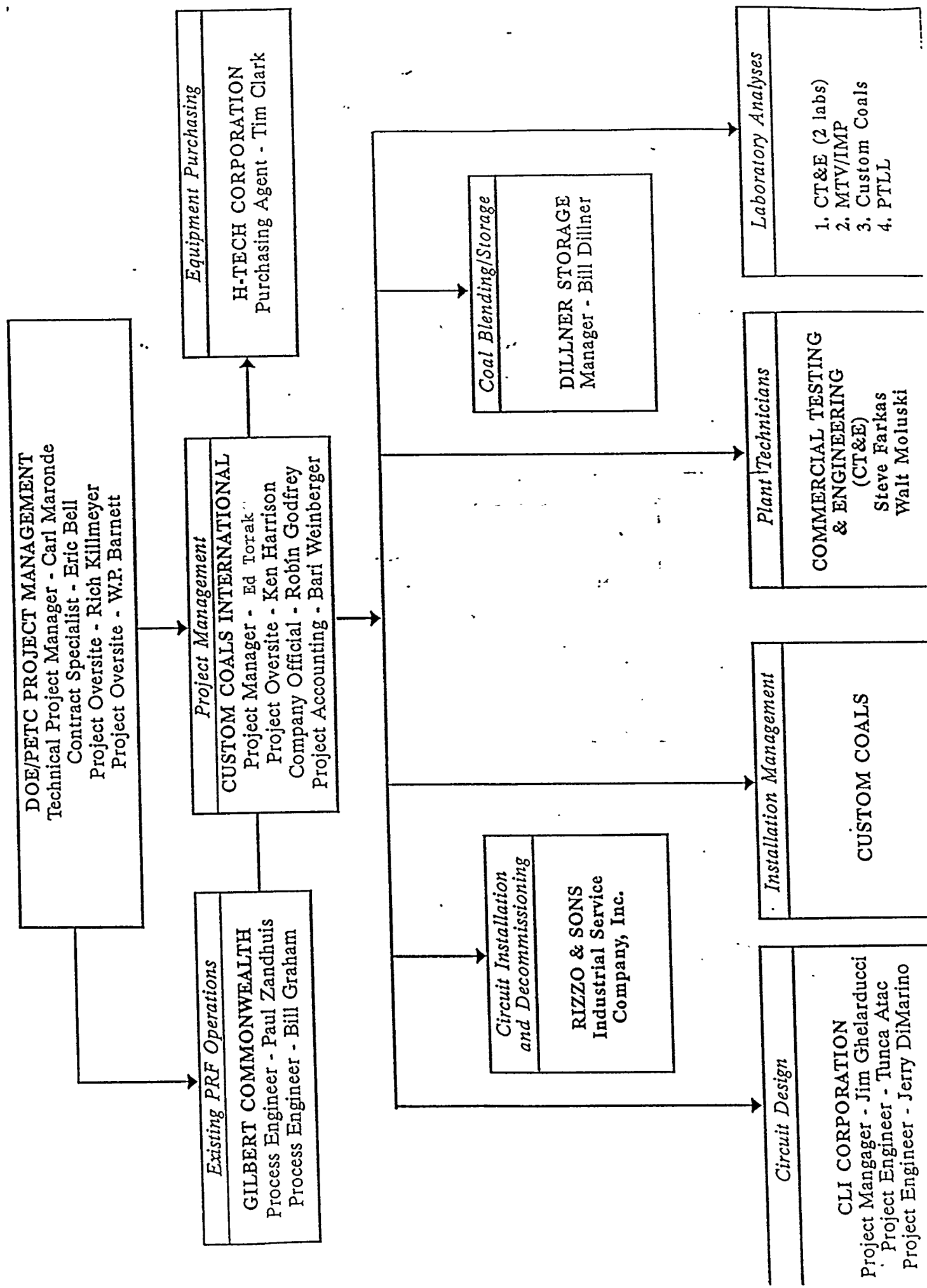
Figure 3 contains the project team organization chart, for the project. The project team includes:

- DOE/PETC's project and site management personnel.
- Custom Coals' project and site management personnel.
- Gilbert Commonwealth's engineers and technicians to operate the existing PRF, during the circuit testing.
- H-Tech Corporation as a subcontractor to Custom Coals to procure all equipment required for the project.
- Dillner Storage as a subcontractor to Custom Coals to provide coal blending and storage services for the project.
- CLI Corporation as a subcontractor to Custom Coals to finalize the circuit design.
- Rizzo & Sons to install the circuit, and provide whatever level of equipment decommissioning that is required at the end of the project.

Custom Coals also performs a number of the more routine sample preparation and analytical procedures at the PRF site (ie., wet screening, coal sample filtering, preparation, pulverizing, and ashing).

All required subcontracts for the project are in place, and merely need to be managed, modified, and updated as the project testing scope evolves. The only project organization change this quarter was the appointment of Ed Torak as Project Manager as a result of Peter Suardini's resignation from Custom Coal's in July.

**Figure 3 - PROJECT TEAM ORGANIZATION CHART**



**DOE/PETC PROJECT MANAGEMENT**  
 Technical Project Manager - Carl Maronde  
 Contract Specialist - Eric Bell  
 Project Oversight - Rich Killmeyer  
 Project Oversight - W.P. Barnett

*Existing PRF Operations*  
**GILBERT COMMONWEALTH**  
 Process Engineer - Paul Zandhuis  
 Process Engineer - Bill Graham

*Project Management*  
**CUSTOM COALS INTERNATIONAL**  
 Project Manager - Ed Torak  
 Project Oversight - Ken Harrison  
 Company Official - Rob'n Godfrey  
 Project Accounting - Bari Weinberger

*Equipment Purchasing*  
**H-TECH CORPORATION**  
 Purchasing Agent - Tim Clark

*Circuit Installation and Decommissioning*  
**RIZZO & SONS**  
 Industrial Service Company, Inc.

*Circuit Design*  
**CLI CORPORATION**  
 Project Manager - Jim Ghelarducci  
 Project Engineer - Tunca Atac  
 Project Engineer - Jerry DiMarino

*Installation Management*  
**CUSTOM COALS**

*Plant Technicians*  
**COMMERCIAL TESTING & ENGINEERING (CT&E)**  
 Steve Farkas  
 Walt Moluski

*Coal Blending/Storage*  
**DILLNER STORAGE**  
 Manager - Bill Dillner

*Laboratory Analyses*  
 1. CT&E (2 labs)  
 2. MTV/IMP  
 3. Custom Coals  
 4. PTL

## SECTION 5 - PROJECT ACCOMPLISHMENTS BY TASK SERIES

Figure 4 contains the work breakdown structure by major task, and minor subtask, for the project. Task 100 "Project Planning and Management" encompasses all the routine reporting requirements, as well as the special plans and reports that must be submitted for the project.

Figure 5 contains the detailed schedule, broken down by the subtasks within the work breakdown structure. The schedule is divided into approximately two week periods (ie., twice monthly), to allow for tighter specifications of document submission and task completion dates. Custom Coals plans to include Figure 5 in each Monthly and Quarterly Technical Progress Report to compare actual accomplishments to this initial schedule. This will be one of the main methods of controlling and monitoring the schedule and success of the project. At the time of this submission, the circuit testing task was approximately two months behind schedule.

### Section 5.1 - Task 100: Project Planning and Management (Months 1-16)

Custom Coals anticipates that the project manager, Ed Torak, will work full-time on the project through submission of the draft final report (end of January 1996). He will be responsible for on-site project management, and will also be responsible for all project reporting.

Table 2 shows the major project reporting requirements, with required frequencies and delivery dates for all documents. The table is broken down into 3 categories, which include:

- Routine Financial Reporting Requirements,
- Routine Technical Reporting Requirements, and
- Special Technical Reporting Requirements, submitted only once during the project.

With the submission of this Quarterly Technical Progress Report all routine reporting requirements have now been submitted through September 1995. During September, Custom Coal's Project Manager completed and presented two project technical papers; one for the Pittsburgh Coal Conference (ie., the Poster Session Presentation) and the other for the Coal Preparation, Utilization, and Environmental Control Contractors Conference. Custom Coals is presently up-to-date with all project reporting requirements.

Figure 4  
MICROMAG PROJECT  
WORK BREAKDOWN STRUCTURE  
(DOE Contract No. DE-AC22-93PC92206)

| <u>TASK</u> | <u>TASK DESCRIPTION</u>                         |
|-------------|---|
| 100         | <b>PROJECT PLANNING AND MANAGEMENT</b>          |
|             | 101 Management Plan                             |
|             | 102 Work Plan (ESH & QA/QC)                     |
|             | 103 Design Report (Two SSA's)                   |
|             | 104 Procurement and Fabrication Plan            |
|             | 105 Installation and Shakedown Plan             |
|             | 106 Coal Proc., Handling, & Logistics Plan      |
|             | 107 Operation and Maintenance Manual (SOP's)    |
|             | 108 Slurry Commissioning Plan                   |
|             | 109 Test, Sampling, and Analytical Plan (QA/QC) |
|             | 110 Decommissioning Plan                        |
| 200         | <b>FINAL CIRCUIT DESIGN</b>                     |
|             | 201 Finalize Flowsheet and P&ID                 |
|             | 202 Finalize Design Drawings                    |
| 300         | <b>EQUIPMENT PROCUREMENT &amp; FABRICATION</b>  |
|             | 301 Process Equipment Procurement               |
|             | 302 Structural Steel Fab. & Procurement         |
|             | 303 Platework Steel Fab. & Procurement          |
|             | 304 Electrical Equipment Procurement            |
|             | 305 Ancillary Equipment Procurement             |
|             | 306 Laboratory Equipment Procurement            |
|             | 307 Operating Supplies Procurement              |
| 400         | <b>MAGNETITE AND COAL PROCUREMENT</b>           |
|             | 401 Magnetite Procurement                       |
|             | 402 Coal Procurement                            |
| 500         | <b>CIRCUIT INSTALLATION</b>                     |
|             | 501 Primary Installation                        |
|             | 502 Piping Installation                         |
|             | 503 Electrical Installation                     |
| 600         | <b>CIRCUIT COMMISSIONING</b>                    |
|             | 601 Functionality and Leak Testing              |
|             | 602 Water Commissioning                         |
|             | 603 Slurry Commissioning                        |
| 700         | <b>CIRCUIT TESTING</b>                          |
|             | 701 Component Testing (Coal #1)                 |
|             | 702 Integrated Testing (Coal #1)                |
|             | 703 Component Testing (Coal #2)                 |
|             | 704 Integrated Testing (Coal #2)                |
| 800         | <b>ANALYTICAL</b>                               |
|             | 801 Preliminary Magnetite/Coal Testing          |
|             | 802 Circuit Testing Analytical                  |
| 900         | <b>CIRCUIT DECOMMISSIONING</b>                  |
| 1000        | <b>DATA EVALUATION</b>                          |
| 1100        | <b>FINAL REPORTING</b>                          |
|             | 1101 Final Equipment Inventory                  |
|             | 1102 Hazardous Waste Report                     |
|             | 1103 Final Report                               |

Figure 5  
**MICROMAG PROJECT**  
**DETAILED SCHEDULE BY TASK & SUBTASK**  
 (DOE Contract No. DE-AC22-93PC92206)

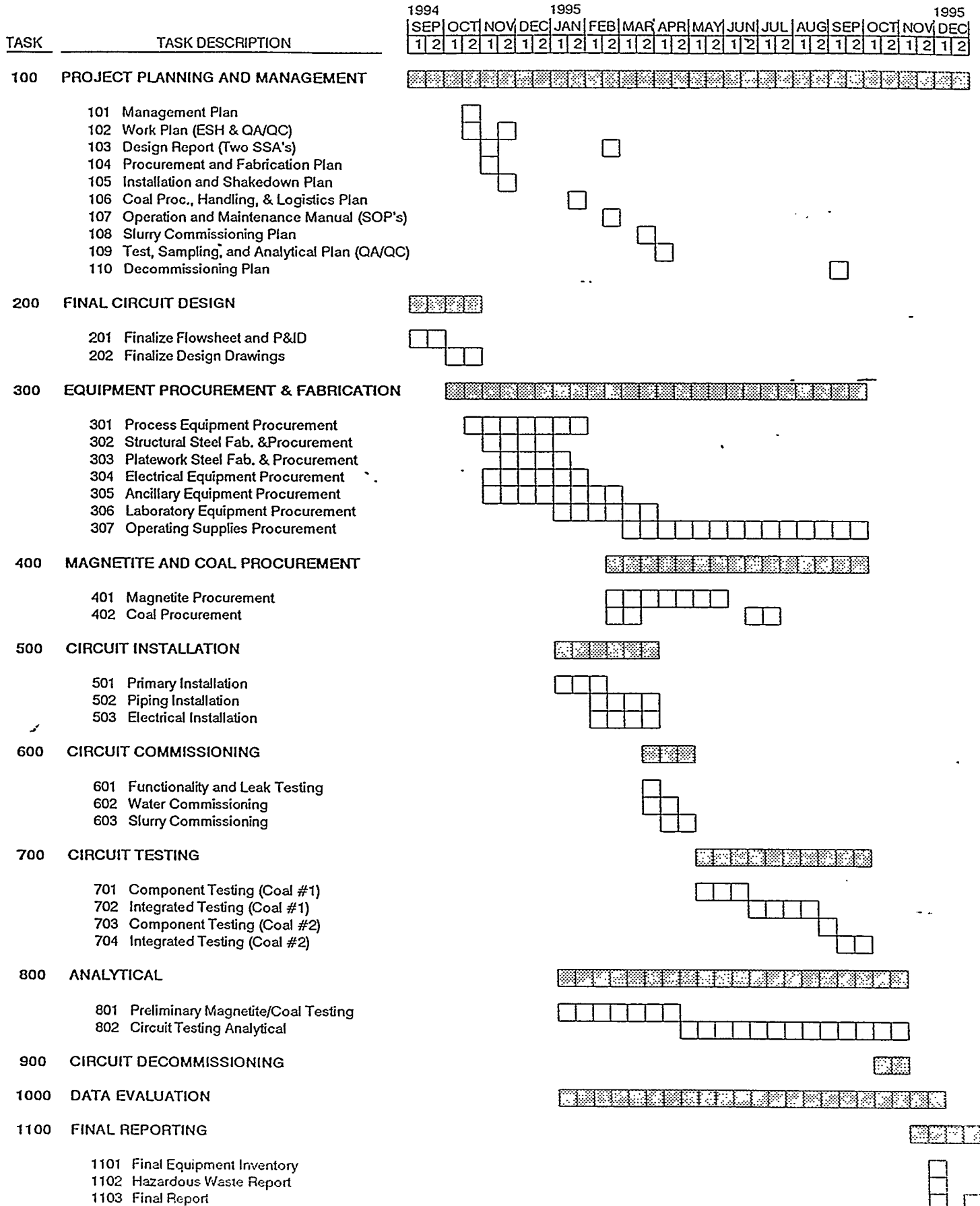




Table 2  
PROJECT REPORTING REQUIREMENTS

I. Routine Financial Reporting Requirements:

| Description                      | Frequency | Variance  |
|----------------------------------|-----------|-----------|
| 1. Project Invoice               | Monthly   | + 10 Days |
| 2. Cost Management Report (Form) | Monthly   | + 10 Days |
| 3. Summary Report (Form)         | Monthly   | + 10 Days |
| 4. Financial Summary Report      | Monthly   | + 10 Days |

II. Routine Technical Reporting Requirements:

| Description                                   | Frequency            | Variance     |
|---|----------------------|--------------|
| 1. Schedule/Status Sheet (On-Site Activities) | Weekly               | Every Friday |
| 2. Milestone Schedule/Status Report (Form)    | Monthly              | + 10 Days    |
| 3. Technical Status Report                    | Monthly              | + 10 Days    |
| 4. Key Personnel Staffing Report              | Quarterly            | + 30 Days    |
| 5. Technical Progress Report                  | Quarterly            | + 30 Days    |
| 6. Property Reports                           | Yearly & Semi-Annual | + 30 Days    |

III. Special Technical Reporting Requirements:

| Description                                       | Proposed Delivery Date | Proposed DOE Approval Date |
|---|------------------------|----------------------------|
| 1. Management Plan                                | October 31, 1994       | November 15, 1994          |
| 2. Draft Work Plan (ESH & QA/QC Plans)            | October 31, 1994       | November 15, 1994          |
| 3. Final Work Plan (ESH & QA/QC Plans)            | January 01, 1995       | January 15, 1995           |
| 4. Draft ET Circuit Design Report (two SSA's)     | November 15, 1994      | November 30, 1994          |
| 5. Final ET Circuit Design Report (two SSA's)     | February 15, 1995      | March 15, 1995             |
| 6. Procurement and Fabrication Plan               | November 15, 1994      | November 30, 1994          |
| 7. Installation and Shakedown Plan                | November 30, 1994      | December 15, 1994          |
| 8. Coal Procurement, Handling, and Logistics Plan | January 31, 1995       | February 15, 1995          |
| 9. Operation and Maintenance Manual (SOP's)       | February 28, 1995      | March 15, 1995             |
| 10. Slurry Commissioning Plan                     | March 31, 1995         | April 15, 1995             |
| 11. Test, Sampling, and Analytical Plan (QA/QC)   | April 15, 1995         | April 30, 1995             |
| 12. Decommissioning Plan                          | September 15, 1995     | September 30, 1995         |
| 13. Final Equipment Inventory                     | November 30, 1995      | December 15, 1995          |
| 14. Hazardous Waste Report                        | November 30, 1995      | December 15, 1995          |
| 15. Draft Final Report                            | November 30, 1995      | December 15, 1995          |
| 16. Final Report                                  | December 31, 1995      | ---                        |

### Section 5.2 - Task 200: Final Circuit Design (Months 1-2)

Custom Coal's subcontracted CLI Corporation to perform the final design of the ET Circuit. During the period from September through November, 1994, CLI completed the design package, and assisted Custom Coals' Project Manager in preparing the bid specification for the circuit installation. In essence, the Circuit Design Task was completed prior to the third quarterly reporting period. CLI's only efforts were to update the P&ID in late March to reflect the actual flowsheet of the as-built circuit.

Figure 6 contains the general flowsheet, including the major equipment and flow streams. Figures 7 and 8 contain the final detailed P&ID and Flowsheet Drawings, respectively. Those drawings specify all equipment and the flow balance, and include all ancillary items (i.e., piping, valves, and instrumentation).

### Section 5.3 - Task 300: Equipment Procurement and Fabrication (Months 2-13)

For organizational purposes, the equipment and procurement and fabrication task was broken down into a number of subtasks (see Figure 5), which include:

- 301 - Process Equipment Procurement
- 302 - Structural Steel Fabrication and Procurement
- 303 - Platework Steel Fabrication and Procurement
- 304 - Electrical Equipment Procurement
- 305 - Ancillary Equipment Procurement
- 306 - Laboratory Equipment Procurement
- 307 - Operating Supplies Procurement

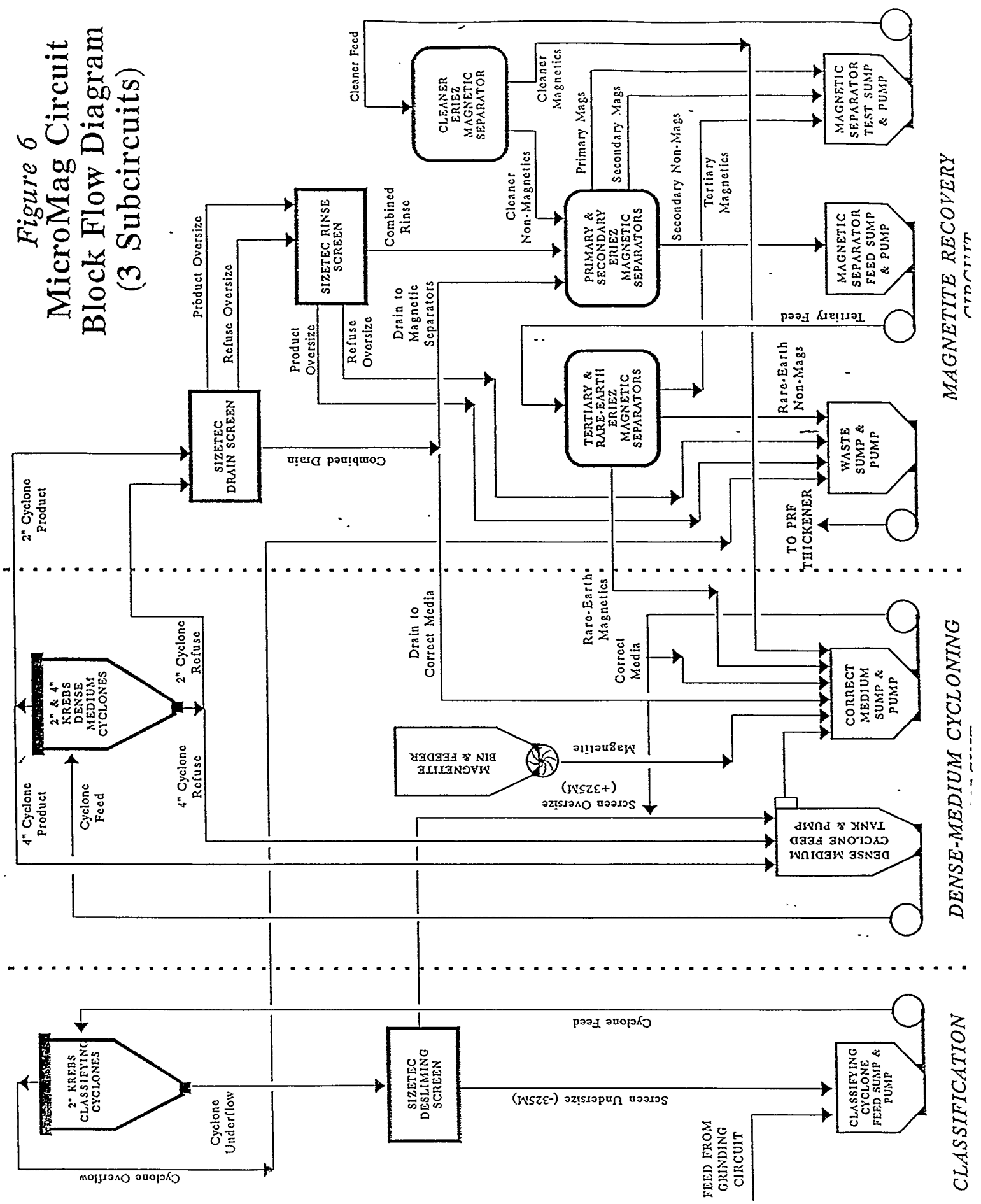
Table 3 contains the equipment list and cost estimate, for all items purchased to date. All of the major equipment was ordered during the second quarterly reporting period. It was delivered to site on the last week of January, 1995. All of the laboratory equipment and project supplies were ordered during the third reporting period.

The cost estimate, at the bottom of Table 3, of approximately \$258K, committed thus far, for purchases and shipping is still well below the revised equipment and supplies budget of \$300K, in the revised cost plan (see Table 1). Hopefully, any spare parts and emergency repairs can all be procured within the remaining equipment and supplies budget.

### Section 5.4 - Task 400: Magnetite and Coal Procurement (Months 7-13)

The two major test materials for the project are the magnetite media and the test coals. Custom Coal's is testing 3 grades of magnetites and 2 types of bituminous coals, during the circuit testing. A detailed discussion of the coal and magnetite issues was presented in the Coal and Magnetite Procurement, Handling, and Logistics Plan, submitted in late January.

**Figure 6**  
**MicroMag Circuit**  
**Block Flow Diagram**  
**(3 Subcircuits)**



MAGNETITE RECOVERY  
CONT'D

DENSE-MEDIUM CYCLONING

CLASSIFICATION





**Table 3**  
**CUSTOM COALS CORPORATION**  
**MICROMAG PROJECT EQUIPMENT LIST**  
**(DOE CONTRACT NO. DE-AC22-83PC92206)**

Revision Date: April 22, 1995

| Unit Number | Unit Description                            | Equip. Number | Manufacturer  | Equipment Description                 | Motor HP | Weight Lbs | Total Cost | Vendor               | FOB Location     | Est. Del. Weeks | Est. Shpg Cost |
|-------------|---|---------------|---------------|---------------------------------------|----------|------------|------------|----------------------|------------------|-----------------|----------------|
| 1001        | Classifying Cyclone Feed Pump               | P-101         | Gould         | 1'x1.5"x11" w/VS 1350/1800 RPM        | 15       | 600        | 4160       | Buckley Ass., Pitts. | Ashland, PA      | 6               | 0              |
| 1002        | Heavy Media Feed Pump                       | P-201         | Gould         | 1.5"x2"x14" w/VS 1040/1640 RPM        | 40       | 1100       | 8085       | Buckley Ass., Pitts. | Ashland, PA      | 6               | 0              |
| 1003        | Correct Media Pump                          | P-202         | Gould         | 1'x1.5"x8" w/VS 1150 RPM (@ PETC)     | 2        | 450        | 230        | Buckley Ass., Pitts. | Ashland, PA      | 6               | 0              |
| 1004        | Magnetic Separator Feed Pump                | P-301         | Gould         | 1'x1.5"x8" w/VS 1170 RPM (@ PETC)     | 3        | 490        | 364        | Buckley Ass., Pitts. | Ashland, PA      | 6               | 0              |
| 1005        | Magnetic Separator Test Pump                | P-302         | Gould         | 1'x1.5"x8" w/VS 1455 RPM              | 5        | 540        | 3787       | Buckley Ass., Pitts. | Ashland, PA      | 6               | 0              |
| 1006        | Spray Water Pump                            | P-102         | Gould         | 1.5"x2"x6" w/DC 3500 RPM              | 5        | 250        | 0          | At PETC              |                  |                 | 0              |
| 1007        | Waste Pump                                  | P-303         | Gould         | 1.5"x2"x8" w/VS 1160 RPM              | 3        | 500        | 3843       | Buckley Ass., Pitts. | Ashland, PA      | 6               | 0              |
| 1008        | Deslime Screen                              | SC-101        | Sizetec       | SSS 2315TD 2x2'x3'                    | .8/1.5   | 1415       | 11175      | Sizetec, Inc.        | Canton, OH       | 10-12           | 432            |
| 1009        | Drain Screen                                | SC-201        | Sizetec       | SSS 2315TD 2x2'x3'                    | .8/1.5   | 1415       | 11175      | Sizetec, Inc.        | Canton, OH       | 10-12           | 0              |
| 1010        | Rinse Screen                                | SC-301        | Sizetec       | DSF 49 F 2x2'x8'                      | 2/2      | 4196       | 22817      | Sizetec, Inc.        | Canton, OH       | 10-12           | 0              |
| 1011        | 325M Layered Screen Panels                  | SC----        | Sizetec       | 2'x3'x1" Frame (10@\$320)             | ---      | 10         | 3200       | Sizetec, Inc.        | Canton, OH       | 1               | 0              |
| 1012        | 100M Layered Screen Panels                  | SC----        | Sizetec       | 2'x3'x1" Frame (6@\$273)              | ---      | 10         | 1638       | Sizetec, Inc.        | Canton, OH       | 1               | 20             |
| 1013        | 200M Layered Screen Panels                  | SC----        | Sizetec       | 2'x3'x1" Frame (6@\$286)              | ---      | 10         | 1716       | Sizetec, Inc.        | Canton, OH       | 1               | 0              |
| 1014        | 90 Micron Profile Wire Screen Panels        | SC-301        | Sizetec       | 2'x3'x1" Frame (2@\$604)              | ---      | 30         | 1208       | Sizetec, Inc.        | Canton, OH       | 4               | 0              |
| 1015        | 2" Classifying Cyclone                      | CY-101        | Krebs         | PC2-1424 w/1 Fl, 3 VF, & 3 AP         | ---      | 40         | 766        | Krebs Engineers      | Menlo Park, CA   | 8               | 0              |
| 1016        | 2" Heavy Media Cyclone                      | CY-201        | Krebs         | PC2-1424 w/2 Fl, 3 VF, & 3 AP         | ---      | 40         | 1051       | Krebs Engineers      | Menlo Park, CA   | 8               | 0              |
| 1017        | 4" Heavy Media Cyclone                      | CY-301        | Krebs         | D4B w/2 Fl, 3 VF, & 3 AP              | ---      | 100        | 2470       | Krebs Engineers      | Menlo Park, CA   | 8               | 120            |
| 1018        | Primary Magnetic Separator                  | MS-301        | Eriez         | CLIMAXX Wet Drum 36" x 24"            | 3        | 1250       | 12050      | Eriez Magnetics      | Erie, PA         | 9-12            | 0              |
| 1019        | Secondary Magnetic Separator                | MS-302        | Eriez         | CLIMAXX Wet Drum 36" x 24"            | 3        | 1250       | 12050      | Eriez Magnetics      | Erie, PA         | 9-12            | 0              |
| 1020        | Tertiary Magnetic Separator                 | MS-303        | Eriez         | CLIMAXX Wet Drum 36" x 24"            | 3        | 1250       | 12050      | Eriez Magnetics      | Erie, PA         | 9-12            | 0              |
| 1021        | Cleaner Magnetic Separator                  | MS-305        | Eriez         | CLIMAXX Wet Drum 36" x 24"            | 3        | 1250       | 12050      | Eriez Magnetics      | Erie, PA         | 9-12            | 0              |
| 1022        | Scavenger Magnetic Separator                | MS-304        | Eriez         | Rare Earth Wet Drum 24" x 18"         | 3        | 700        | 24800      | Eriez Magnetics      | Erie, PA         | 9-12            | 0              |
| 1023        | Magnetite Rotary Feeder                     | FD-201        | Prater        | 6" Rotary Alflock Feeder              | 0.5      | 185        | 2069       | J&B Industrial       | Chicago, IL      | 4-6             | 150            |
| 1024        | Motor Control Center (NEMA 12)              | MCC-401       | Allen-Brad.   | 4 Vertical Sections w/o TMCB          | 200 A    | 1000       | 8458       | Allen Bradley, Inc.  | Milwaukee, WI    | 4-6             | 0              |
| 1025A       | Customized Control Cabinet (NEMA 4)         | CC-401        | CDI           | Square D Comp. in Hoffman Box         | ---      | 150        | 3150       | Control Design, Inc. | Pittsburgh, PA   | 4-6             | 40             |
| 1025B       | TMCB & Safety Switches                      | ---           | Square D      | TMCB & 23 Man. Switches (17 New)      | ---      | 250        | 2880       | All Phase            | Pittsburgh, PA   | 1-2             | 0              |
| 1026        | Heavy Media Cyclone Feed Flowmeter          | FIT-1         | Polysonics    | MST-P Port. Ultrasonic Flowmeter      | ---      | 20         | 4825       | Barthold Systems     | Alliquippa, PA   | 4-6             | 0              |
| 1027A       | Correct Media Nuclear Density Gauge         | DIT-1         | Berthold      | IMP-389 w/ NaI Detector & Comm.       | ---      | 90         | 281        | Denko Engrg.         | Bell Vernon, PA  | 2-3             | 0              |
| 1027B       | Nuclear Density Gauge Digital Meter         | DIT-1A        | Red Lion      | IMP-20102 Digital Meter w/ Relays (2) | ---      | 6          | 291        | Process Engrg.       | Pittsburgh, PA   | 3-4             | 0              |
| 1028        | Classifying Cyclone Sump Level Transmitter  | LIT-1         | Warrick       | 16ML1A4-X-03 w/2' & 2'4" Probes       | ---      | 6          | 291        | Process Engrg.       | Pittsburgh, PA   | 3-4             | 0              |
| 1029        | Correct Media Sump Level Transmitter        | LIT-2         | Warrick       | 16ML1A4-X-03 w/2' & 2'4" Probes       | ---      | 6          | 291        | Process Engrg.       | Pittsburgh, PA   | 3-4             | 0              |
| 1030        | Mag. Sep. Feed Sump Level Transmitter       | LIT-3         | Warrick       | 16ML1A4-X-03 w/3' & 3'4" Probes       | ---      | 6          | 302        | Process Engrg.       | Pittsburgh, PA   | 3-4             | 0              |
| 1031        | Mag. Sep. Test Sump Level Transmitter       | LIT-4         | Warrick       | 16ML1A4-X-03 w/2' & 1'8" Probes       | ---      | 6          | 285        | Process Engrg.       | Pittsburgh, PA   | 3-4             | 0              |
| 1032        | Clarified Water Head Tank Level Transmitter | LIT-5         | Warrick       | Spare Probes (4 @ 3'3'4", 4'4'4")     | ---      | 4          | 91         | Process Engrg.       | Pittsburgh, PA   | 3-4             | 0              |
| 1033        | Spare Level Probes                          | LIT----       | Lightning     | Mixer w/ 5' Long Agitator             | 2.3      | 208        | 0          | At PETC              |                  |                 | 0              |
| 1034        | Correct Media Sump Mixer                    | MX-201        | Vangura       | Fabricated Structure, Floor, & Rail   | ---      | 26000      | 37880      | Vangura Iron, Inc.   | W. Milfin, PA    | 4-6             | 0              |
| 1035        | Structural Steel, Flooring, & Handrail      | SS-101        | Vangura       | Fabricated Sumps, Chutes, & Frames    | ---      | 6000       | 18265      | Vangura Iron, Inc.   | W. Milfin, PA    | 4-6             | 0              |
| 1036        | Platwork Steel                              | PS-101        | Vangura       | 1-1/2" Beaver Tails (26@\$14.50)      | ---      | 13         | 386        | Howard Baird Ass.    | Pittsburgh, PA   | 3-4             | 0              |
| 1037        | Deslime and Rinse Screen Spray Nozzles      | ---           | Durex         | Hanging Scale with Spare Cup          | ---      | 20         | 203        | Gilson Co., Inc.     | Worthington, OH  | 1-2             | 0              |
| 1038        | Marley Liquid Density Gauge (Manual)        | ---           | Marley        | Six Port Units (5 Reg. & 1 Elec.)     | ---      | 80         | 561        | Fire Fighter Sales   | Pittsburgh, PA   | 1-2             | 0              |
| 1039        | Fire Extinguishers                          | ---           | ABC Fire Ptl  | ABC Fire Ptl                          | ---      | 15         | 1492       | Cole-Parmer Inst     | Niles, IL        | 3-4             | 0              |
| 1040        | Variable Area Bypass Flowmeters             | ---           | Cole-Parmer   | Four Units (3/4", 1", 1-1/2", & 2")   | ---      | 500        | 9840       | Lee Supply Co.       | Charleroi, PA    | 3-4             | 0              |
| 1041        | Manual Ball, 3-Way, and Diaphragm Valves    | ---           | Asahi/Grinnel | Steel Valves (41) & CPVC Valves (68)  | ---      | 25         | 1453       | Techematic, Inc.     | Sylvan Lk., MI   | 1-2             | 0              |
| 1042        | Solenoid Operated Ball Valves (w/ Actuator) | ---           | ASCO/Unitorq  | 2" Unit (1) & 1" Units (4), w/ Spares | ---      | 5          | 375        | Newport Elec., Inc.  | Santa Ana, CA    | 1               | 20             |
| 1043        | Digital Meter (NEMA 4 & UL Approved)        | DIT-1A        | Newport       | INFCP-210 Meter & SPC4 Cover          | ---      | 200        | 1377       | Lee Supply Co.       | Charleroi, PA    | 1               | 20             |
| 1044        | Steel Flanges and Gaskets                   | ---           | Grinnell      | Flanges (168) & Rubber Gaskets (99)   | ---      | 50         | 1892       | M.S. Jacobs          | Pittsburgh, PA   | 2-4             | 0              |
| 1045        | Air, Water, and Slurry Gauges & Regulators  | ---           | Ashcroft      | Pressure Gauges (6) & Regulators (5)  | ---      | 100        | 2740       | Eriez Magnetics      | Erie, PA         | 4-6             | 0              |
| 1046        | Lab. Matrix Separator (HGPM)                | ---           | Eriez         | Separator, Cup, and 3 Magnet Sats     | ---      | 100        | 5375       | Capco                | Jacksonville, FL | 2-4             | 0              |
| 1047        | Wet Sample Splitter and Samplers            | ---           | Capco         | Wet Splitter (110 V.) & 2 Samplers    | ---      | 100        | 1251       | Workman Dev.         | Alum Crk., WV    | 1               | 0              |
| 1048        | Deslime and Rinse Screen Spray Nozzles      | ---           | Spray System  | 36 Spray Nozzles                      | ---      | 10         | 0          |                      |                  |                 | 0              |

Purchase Total \$ 256499      Shipping Total \$ 1622  
 Delivered Total \$ 258121

Table 4 contains a complete description of two of the three magnetites and a partial description of the third magnetite that Custom Coals is using for the project, which include:

- PennMag Grade-K Magnetite - Ground natural magnetite, with a mean particle size of 9.8 microns.
- PennMag Grade-L Magnetite - Finely ground natural magnetite with a mean particle size of 6.6 microns.
- Pea Ridge Grade-M Magnetite - Extremely fine magnetite with a mean particle size of 3.0 microns.

Similarly, Custom Coals selected two test coals for the ET circuit testing. The coals are:

- Pittsburgh No.8 Seam bituminous raw coal from Ohio Valley Coal Company in Belmont County, Ohio.
- Lower Kittanning "B" Seam bituminous raw coal from PB&S Coal Company's, Longview Mine in Somerset County, Pennsylvania.

Tables 5 and 6 contain the size and washability analysis for the respective coals. Both coals are obtained from underground mines, and contain dry ash contents of between 20 and 30 Wt%. Over half of the sulfur in both coals is in the pyritic form, so they are good candidates for aggressive cleaning studies. They also both have anticipated yields of 70 to 80 Wt%, when cleaned at about 1.60 SG.

The major differences between the coals is that the Pittsburgh No. 8 Seam raw coal has a much higher organic sulfur content, and is much harder (HGI = 60-70) than the Lower Kittanning "B" Seam raw coal (HGI = 90-100). Testing of coals with different friabilities is desirable, to allow for comparison of how attrition affects fine coal contamination of the recirculating media, and subsequent media recovery and cyclone performance. The Pittsburgh No. 8 Seam Coal should be the less challenging coal and is currently being tested. It was also used for the circuit commissioning. The Lower Kittanning "B" Seam raw coal will be the second coal tested. It is of major interest to Custom Coals because it will be one of the major feed coals used to make compliance coal at Custom Coals Laurel Cleaning Plant, which will become operational in the fall of 1995.

**TABLE 4**  
**MICRONIZED MAGNETITE CHARACTERISTICS**

**Magnetite Head Analysis**

| Analysis         | Grade-K | Grade-L | Grade-M |
|------------------|---------|---------|---------|
| Moisture (Wt%)   | 0.1     | 0.20    | -       |
| Ash (Wt%)        | 103*    | 102*    | -       |
| Specific Gravity | 5.0     | 4.9     | -       |
| Moment (EMU/g)   | 86      | 75      | -       |

\*Note: Magnetite gains weight during the ashing process.

**Magnetite Davis-Tube Recovery Profiles**

| Davis-Tube Settings |       | Davis-Tube Recoveries (Wt%) |         |         |
|---------------------|-------|-----------------------------|---------|---------|
| Amps                | Gauss | Grade-K                     | Grade-L | Grade-M |
| 0.30                | 750   | 84-86                       | 20-22   | -       |
| 0.50                | 1,250 | 96-98                       | 70-72   | -       |
| 1.70                | 3,700 | 98-99                       | 95-97   | -       |

**Magnetite Size**

| Microtrac Results             | Grade-K | Grade-L | Grade-M |
|-------------------------------|---------|---------|---------|
| D <sub>90</sub> (90% Passing) | 18.0    | 12.8    | 5.0     |
| D <sub>50</sub> (50% Passing) | 8.9     | 5.7     | 2.7     |
| D <sub>10</sub> (10% Passing) | 3.5     | 2.4     | 1.4     |
| MVD (Mean Volume Dia.)        | 9.8     | 6.6     | 3.0     |
| Moment (EMU/g)                | 87      | 77      | -       |



Table 5  
GROUND RAW COAL SIZE ANALYSIS AND WASHABILITY  
Pittsburgh No. 8 Seam Coal (PETC/PRF Dry Grind)  
Ohio Valley Coal Company  
(HGI = 60-70)

Top x 0 size analysis representing 100.00 Wt% of total raw coal sample

| <u>Size Fraction</u> |   |               | <u>Size Analysis (D.B.)</u> |              |              | <u>Cumulative Analysis (D.B.)</u> |              |              |
|----------------------|---|---------------|-----------------------------|--------------|--------------|-----------------------------------|--------------|--------------|
|                      |   |               | Weight                      | Ash          | Sulfur       | Weight                            | Ash          | Sulfur       |
| <u>Pass</u>          |   | <u>Retain</u> | <u>(Wt%)</u>                | <u>(Wt%)</u> | <u>(Wt%)</u> | <u>(Wt%)</u>                      | <u>(Wt%)</u> | <u>(Wt%)</u> |
| Top                  | X | 30M           | 1.00                        | 28.68        | 5.19         | 1.00                              | 28.68        | 5.19         |
| 30M                  | X | 50M           | 3.30                        | 28.68        | 5.19         | 4.30                              | 28.68        | 5.19         |
| 50M                  | X | 70M           | 3.50                        | 21.50        | 4.64         | 7.80                              | 25.46        | 4.94         |
| 70M                  | X | 100M          | 5.40                        | 18.74        | 4.74         | 13.20                             | 22.71        | 4.86         |
| 100M                 | X | 200M          | 16.00                       | 14.98        | 5.00         | 29.20                             | 18.47        | 4.94         |
| 200M                 | X | 400M          | 22.60                       | 14.08        | 5.25         | 51.80                             | 16.56        | 5.07         |
| <u>400M</u>          | X | <u>0</u>      | <u>48.20</u>                | <u>32.43</u> | <u>3.83</u>  | <u>100.00</u>                     | <u>24.21</u> | <u>4.47</u>  |
|                      |   | Total         | 100.00                      | 24.21        | 4.47         |                                   |              |              |
|                      |   | Head          | 100.00                      | 23.40        | 4.51         |                                   |              |              |

Top x 0 washability representing 100.00 Wt% of total raw coal sample

| <u>Gravity Fraction</u> |   |              | <u>Direct Analysis (D.B.)</u> |              |              | <u>Cumulative Analysis (D.B.)</u> |              |             |
|-------------------------|---|--------------|-------------------------------|--------------|--------------|-----------------------------------|--------------|-------------|
|                         |   |              | Weight                        | Ash          | Sulfur       | Weight                            | Ash          | Sulfur      |
| <u>Sink</u>             |   | <u>Float</u> | <u>(Wt%)</u>                  | <u>(Wt%)</u> | <u>(Wt%)</u> | <u>(Wt%)</u>                      | <u>(Wt%)</u> |             |
| Float                   | X | 1.30         | 46.00                         | 2.76         | 2.35         | 46.00                             | 2.76         | 2.35        |
| 1.30                    | X | 1.40         | 20.20                         | 8.13         | 2.60         | 66.20                             | 4.40         | 2.43        |
| 1.40                    | X | 1.50         | 6.40                          | 17.32        | 3.04         | 72.60                             | 5.54         | 2.48        |
| 1.50                    | X | 1.60         | 2.50                          | 33.31        | 4.67         | 75.10                             | 6.46         | 2.55        |
| 1.60                    | X | 1.80         | 2.00                          | 34.30        | 4.94         | 77.10                             | 7.18         | 2.62        |
| 1.80                    | X | 2.20         | 3.10                          | 52.69        | 3.23         | 80.20                             | 8.94         | 2.64        |
| <u>2.20</u>             | X | <u>Sink</u>  | <u>19.80</u>                  | <u>83.19</u> | <u>10.36</u> | <u>100.00</u>                     | <u>23.64</u> | <u>4.17</u> |
|                         |   | Total        | 100.00                        | 23.64        | 4.17         |                                   |              |             |
|                         |   | Head         | 100.00                        | 23.83        | 4.42         |                                   |              |             |

Table 6  
 CRUSHED RAW COAL SIZE ANALYSIS AND WASHABILITY  
 Longview Mine, Kittanning "B" Seam  
PB&S Underground Mined Coal  
 (HGI =90-100)

1-1/2" x 0 size analysis representing 100.00 Wt% of total raw coal sample

| <u>Size Fraction</u> |   |               | <u>Size Analysis (D.B.)</u> |              |               | <u>Cumulative Analysis (D.B.)</u> |              |               |
|----------------------|---|---------------|-----------------------------|--------------|---------------|-----------------------------------|--------------|---------------|
| <u>Pass</u>          |   | <u>Retain</u> | <u>Weight</u>               | <u>Ash</u>   | <u>Sulfur</u> | <u>Weight</u>                     | <u>Ash</u>   | <u>Sulfur</u> |
|                      |   |               | <u>(Wt%)</u>                | <u>(Wt%)</u> | <u>(Wt%)</u>  | <u>(Wt%)</u>                      | <u>(Wt%)</u> | <u>(Wt%)</u>  |
| 1-1/2"               | X | 3/8"          | 21.78                       | 36.77        | 2.88          | 21.78                             | 36.77        | 2.88          |
| 3/8"                 | X | 1.0mm         | 50.44                       | 18.72        | 2.03          | 72.22                             | 24.16        | 2.29          |
| 1.0mm                | X | 150M          | 21.64                       | 12.74        | 1.93          | 93.86                             | 21.53        | 2.20          |
| 150M                 | X | 500M          | 3.69                        | 11.82        | 1.88          | 97.55                             | 21.16        | 2.19          |
| 500M                 | X | 0             | 2.45                        | 18.43        | 1.21          | 100.00                            | 21.10        | 2.17          |
|                      |   | Total         | 100.00                      | 21.10        | 2.17          |                                   |              |               |

1-1/2" x 500M washability representing 97.55 Wt% of total raw coal sample

| <u>Gravity Fraction</u> |   |              | <u>Direct Analysis (D.B.)</u> |              |               | <u>Cumulative Analysis (D.B.)</u> |              |               |
|-------------------------|---|--------------|-------------------------------|--------------|---------------|-----------------------------------|--------------|---------------|
| <u>Sink</u>             |   | <u>Float</u> | <u>Weight</u>                 | <u>Ash</u>   | <u>Sulfur</u> | <u>Weight</u>                     | <u>Ash</u>   | <u>Sulfur</u> |
|                         |   |              | <u>(Wt%)</u>                  | <u>(Wt%)</u> | <u>(Wt%)</u>  | <u>(Wt%)</u>                      | <u>(Wt%)</u> | <u>(Wt%)</u>  |
| Float                   | X | 1.30         | 19.80                         | 3.02         | 0.69          | 19.80                             | 3.02         | 0.69          |
| 1.30                    | X | 1.40         | 42.10                         | 7.95         | 0.83          | 61.90                             | 6.37         | 0.79          |
| 1.40                    | X | 1.45         | 8.43                          | 16.40        | 1.00          | 70.33                             | 7.57         | 0.81          |
| 1.45                    | X | 1.55         | 5.66                          | 25.22        | 1.40          | 75.99                             | 8.89         | 0.85          |
| 1.55                    | X | 1.65         | 3.06                          | 32.93        | 1.87          | 79.05                             | 9.82         | 0.89          |
| 1.65                    | X | 1.80         | 2.87                          | 40.85        | 2.19          | 81.92                             | 10.91        | 0.94          |
| 1.80                    | X | Sink         | 18.08                         | 68.43        | 7.80          | 100.00                            | 21.31        | 2.18          |
|                         |   | Total        | 100.00                        | 21.31        | 2.18          |                                   |              |               |
|                         |   | Head         | 100.00                        | 21.16        | 2.19          |                                   |              |               |

In late February, Custom Coals' procured the 80-ton bulk shipment of Pittsburgh No. 8 Seam Coal, required for the commissioning and testing phases. The coal was delivered to Dillner Storage and blended in fourteen 6-ton lots. These lots will be gradually transported to the PRF as feed for the testing. During the blending, Custom Coals' obtained a 100 pound composited sample of the coal and sent it to CT&E for analyses. During July, Custom Coal's Project Manager procured a 46-ton bulk sample of the second coal, Lower Kittanning "B" Seam, and had it delivered to Dillner Storage. It was later blended and split into 6-ton piles for gradual transport to DOE's PRF. A bulk sample was collected, and the individual piles (ie., lots) were covered with poly tarps to avoid any moisture pickup.

### Section 5.5 - Task 500: Circuit Installation (Months 5-7)

The major focus of the project work, during the third quarterly reporting period (January through March 1995), was the circuit installation task. Custom Coals subcontracted Rizzo & Sons to perform the circuit installation, based on their experience working at the site and the competitiveness of their bid (\$121K). The installation of the circuit began on January 23rd, and was completed on March 27th, including \$11K of additional work that was not in the work scope. For organizational purposes, Custom Coals broke down the circuit installation into 3 subtasks that Rizzo's performed according to the following schedule:

- Primary Installation: (January 23rd - February 10th) - Structure, flooring, handrail, equipment, and platework.
- Piping Installation: (February 14th - March 27th)
- Electrical Installation: (February 14th - March 27th)

From January 23rd through February, Rizzo & Sons had approximately 5-7 men working on-site on the circuit installation task. In March, the work became more detailed and the crew was reduced to 2-4 men. Rizzo's men worked 10-hour shifts (7:00AM through 5:30PM) Monday through Thursday, with Fridays off. Custom Coals' Project Manager was on-site during the entire installation period to ensure that all installations occurred in accordance with the design drawings, the SSA's and DOE's work rules.

The new structure that was installed is permanent and consists of a number of column rows, installed in the PRF's ET circuit area, and fastened to the existing structure. The floor levels match the existing structure on all except the highest floor, and consist of 3/8" checkerplate flooring with removable handrail and toeplate. Design specifications are 150#/sq.ft. live load and 2000# point loading.

The structure and equipment on each floor of the circuit is as follows:

- 1086' Elevation - The ground level concrete floor is part of the new structure. The 20'x 20' new equipment area contains the 6 slurry sumps and pumps shown on the bottom of Figure 6, as well as all sample prep equipment setup at the site. All the sumps and pumps, as well as the structural steel are bolted to the concrete floor.
- 1096' Elevation - The second floor consists of a new 22'x 13' structure adjacent to the existing circuit. It is enclosed in removable handrail and toeplate. This level contains the primary, secondary, tertiary, and scavenger rare-earth magnetic separators, as well as the magnetite hopper and deslime screen. It also contains the Berthold Density Gauge and the Polysonics Ultrasonic Flowmeter.
- 1106' Elevation - The third floor also consists of a new 22'x 13' structure adjacent to the existing circuit, enclosed in removable handrail and toeplate. This level contains the rinse screen, the media distribution and splitter boxes, and the classifying cyclone. It also contains the control cabinet used to operate and monitor the circuit.
- 1116' Elevation - The fourth floor consists of a new 10'x 20' structure adjacent to the existing circuit, and enclosed in removable handrail and toeplate. This level contains the clarified water head tank and pump, the two heavy-media cyclones, the drain screen, and the cleaner magnetic separator.

The general arrangement drawings were used to place the structural steel, flooring, handrails, equipment, and platework in the initial part of the installation.

The detailed process piping requirements are shown in the circuit P&ID, (see Figure 9). Figure 9 contains all slurry and water piping lines, including all fittings and valves. Most of the slurry piping was specified as CPVC ("P") to save money and for ease of installation. Steel piping was used for the high-pressure, dense-medium cyclone feed lines.

A detailed piping list for the slurry lines, water lines, and compressed air lines was included in the design package. The piping routes were determined in the field during installation, by Custom Coals and Rizzo staff. All gravity lines were installed first to ensure maximum slope, while maintaining sampling capabilities. Pump discharge lines, water lines, and air lines were installed later, with priorities on maintaining access to the circuit and sampling capabilities.

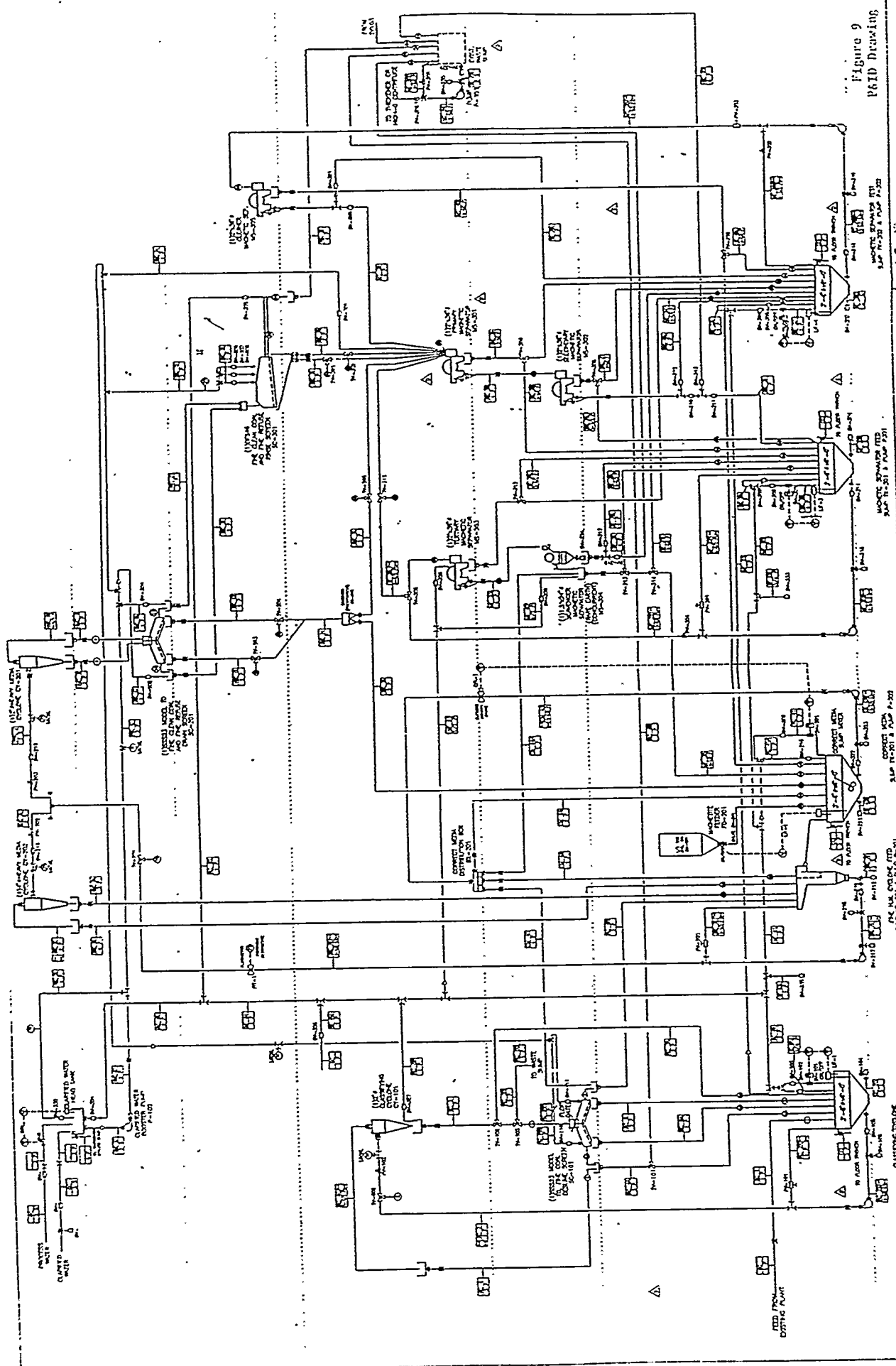


Figure 9  
PAID DRAWING

U.S. DEPT. OF COMMERCE - PHYSICS-INDUSTRY RELATIONS DIVISION  
MICRO-MACH PROCESS & P. D. (10-10-61)  
SERIES & INSTRUMENT (10-10-61)

LEGEND:  
 — LINE RESOLUTION  
 — LINE VELOCITY IN FPS  
 — LINE SIZE & RATE

LEGEND:  
 — SIGNAL WAVE  
 — PULSE WAVE  
 — PART UNIT WAVE  
 — CONTROL WAVE  
 — CONTROL WAVE

The final installation subtask, the electrical installation, started in mid-February 1995 and was also completed in late-March 1995. Rizzo & Sons were responsible for installing the following units:

- A new 200 Amp. Thermal Magnetic Circuit Breaker (TMCB) in DOE's existing Square D, Model 5 MCC in the PRF MCC room.
- A new, NEMA-12 Allen Bradley MCC in the PRF MCC room (3 Vertical Sections).
- A new customized Control Cabinet in the field to operate and monitor the circuit.
- 23 new disconnects in the field, one next to each new 480 Volt motor.

The electrical work included all conduit runs, wiring, and terminations between these units, and the 23, 480-Volt motors in the circuit. It also included the conduit runs, wiring, and termination between the Control Cabinet and the 11 fixed instruments in the field (1 Berthold nuclear density gauge, 5 Warrick level probe systems, and 5 air solenoids). The circuit also includes a Polysonics portable ultrasonic flowmeter, that does not require any permanent wiring. An illustration of these instrument locations is shown in Figure 9.

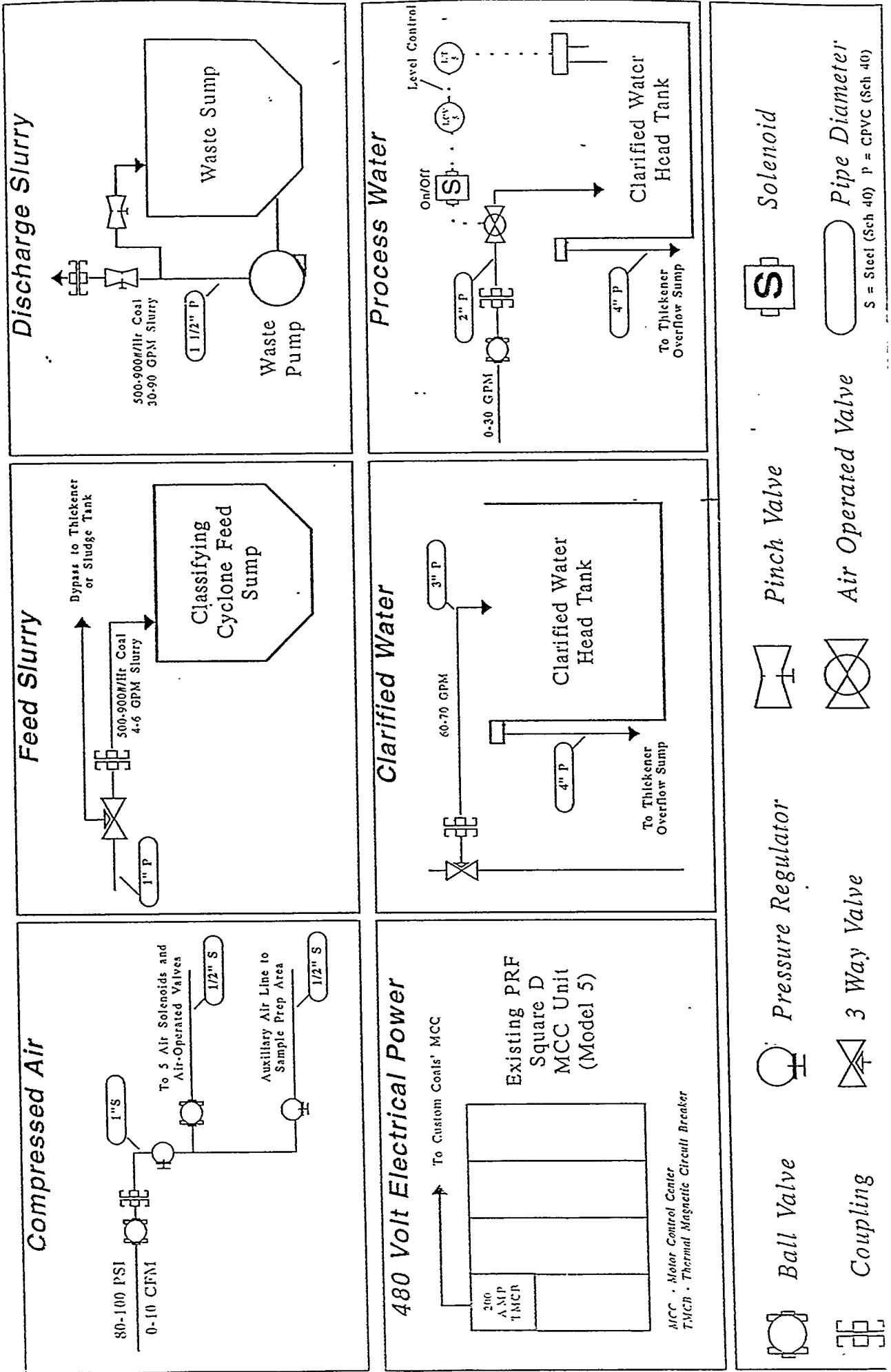
All aspects of the ET Circuit needed to be tied into the existing PRF system. Figure 10 contains the interface drawing for these various tie-ins. The Installation and Shakedown Plan, submitted in late December, included a more detailed discussion of the various installation tasks and work rules.

#### Section 5.6 - Task 600: Circuit Commissioning (Month 8)

The circuit commissioning task went very smoothly and was completed near the end of April, 1995. The operating staff, at the PRF site, during the commissioning period included:

- Custom Coals' Project Manager.
- One to two men from Rizzo's to assist with required modification and commissioning tasks.
- A part-time Project Engineer (Ed Torak), to assist with the on-site work.
- Two to three full-time Project Technicians (subcontracted from CT&E), to maintain, operate, and sample the circuit.

**Figure 10**  
**CIRCUIT INTERFACE & TIE-IN DRAWING**  
 GC/Existing PRF (black) & Custom Coal's MicroMag Circuit (green)



The commissioning task was broken down into three subtasks:

- Functionality and Leak Testing - to test motors and the sump level controls.
- Water Commissioning - to balance the circuit flowrates and correct any leaks.
- Slurry Commissioning - to balance the circuit with slurry and calibrate the nuclear density gauge and ultrasonic flowmeter.

The screens, cyclones, and magnetic separators were also tested for proper flow patterns and volume splits during the slurry commissioning period. The commissioning plan was discussed in detail in the Installation and Shakedown Plan, submitted late December 1994, and was discussed in even more detail in the Slurry Commissioning Plan, submitted in late March 1995.

#### Section 5.7 - Task 700: Circuit Testing (Months 9-13)

##### **5.7.1 COMMISSIONING TEST RESULTS**

The circuit slurry commissioning task was carried out over the entire month of April, and was broken down by the three subcircuits:

- Classifying Circuit Commissioning Tests
- Heavy-Media Cyclone Commissioning Tests
- Magnetite Recovery Circuit Commissioning Tests

Two men from Rizzo's installation staff stayed on site for the entire commissioning period to assist with required modifications and troubleshooting. The following discussion describes the commissioning results from these three areas of the circuit.

#### Classifying Circuit Commissioning Results

The goal of the classifying circuit commissioning was to test that subcircuits' ability to remove the majority of the -500M slimes (greater than 90Wt%), while recovering the majority of the +325M particles (greater than 90Wt%), with a high solids content product (greater than 35Wt%). A total of 7 tests were performed and completely analyzed during the testing, using two different circuits. The circuits were:

- Original Circuit - PRF feed to classifying cyclone, followed by north side of deslime screen, with deslime screen undersize recycled. This circuit was used for the first 5 tests.



- Modified Circuit - PRF feed to north side of deslime screen (desliming), followed by classifying cyclone and south side of deslime screen (dewatering), with south side screen undersize recycled to the classifying cyclone. This circuit was used for the last 2 tests.

Table 7 contains the operating conditions and results for the 7 tests.

As Table 7 illustrates, the initial circuit provided high recoveries, but it was impossible to simultaneously obtain efficient desliming and dewatering. Use of the modified circuit allowed the north side of the screen to focus on desliming and the south side of the screen to focus on dewatering. As a result, CT#6 and CT#7 were the only two tests to achieve the goal of greater than 35 Wt% solids in the final product (ie., 36.5 and 61.5 Wt%, respectively).

Custom Coals plans to use the modified circuit to accomplish the following more aggressive objectives.

- Target over 60 Wt% solids recovery (yield) to obtain 500#/hr of solids product, from 800#/hr of solids feed.
- Target over 60% Wt% solids content in the final product.
- Target over 95 Wt% rejection of -500M particles.
- Target over 95 Wt% recovery of +325M particles.
- Target D-50 separation size of 30-40 microns.

#### Heavy-Media Cyclone Commissioning Results

The second slurry commissioning subtask involved two tests to assess the flow and performance of the parallel 2" and 4" Krebs Heavy-Media Cyclones. Table 8 contains a summary of the test results and conditions.

Table 8 suggests that the 4" Cyclone was separating the +500M particles very efficiently for the feedrate and operating conditions in CMT#1 (ie., 84 Wt% yield, with a 7.5 Wt% Clean Coal Ash Content and 77 Wt% Refuse Ash Content, for a 18.9 Wt% Feed Ash Content), even with the relatively coarse, Lot#1 Grade-K Magnetite. Unfortunately, the 2" Cyclone yield was only 11.2 Wt% for the +500M particles in Test CMT#1. Even with the smallest acceptable apex size of .25 inches, used in CMT#2, the 2" Cyclone yield only increased to about 50 Wt%. Different size inlets and lower pressures will be tried in future testing in an attempt to improve the performance of the 2" Cyclone.

**TABLE 7**  
**CLASSIFYING CIRCUIT COMMISSIONING TESTS**  
**(Pittsburgh No. 8 Seam Raw Coal)**

| <u>GENERAL DATA</u>          | <u>Initial Tests</u> |             | <u>New Spray Bars</u> |             | <u>Modified Circuit</u> |             |
|------------------------------|----------------------|-------------|-----------------------|-------------|-------------------------|-------------|
|                              | <u>CT#1</u>          | <u>CT#2</u> | <u>CT#4</u>           | <u>CT#5</u> | <u>CT#6</u>             | <u>CT#7</u> |
| Date                         | 04/03/95             | 04/04/95    | 04/13/95              | 04/24/95    | 04/27/95                | 05/02/95    |
| Circuit Type                 | Original             | Original    | Original              | Original    | Modified                | Modified    |
| Feed Rate (#/hr)             | 644                  | 712         | 819                   | 783         | 739                     | 769         |
| <u>CYCLONE CONDITIONS</u>    |                      |             |                       |             |                         |             |
| Feed Inlet (sq. in.)         | 0.25                 | 0.25        | 0.25                  | 0.25        | 0.25                    | 0.25        |
| Vortex (Inches)              | 0.625                | 0.625       | 0.625                 | 0.625       | 0.625                   | 0.80        |
| Apex (Inches)                | 0.375                | 0.375       | 0.25                  | 0.25        | 0.25                    | 0.25        |
| Feed Pressure (PSI)          | 33                   | 42          | 46                    | 46          | 48                      | 45          |
| Feed Rate (GPM)              | 17.8                 | 20.7        | 18.5                  | 18.0        | 17.2                    | 22.1        |
| <u>SCREEN CONDITIONS</u>     |                      |             |                       |             |                         |             |
| North Side Panel (Mesh)      | 325                  | 325         | 200                   | 200         | 325                     | 325         |
| North Side Sprays (GPM)      | 5.0                  | 5.8         | 9.8                   | 14.5        | 15.0                    | 18.5        |
| South Side Panel (Mesh)      | --                   | --          | --                    | --          | 200                     | 100         |
| South Side Sprays (GPM)      | --                   | --          | --                    | --          | 2.4                     | 0.0         |
| <u>PRODUCT QUALITY</u>       |                      |             |                       |             |                         |             |
| Solids Content (Wt%)         | 26.5                 | 16.1        | 31.5                  | 18.6        | 36.5                    | 61.5        |
| Solids Flowrate (#/hr)       | 489                  | 561         | 606                   | 424         | 480                     | 396         |
| + 325 Mesh (Wt%)             | --                   | --          | 80.8                  | 91.1        | 77.6                    | 83.4        |
| 325 x 500 Mesh (Wt%)         | --                   | --          | 11.5                  | 4.8         | 13.7                    | 12.9        |
| -500 Mesh (Wt%)              | --                   | --          | 7.7                   | 4.1         | 8.7                     | 3.7         |
| <u>CIRCUIT PERFORMANCE</u>   |                      |             |                       |             |                         |             |
| Overall Recovery (Wt%)       | 75.9                 | 78.8        | 74.0                  | 54.1        | 65.0                    | 51.5        |
| + 325 Mesh Recovery (Wt%)    | --                   | 98.5        | 99.1                  | 88.0        | 99.7                    | 85.9        |
| -500 Mesh Rejection (Wt%)    | --                   | 61.2        | 81.7                  | 93.9        | 85.0                    | 94.8        |
| D-50 Size of Sepn. (Microns) | --                   | --          | 30                    | 60          | 30                      | 40          |

Notes: - Original Circuit - Classifying Cyclone, followed by Deslime Screen (North Side), with Deslime Screen Underflow Recycled.

- Modified Circuit - North Side of Deslime Screen (Desliming), followed by Classifying Cyclone and South Side of Deslime Screen (Dewatering), with South Side Screen Undersize Recycled to Cyclone.

**TABLE 8**  
**HEAVY-MEDIA CYCLONE SPLITS**  
**Pittsburgh No. 8 Seam Commissioning Tests**  
**(Grade-K Magnetite, Lot #1)**

| Test # | H.M.<br>Cyclone | Conditions            |                        | Feed         |                       | Overflow     |                         |                       | Underflow    |                       |
|--------|-----------------|-----------------------|------------------------|--------------|-----------------------|--------------|-------------------------|-----------------------|--------------|-----------------------|
|        |                 | Feed<br>Rate<br>(GPM) | Feed<br>Pres.<br>(PSI) | Slurry<br>SG | +500M<br>Ash<br>(Wt%) | Slurry<br>SG | +500M<br>Yield<br>(Wt%) | +500M<br>Ash<br>(Wt%) | Slurry<br>SG | +500M<br>Ash<br>(Wt%) |
| CMT#1  | 4"              | 28                    | 81                     | 1.34         | 18.9                  | 1.25         | 84.0                    | 7.5                   | 1.85         | 77.1                  |
| CMT#1  | 2"              | 10                    | 22                     | 1.34         | 18.9                  | 1.13         | 11.2                    | 4.6                   | 1.56         | 20.7                  |
| CMT#2  | 2"              | 10                    | 22                     | 1.32         | 19.2                  | 1.15         | 50.0                    | 5.8                   | 1.70         | 32.6                  |

- Notes:
- The 4" Cyclone had 0.12 sq. in. inlet, 1.00 inch vortex, and 0.625 inch apex.
  - The 2" Cyclone had 0.09 sq. in. inlet, 0.375 inch vortex, and 0.375 inch apex in CMT#1 and 0.25 inch apex in CMT#2.

### Magnetite Recovery Circuit Commissioning Test Results

The third and final slurry commissioning subtask involved three tests to assess the magnetite recovery circuit performance (ie., magnetite losses) for the screens and magnetic separators within the MicroMag circuit, once again using the relatively coarse, Lot#1 Grade-K Magnetite. Table 9 contains the total magnetite losses for each test, broken down by the two main sources:

- Rare-Earth Scavenger Magnetic Separator Tailing (Sample 36) - Which represents the total losses occurring within the 5 Eriez drum separators (see Figure 1).
- Combined Rinse Screen Products (Samples 22 & 23) - Which represents the magnetite trapped in the coarse particles overflowing the refuse and clean coal product screens (also see Figure 1).

The first test listed in Table 9 (MT#2), was a test performed with only magnetite, and no coal slurry. As a result, the magnetics losses were extremely low in the magnetic separator tailings (0.3-0.8 #/ton), and negligible in the Combined Rinse Screen Products (i.e., because there were no products). The magnetics contents and losses are based on two calculations (Davis-Tube based and EMU based), with Davis-Tube based values being an initial approximation, based on Davis-Tube magnetic separations, and EMU based values being a correction due to the slight inefficiency of the Davis Tube. The EMU calculations are based on magnetic moment measurements of the feed, mags, and nonmags from the Davis-Tube tests. The actual losses are probably somewhere in between, but closer to the EMU-based losses.

The last two test results listed in Table 9 are for two tests done with coal and magnetite slurry; the first (CMT#1) done with the finest, 325M drain and rinse screen panels and a deep bed in the rinse screen (-3 degree angle), and the second (CMT#2) done with coarser, 200M drain and rinse panels and a shallow bed on the rinse screen (0 degree angle). The results show that acceptable magnetics losses through the magnetic separators (1.1-3.3 #/ton) were achieved for both tests. However, the magnetics losses in the rinse screen products were unacceptably high (35-88 #/ton), for both tests. The coarser 200M panels and flattening of the rinse screen improved the results but the losses of 35-40 #/ton are still an order of magnetite above acceptable targets (2-5 #/ton). However, these were just some initial scoping tests for each of the units and no attempt was made to optimize the circuits.

**TABLE 9**  
**MAGNETITE LOSSES**  
**Pittsburgh No. 8 Seam Commissioning Tests**  
**(Grade-K Magnetic, Lot #1)**

| Test  | Stream                 | Davis-Tube Based Results |            |                  |                  | EMU Based Results |                  |
|-------|------------------------|--------------------------|------------|------------------|------------------|-------------------|------------------|
|       |                        | Stream Info.             |            | Solids Magnetics | Magnetics Losses | Solids Magnetics  | Magnetics Losses |
|       |                        | Solids (#/hr)            | Flow (GPM) | (Wt%)            | (#/Ton)          | (Wt%)             | (#/Ton)          |
| MT#2  | 36 - Scav. Sep. Tails  | 5                        | 60         | 1.5              | 0.3              | 3.9               | 0.8              |
| CMT#1 | 36 - Scav. Sep. Tails  | 100                      | 60         | 0.6              | 2.2              | 0.9               | 3.3              |
| CMT#1 | 22/23 - Rinse Products | 400                      | --         | 5.0              | 80               | 5.5               | 88               |
| CMT#1 | Total Circuit          | 500                      | --         | 4.1              | 82.2             | 4.6               | 91.3             |
| CMT#1 | 36 - Scav. Sep. Tails  | 100                      | 60         | 0.3              | 1.1              | 0.6               | 2.2              |
| CMT#2 | 22/23 - Rinse Products | 400                      | --         | 2.2              | 35               | 2.5               | 40               |
| CMT#2 | Total Circuit          | 500                      | --         | 1.8              | 36.1             | 2.1               | 42.2             |

- Notes:
- MT#2 had only magnetite being fed and 22 and 23 streams were negligible.
  - 36 is Rare-Earth Scavenger Magnetic Separator Tailings (Final Magnetic Separator Nonmags).
  - 22 is Rinse Screen Refuse Discharge (Final Refuse Nonmag).
  - 23 is Rinse Screen Clean Coal Discharge (Final Clean Coal Nonmags).
  - Data Assumes 500#/hr total coal feed, and that pure magnetics are 86 Emug.
  - CMT#1 done with 325M panels with -3° angle on rinse screen, and CMT#2 done with 200M panels with 0° angle on rinse screen.

### 5.7.2 QA\QC RESULTS

The QA/QC required for the plant testing can be broken down into three main areas:

- Sample handing, preparation, and analyses accuracy checks - Which requires adopting and adhering to certain set procedures and equipment.
- Instrument accuracy checks - Which encompasses flowmeters, pressure gauges, and nuclear density gauges.
- Sample and test, repeatability and reproducibility - Which can be affected by procedures and approach, but are more system dependent (ie., stabilization time, system consistency, and feed consistency).

The circuit is set up with a number of manual and redundant systems to routinely check the accuracy of the instruments. When coupled with the planned routine

maintenance of the instruments, Custom Coals does not anticipate any significant accuracy problems in those areas, at least none that would skew overall test conclusions and results.

The majority of Custom Coals QA/QC will focus on the last two areas, particularly obtaining accurate sample analyses and material balances. To date, a number of issues have already been addressed. For example, Table 10 contains the ASTM Standards for within lab repeatability, and between labs reproducibility, of coal laboratory analyses. Since Custom Coals is doing all sample preparation at site, including moisture and ash analyses, a test was done to compare the analyses obtained on samples with PETC's Furnaces (the standard method) to CT&E's commercial laboratory results. Table 11 illustrates, via the duplicate analyses that Custom Coals is well within ASTM repeatability for moisture and ash analyses, using the PETC furnaces. Table 11 also illustrates that Custom Coals analyses match CT&E's for moisture and ash within ASTM reproducibility.

**TABLE 10  
ASTM STANDARDS  
FOR COAL ANALYTICAL VARIANCES**

| <u>Analysis</u> | <u>Coal Type</u>          | <u>ASTM Allowable Differences on Duplicate Samples</u> |   |
|-----------------|---------------------------|--|---|
|                 |                           | <u>Repeatability<br/>Within Lab</u>                    | <u>Reproducibility<br/>Between Labs</u> |
| Moisture        | Any                       | 0.30 Wt%   | 0.50 Wt%                                |
| Ash             | Raw Coal                  | 0.50 Wt%   | 1.00 Wt%                                |
|                 | Clean Coal                | 0.20 Wt%   | 0.30 Wt%                                |
|                 | Refuse Coal               | 1.00 Wt%   | 2.00 Wt%                                |
| Btu/lb.         | Any                       | 50   | 100                                     |
| Sulfur          | <2.0% Sulfur Coal         | 0.05 Wt%   | 0.10 Wt%                                |
|                 | >2.0% Sulfur Coal         | 0.10 Wt%   | 0.20 Wt%                                |
| Pyritic Sulfur  | <2.0% Pyritic Sulfur Coal | 0.05 Wt%   | 0.30 Wt%                                |
|                 | >2.0% Pyritic Sulfur Coal | 0.10 Wt%   | 0.40 Wt%                                |

TABLE 11  
COMPARISON OF COAL ANALYSES  
PETC AND CT&E FURNACES  
(Test PCT #1, 05/16/95)

| Sample No. | Sample Name                   | Residual Moisture (Wt%) |      | Dry Ash Content (Wt%) |       |
|------------|-------------------------------|-------------------------|------|-----------------------|-------|
|            |                               | PETC                    | CT&E | PETC                  | CT&E  |
| 1          | PRF Feed                      | 1.93/1.93               | 1.86 | 27.31/27.48           | 26.89 |
| 2          | Class. Cyclone Feed           | 1.43/1.49               | 1.50 | 25.98/25.97           | 25.41 |
| 3          | Class. Cyclone Underflow      | 1.86/1.92               | 1.92 | 26.88/26.66           | 26.02 |
| 4          | Class. Cyclone Overflow       | 1.77/1.88               | 1.70 | 32.21/32.37           | 31.73 |
| 5          | Deslime Screen Unders (South) | 1.04/1.04               | 1.02 | 56.25/56.00           | 54.97 |
| 5A         | Deslime Screen Unders (North) | 1.72/1.68               | 1.59 | 38.97/39.24           | 38.44 |
| 6          | Deslime Screen Disch. (South) | 1.47/1.47               | 1.41 | 20.91/21.04           | 20.77 |
| 6A         | Deslime Screen Disch. (North) | 1.77/1.83               | 1.69 | 24.19/24.15           | 23.65 |

Note: Analyses on PETC Furnace Performed by CT&E Personnel.

Another area of QA/QC testing that has been performed at site is testing of the Carpco Wet-Splitting Unit for accuracy and reproducibility. The testing was done with three types of feed:

- Water-only testing
- Coal/water slurry testing
- Magnetite/water slurry testing

The results from the testing, shown in Table 12 illustrate that the unit makes two consistent 5.5 Wt% splits, that essentially match the composition of the waste stream removed from the bottom (Split #3). The only problem is that a significant portion of the feed is retained within the unit (0.3 to 1.8 Wt%), and the retained portion is higher solids content than the splits, meaning that the splits are slightly lower solids content than the actual feed sample. It appears that the solids retained in the Carpco Unit essentially match the passing portion in composition.

**TABLE 12**  
**WET-SPLITTING RESULTS FOR CARPCO UNIT**

I. Water-Only Testing: (10,000 gram Feed Sample)

| <u>Portion</u>   | <u>Removed Recovery (Wt%)</u> | <u>Total Recovery (Wt%)</u> |
|------------------|-------------------------------|-----------------------------|
|                  | --                            |                             |
| Split #1         | 5.4                           | 5.4                         |
| Split #2         | 5.6                           | 5.6                         |
| Split #3 (Waste) | 89.0                          | 88.7                        |
| <u>Retained</u>  | <u>--</u>                     | <u>0.3</u>                  |
| Total            | 100.0                         | 100.0                       |

II. Coal/Water Slurry Testing: (5,000 gram at 10.0 Wt% Solids)

| <u>Portion</u>   | <u>Total Slurry Recovery (Wt%)</u> | <u>Total Solids Recovery (Wt%)</u> | <u>Solids Content (Wt%)</u> | <u>Ash Content (Wt%, Dry)</u> |
|------------------|------------------------------------|------------------------------------|-----------------------------|-------------------------------|
| Split #1         | 5.5                                | 5.3                                | 9.6                         | 26.7                          |
| Split #2         | 5.6                                | 5.4                                | 9.7                         | 27.2                          |
| Split #3 (Waste) | 87.3                               | 84.2                               | 9.6                         | 26.9                          |
| <u>Retained</u>  | <u>1.6</u>                         | <u>5.1</u>                         | <u>33.2</u>                 | <u>--</u>                     |
| Total            | 100.0                              | 100.0                              | 10.0                        | --                            |

III. Magnetite/Water Slurry Testing: (Cleaner Mag Separator Concentrate Sample)

| <u>Portion</u>   | <u>Total Slurry Recovery (Wt%)</u> | <u>Total Solids Recovery (Wt%)</u> | <u>Solids Content (Wt%)</u> | <u>Solids Analysis</u> |                       |                              |
|------------------|------------------------------------|------------------------------------|-----------------------------|------------------------|-----------------------|------------------------------|
|                  |                                    |                                    |                             | <u>MVD (Microns)</u>   | <u>Moment (Emu/g)</u> | <u>Davis-Tube Rec. (Wt%)</u> |
| Split #1         | 5.4                                | 5.3                                | 27.3                        | 9.9                    | 87.0                  | 99.8                         |
| Split #2         | 5.5                                | 5.4                                | 27.3                        | 9.9                    | 87.1                  | 99.6                         |
| Split #3 (Waste) | 87.3                               | 85.8                               | 27.3                        | 9.9                    | 87.4                  | 99.7                         |
| <u>Retained</u>  | <u>1.8</u>                         | <u>3.5</u>                         | <u>53.4</u>                 | <u>10.1</u>            | <u>86.2</u>           | <u>99.6</u>                  |
| Total            | 100.0                              | 100.0                              | 27.8                        | 9.9                    | 87.3                  | 99.7                         |



In May, additional testing was conducted using the Carpcoc wet-slitting device. Table 13 contains wet splitting results obtained for a Heavy-Media Cyclone Feed Sample (Sample #7), containing a coal/magnetite slurry. Two methods were employed:

- Flushing after removing the splits (Test PHT #21) - which should be the best method of obtaining an accurate "wt% solids" split.
- Flushing prior to removing the splits (Test PHT #22) - which should be the best method of obtaining an accurate "solids composition" split.

The results in Table 13 verify the theories listed above, and illustrate that the splitting accuracy of the Carpcoc Unit is more than acceptable, provided the slurry is well mixed as it is poured into the unit.

Presently, Custom Coals does not need to employ the Carpcoc wet-slitting device, because all samples can be filtered in a timely fashion. However, as finer magnetites are tested during the project, it may become necessary to use the unit to reduce sample sizes.

Five additional QA/QC issues were also assessed and tested. They included:

- MTU/IMP Laboratory Investigation Results
- Davis-Tube Separation and Magnetic Moment Measurement, Reproducibility Testing done by MTU's IMP.
- Wet Screening Accuracy Testing done by Custom Coals.
- Duplicate Testing and Sample Reproducibility Checks, done by Custom Coals during the Heavy-Media Cyclone Components Tests
- Marcy Balance Sensitivity Testing

**TABLE 13**  
**CARPCO WET SPLITTER TEST**  
**WITH COAL/MAGNETITE SLURRY**  
**(Pittsburgh No. 8 Seam Coal, Grade-K Magnetite)**

I. Test PHT#21 - Cyclone Feed (Sample #7) - Flush after removing splits.

| Sample            | Slurry      |              | Total Solids |              |           |                      | +500M Solids |           | -500M Solids Analyses |                |                |                 |
|-------------------|-------------|--------------|--------------|--------------|-----------|----------------------|--------------|-----------|-----------------------|----------------|----------------|-----------------|
|                   | Weight (g.) | Direct (Wt%) | Weight (g.)  | Direct (Wt%) | Ash (Wt%) | Solids Content (Wt%) | Direct (Wt%) | Ash (Wt%) | Ash (Wt%)             | Micotrac (MVD) | Moment (Emu/g) | D.T. Rec. (Wt%) |
| Split #1          | 965.2       | 5.8          | 512.1        | 5.7          | 63.11     | 53.1                 | 23.3         | 13.44     | 79.54                 | 12.3           | 54.37          | 63.4            |
| Split #2          | 932.4       | 5.6          | 495.6        | 5.5          | 62.45     | 53.2                 | 23.8         | 13.46     | 80.07                 | 12.2           | 54.39          | 61.5            |
| Split #3 (Waste)  | 14,665.0    | 88.6         | 7,803.0      | 86.8         | 66.05     | 53.2                 | 21.7         | 14.14     | 79.47                 | 11.3           | 56.16          | 65.0            |
| Rec. Total        | 16,562.6    | 100.0        | 8,810.7      | 98.0         | 65.68     | 53.2                 | 21.9         | 14.06     | 79.50                 | 11.4           | 55.96          | 64.7            |
| Split #4 (Losses) | 397.4       | 2.3          | 183.2        | 2.0          | 75.96     | 46.1                 | 33.0         | 63.56     | 84.04                 | 11.4           | 57.90          | 65.9            |
| Head              | 16,960.0    | 102.3        | 8,993.9      | 100.0        | 65.89     | 53.0                 | 22.1         | 15.55     | 79.54                 | 11.4           | 55.99          | 64.7            |

Note: Split #4 represents only portion left in splitter after initial split. It does not include water required to flush it out.

II. Test PHT#22 - Cyclone Feed (Sample #7) - Flush Prior to Removing Splits.

| Sample           | Slurry      |              | Total Solids |              |           |                      | +500M Solids |           | -500M Solids Analyses |                |                |                 |
|------------------|-------------|--------------|--------------|--------------|-----------|----------------------|--------------|-----------|-----------------------|----------------|----------------|-----------------|
|                  | Weight (g.) | Direct (Wt%) | Weight (g.)  | Direct (Wt%) | Ash (Wt%) | Solids Content (Wt%) | Direct (Wt%) | Ash (Wt%) | Ash (Wt%)             | Micotrac (MVD) | Moment (Emu/g) | D.T. Rec. (Wt%) |
| Split #1         | 1,081.1     | 5.8          | 544.9        | 5.8          | 64.70     | 50.4                 | 22.6         | 17.14     | 78.71                 | 12.2           | 55.01          | 63.6            |
| Split #2         | 1,064.3     | 5.7          | 526.1        | 5.7          | 67.59     | 49.4                 | 23.2         | 16.34     | 81.15                 | 12.0           | 56.22          | 63.3            |
| Split #3 (Waste) | 16,535.0    | 88.5         | 8,260.0      | 88.5         | 65.32     | 50.0                 | 20.8         | 17.41     | 82.44                 | 11.5           | 56.05          | 66.6            |
| Rec. Total       | 18,680.4    | 100.0        | 9,331.0      | 100.0        | 65.41     | 50.0                 | 21.0         | 17.36     | 82.11                 | 11.6           | 56.00          | 66.2            |
| Losses (+)       | 166.2       | 0.9          | 0.0          | -            | -         | 0.0                  | -            | -         | -                     | -              | -              | -               |
| Total Flush (-)  | 1,406.6     | -7.5         | 0.0          | -            | -         | 0.0                  | -            | -         | -                     | -              | -              | -               |
| Head             | 17,440.0    | 93.4         | 9,331.0      | 100.0        | 65.41     | 53.5                 | 21.0         | 17.36     | 82.11                 | 11.6           | 56.00          | 66.2            |

## MTU/IMP LABORATORY INVESTIGATION RESULTS

In February 1995, Custom Coals subcontracted MTU's IMP to perform a laboratory investigation to determine required laboratory procedures for the fine-coal and magnetite slurry and solid samples that will be generated during the project testing. The main analytical concerns were obtaining accurate and reproducible:

- density, viscosity, and agglomeration measurements
- magnetics/nonmagnetics separations
- magnetics analyses (ie., magnetic moments and compositions)
- magnetics and nonmagnetics size analyses, down to submicron sizes.

The goal is to have MTU's IMP to continue to provide laboratory analyses services, for the project test samples, using the equipment and procedures they developed during this investigation.

### Mictotrac Size Analyses

One of the first areas of concern was developing sample pretreatment methods to obtain accurate particle size analysis of solids and slurry samples, using the IMP's Leeds and Northrup Microtrac Particle Size Analyzer. During the testing, the IMP staff found that three pretreatment steps were necessary to obtain accurate and reproducible size analyses with the unit. It was included that:

- The samples had to be wetted in the presence of a surfactant, if they were dry, to enhance both wetting and dispersion.
- The samples had to be demagnetized to ensure that any magnetite agglomerates were broken up.
- The samples had to be treated with an ultrasonic probe, for 5-10 minutes to ensure that all coal agglomerates were broken up.

The samples had to also be well agitated during these steps, as well as during removal of the small portion for analyses, to ensure good dispersion and a representative sample.

Once these procedures were followed, the IMP staff found that they could obtain essentially identical analyses for parallel splits, even when one split had been filtered and dried and the other had not. They also found that the Microtrac analyses for feed, magnetics, and nonmagnetics balanced around their magnetics separations, which was also an important QA/QC test.

As a check of their Microtrac analyses for bias, the IMP also sent samples of the feed magnetite to another laboratory (PTLL) for testing in a similar machine (a Malvern Unit), and also did an elaborate particle counting analysis in their SEM to determine the particle size populations. The size distribution proved to be very similar with the following reported results:

- MTU's IMP Mitrotrac - 5.7 micron mean volume diameter (MVD).
- PTLL's Malvern - 5.8 micron mean volume diameter (MVD).
- MTU's IMP SEM - 6.2 micron mean volume diameter (MVD).

For the remainder of the project the -500M particle size analyses will be done with the IMP's Microtrac.

### Solids Density Measurements

Table 14 shows some solids density measurements that the IMP has performed as part of their investigation. Once they switched to kerosene as the measuring media, the accuracy and reproducibility of their measurements greatly improved (to +/- .02 SG units) over those obtained with water, due to improved wetting. All required solids density measurements will be done by the IMP.

### Davis-Tube Separation Testing (Magnetite Only)

The first step in MTU's IMP Davis-Tube separation testing was to determine a profile of Amps vs. Gauss for their Davis Tube and see if the separations matched earlier work during this project by Eriez Magnetics. The results provided essentially identical, except that MTU recovered all nonmags, so they could reconstitute yields from weights of both products, as well as from feed and mags weights. The IMP also determined that once magnetics saturations were reached on the Davis-Tube (ie., at about 0.7 amps), the recoveries remained constant, up to the maximum setting of 1.7 amps. This indicated that any amp level could be used between 0.7 and 1.7 amps to lead to similar results. However, they later found that when the highest 1.7 amp level was used the Davis-Tube had much higher capacity (ie., up to 6 grams of magnetics). This proved to be desirable to allow bigger samples, and subsequently more nonmagnetics to analyze, and better overall particle recovery (ie., approaching 99 Wt%). It was therefore decided that all Davis Tube measurements would be made at 1.7 amps.

**TABLE 14**  
**SOLIDS DENSITIES**  
(Measured with Kerosene)

| SAMPLE                          | SG   |
|---------------------------------|------|
| PennMag Grade-K "Old" Magnetite | 4.73 |
| DOE 90-X Magnetite              | 4.86 |
| Hi-Temp. Magnetite              | 4.57 |
| Pittsburgh No. 8 (-325 M)       | 1.68 |
| Lower Kittanning (-325 M)       | 1.42 |

#### Davis-Tube Separations & Magn. Moment Measurements (Coal & Magn.)

In combination with the Davis-Tube separations, the MTU's IMP has also made magnetic moment measurements of the feed, mags, and nonmags to compliment the measurements. Table 15 shows the results for separations with the initial PennMag Grade-K magnetite (old magnetite), which has a pure magnetics moment of about 84 Emu/g, and the coarser Lot #1, PennMag Grade-K Magnetite from PeaRidge (new magnetite) which has a pure magnetics moment of about 87 Emu/g. The results indicate the occasional and unexplained inefficiency of magnetics separation with the Davis-Tube, for coal and magnetite mixtures, as shown by the drop in Emu/g of the magnetics product (see DT-33, S-15, and S-16) and the higher than expected Emu/g of the nonmagnetics (see DT-33).

The inefficiencies, illustrated in Table 15, are not understood. As a result, the product team plans to compliment the Davis-Tube separation results, with magnetics moment measurements, so that magnetics contents and magnetics losses can be calculated two ways:

- From Davis-Tube magnetics at 1.70 amps.
- From magnetics moment of all samples (feeds, mags, and nonmags).

Another advantage of the magnetic moment measurements is that they allow a quick and inexpensive estimate of magnetics content of a sample. For instance, for the new magnetite testing the magnetics content can be estimated by measuring the sample Emu/g and dividing it by 87 Emu/g (the magnetic moment of pure magnetics). This has proven to be a valuable tool in the project testing.

TABLE 15  
DAVIS-TUBE AND MOMENT BALANCES  
(Old and New PennMag Grade-K Magnetite)

I. OLD MAGNETITE:

| <u>Test Number</u> | <u>Feed Description</u>                    | <u>Sample</u>   | <u>Weight (Grams)</u> | <u>Weight (Wt%)</u> | <u>Moment (Emu/g)</u> | <u>Moment Dist. (Wt%)</u> |
|--------------------|--|-----------------|-----------------------|---------------------|-----------------------|---------------------------|
| DT-24              | Magnetite Only                             | Mags            | 5.64                  | 95.5                | 84.30                 | 99.94                     |
|                    |  | <u>Non Mags</u> | <u>0.27</u>           | <u>4.5</u>          | <u>1.00</u>           | <u>0.06</u>               |
|                    |  | Total           | 5.91                  | 100.0               | 80.55                 | 100.00                    |
| DT-37              | Pitts. No. 8 Coal Only                     | Mags            | 0.00                  | 0.0                 | 0.00                  | 0.00                      |
|                    |  | <u>Non Mags</u> | <u>5.87</u>           | <u>100.0</u>        | <u>0.21</u>           | <u>100.00</u>             |
|                    |  | Total           | 5.87                  | 100.0               | 0.21                  | 100.00                    |
| DT-33              | Sim. Cyclone Feed<br>(1.0/4.7g. Coal/Mag.) | Mags            | 4.32                  | 76.9                | 80.40                 | 99.39                     |
|                    |  | <u>Non Mags</u> | <u>1.30</u>           | <u>23.1</u>         | <u>1.67</u>           | <u>0.61</u>               |
|                    |  | Total           | 5.62                  | 100.0               | 62.21                 | 100.00                    |

II. NEW MAGNETITE:

| <u>Test Number</u> | <u>Feed Description</u>     | <u>Sample</u>   | <u>Weight (Grams)</u> | <u>Weight (Wt%)</u> | <u>Moment (Emu/g)</u> | <u>Moment Dist. (Wt%)</u> |
|--------------------|-----------------------------|-----------------|-----------------------|---------------------|-----------------------|---------------------------|
| DT-54              | Magnetite Only              | Mags            | 4.92                  | 99.2                | 86.74                 | 99.94                     |
|                    |                             | <u>Non Mags</u> | <u>0.04</u>           | <u>0.8</u>          | <u>7.35</u>           | <u>0.06</u>               |
|                    |                             | Total           | 4.96                  | 100.0               | 86.10                 | 100.00                    |
| S-13               | Cyclone Feed                | Mags            | 4.00                  | 68.7                | 87.07                 | 99.73                     |
|                    |                             | <u>Non Mags</u> | <u>1.83</u>           | <u>31.3</u>         | <u>0.53</u>           | <u>0.27</u>               |
|                    |                             | Total           | 5.83                  | 100.0               | 59.98                 | 100.00                    |
| S-15               | Final Coal Product          | Mags            | 0.05                  | 0.3                 | 83.71                 | 67.88                     |
|                    |                             | <u>Non Mags</u> | <u>15.76</u>          | <u>99.7</u>         | <u>0.12</u>           | <u>32.12</u>              |
|                    |                             | Total           | 15.81                 | 100.0               | 0.37                  | 100.00                    |
| S-16               | Scav. Mag. Sep.<br>Tailings | Mags            | 0.05                  | 0.6                 | 70.67                 | 54.23                     |
|                    |                             | <u>Non Mags</u> | <u>8.40</u>           | <u>99.4</u>         | <u>0.36</u>           | <u>45.77</u>              |
|                    |                             | Total           | 8.45                  | 100.0               | 0.78                  | 100.00                    |

## DAVIS-TUBE AND MAGNETIC MOMENT REPRODUCIBILITY TESTING

During May, MTU's IMP performed a number of duplicate analyses to observe the reproducibility and closure of the Davis-Tube magnetics separations and magnetic moment measurements they perform, as part of their routine analyses for the project. Table 16 illustrates duplicate Davis-Tube separations for two methods they have tested during the project. All four separations were performed with identical dried splits of a Combined Drain Screen Underflow Sample (Sample #16) from the commissioning tests. The two methods tested included:

- Complete water evaporation of the Davis-Tube products to ensure complete, particle recovery, followed by magnetics moment analyses (Lab. No. S-8-1A & S-8-1B).
- Partial settling of Davis-Tube products followed by decanting and micropore filtering (Lab. No. S-8-2A & S-8-2B).

The second method was the standard method MTU's IMP normally employs.

The results in Table 16, and in other duplicate tests, illustrates that either method leads to very good reproducibility of separations (ie., magnetics yields, moment measurements, and moment distributions). The major difference is that the water evaporation method causes a significant weight gain due to precipitation of solids from the vast amount of water used in the Davis-Tube Procedure; whereas, the normal method leads to a slight weight loss due to decanting and filtering losses. Custom Coals has decided that the normal method (ie., decanting and filtering) is preferred, and has setup procedures to maximize sample size so that the slight losses of colloidal and/or soluble particles do not skew results.

Similarly, Table 17 contain a number of duplicate magnetic moment measurements for samples with vastly differing magnetics contents. The results illustrate that the moment measurements are reproducible to within 0.3 to 0.7 EMU/g. This does not create a problem for high EMU content samples, but can cause significant percentage-basis errors for samples containing minute amounts of magnetite (ie., see R.E. Magnetic Separator Tailings in Table 17). Custom Coals plans to duplicate and triplicate the magnetic moment samples, and also plans to combine the moment measurements with Davis-Tube separations, to reduce the likelihood of errors and ensure that accurate determinations of magnetics losses are obtained during integrated testing.

**TABLE 16**  
**DAVIS-TUBE SEPARATION**  
**ACCURACY AND REPEATABILITY TESTING**  
**(Pittsburgh No. 8 Seam Coal, Grade-K Magnetite)**

| <u>MTU/IMP</u><br><u>Lab. No.</u> | <u>Particle Recovery</u><br><u>Method/Approach</u> | <u>Davis Tube</u><br><u>Product</u> | <u>Weight</u><br><u>(g)</u> | <u>Weight</u><br><u>(Wt%)</u> | <u>Moment</u><br><u>(Emu/g)</u> | <u>Moment</u><br><u>Dist. (%)</u> |
|-----------------------------------|--|-------------------------------------|-----------------------------|-------------------------------|---------------------------------|-----------------------------------|
| 5-8-1A                            | Water Evaporation                                  | Mags                                | 6.444                       | 82.46                         | 85.099                          | 99.85                             |
|                                   |  | <u>NonMags</u>                      | <u>1.371</u>                | <u>17.54</u>                  | <u>0.601</u>                    | <u>0.15</u>                       |
|                                   |  | Recon. Feed                         | 7.815                       | 100.00                        | 70.275                          | 100.00                            |
|                                   |  | Head                                | 7.537                       | -                             | 74.084                          | -                                 |
| 5-8-1B                            | Water Evaporation                                  | Mags                                | 6.893                       | 82.09                         | 86.007                          | 99.83                             |
|                                   |  | <u>NonMags</u>                      | <u>1.504</u>                | <u>17.91</u>                  | <u>0.652</u>                    | <u>0.17</u>                       |
|                                   |  | Recon. Feed                         | 8.397                       | 100.00                        | 70.719                          | 100.00                            |
|                                   |  | Head                                | 8.064                       | -                             | 74.084                          | -                                 |
| 5-8-2A                            | Settle, Decant, & Filter                           | Mags                                | 6.424                       | 85.61                         | 85.285                          | 99.84                             |
|                                   |  | <u>NonMags</u>                      | <u>1.080</u>                | <u>14.39</u>                  | <u>0.595</u>                    | <u>0.16</u>                       |
|                                   |  | Recon. Feed                         | 7.504                       | 100.00                        | 73.096                          | 100.00                            |
|                                   |  | Head                                | 7.527                       | -                             | 74.084                          | -                                 |
| 5-8-2B                            | Settle, Decant, & Filter                           | Mags                                | 5.301                       | 85.96                         | 87.052                          | 99.84                             |
|                                   |  | <u>NonMags</u>                      | <u>0.866</u>                | <u>14.04</u>                  | <u>0.855</u>                    | <u>0.16</u>                       |
|                                   |  | Recon. Feed                         | 6.167                       | 100.00                        | 74.948                          | 100.00                            |
|                                   |  | Head                                | 6.254                       | -                             | 73.986                          | -                                 |

Notes: All four separations done with identical splits of Test CMT#1, Sample #16 (Combined Drain Screen Underflow), from Commissioning Tests.



**TABLE 17**  
**MAGNETIC MOMENT**  
**MEASUREMENT REPRODUCIBILITY**  
**(Pittsburgh No. 8 Seam Coal, Grade-K Magnetite)**

| <u>MTU/IMP</u><br><u>Lab No.</u> | <u>Test</u><br><u>Number</u> | <u>Sample</u><br><u>Number</u> | <u>Sample</u><br><u>Description</u> | <u>Davis Tube</u><br><u>Product</u> | <u>Magnetic Moment</u>           |                                  |                               |
|----------------------------------|------------------------------|--------------------------------|-------------------------------------|-------------------------------------|----------------------------------|----------------------------------|-------------------------------|
|                                  |                              |                                |                                     |                                     | <u>Dup. #1</u><br><u>(Emu/g)</u> | <u>Dup. #2</u><br><u>(Emu/g)</u> | <u>Avg.</u><br><u>(Emu/g)</u> |
| S-2                              | MT #2                        | #40                            | Cleaner Magnetic<br>Separator Conc. | Head                                | 86.995                           | 86.800                           | 86.897                        |
|                                  |                              |                                |                                     | Mags                                | 87.324                           | 86.989                           | 87.156                        |
| S-8                              | CMT #1                       | #16                            | Combined Drain<br>Screen Effluent   | Head                                | 74.886                           | 74.783                           | 74.834                        |
|                                  |                              |                                |                                     | Mags                                | 85.577                           | 84.993                           | 85.285                        |
|                                  |                              |                                |                                     | NonMags                             | 0.636                            | 0.554                            | 0.595                         |
| S-14                             | CMT #1                       | #22                            | Rinse Screen<br>Refuse Discharge    | Head                                | 8.746                            | 9.441                            | 9.093                         |
|                                  |                              |                                |                                     | NonMags                             | 0.297                            | 0.316                            | 0.307                         |
| S-16                             | CMT #1                       | #36                            | R.E. Magnetic<br>Separator Tails    | Head                                | 0.922                            | 0.940                            | 0.931                         |
|                                  |                              |                                |                                     | NonMags                             | 0.723                            | 0.437                            | 0.580                         |

Note: All measurements done with 0.03 to 0.15 gram sample dependent on bulk density of sample.

## WET SCREENING ACCURACY TESTING

Custom Coals performed QA/QC testing to assess the completeness of the 500M wet screening being done with the homemade, vibrating-vacuum unit being used at site (see results in Table 18). In the testing, samples of heavy-media cyclone overflow (Sample #9A), underflow (Sample #8A), and feed (Sample #7) were subjected to normal screening and washing, where the sample is assumed complete once the lab screen effluent becomes clear (PHT#1). The washing amounts were also doubled in a similar test to assess any improvement (PHT#2). Since all the magnetite is slightly finer than 500M the distribution of magnetics offers the best possible quantification of screening efficiency. The results in Table 18 illustrate, that in all cases, over 99.95 Wt% of the sample magnetics were screened into the 500Mx0 fraction, where they belong. This is extremely efficient, and illustrates that the normal washing approach is more than adequate for our test samples. We will merely need to continue with our daily inspection of the screens for holes and keep screening until the effluent becomes clear.

## DUPLICATE TESTING AND SAMPLE REPRODUCIBILITY

The final set of QA/QC-related tests, performed in May were duplicate testing and sampling done as part of the Heavy-Media Cyclone Component Testing. These tests were performed during the second batch of Heavy-Media Cyclone Component Tests (PHT#11-#20), at 10:1 media-to-coal ratio, after the inadequate mixing occurring during batch #1 had been principally corrected. Table 19 contains the results from two identical, back-to-back tests and illustrates the good performance reproducibility that can occur when the mixing stays steady.

By contrast, Table 20 shows the variability of a number of "actual" and "reconstituted" feed samples that were taken over a slightly longer period. The results indicate that the mixing is not yet perfect, and there are random and biased variations that occur as the sump volume is dropping that need to be considered when drawing conclusions from the data.

**TABLE 18**  
**QA/QC TEST FOR ON-SITE WET SCREENING**  
**(Pittsburgh No. 8 Seam Coal, Grade-K Magnetite)**

|                                 | <u>PHT#1 (Normal Washing)</u>              |   | <u>PHT#2 (Double Washing)</u>              |   |                                      |
|---------------------------------|--|---|--|---|--------------------------------------|
|                                 | <u>Sample #9A<br/>Cyclone<br/>Overflow</u> | <u>Sample #8A<br/>Cyclone<br/>Underflow</u> | <u>Sample #9A<br/>Cyclone<br/>Overflow</u> | <u>Sample #8A<br/>Cyclone<br/>Underflow</u> | <u>Sample #7<br/>Actual<br/>Feed</u> |
| <u>Top x 325M Size Fraction</u> |  |   |  |   |                                      |
| Weight Distribution (Wt%)       | 44.9                                       | 7.3   | 47.4                                       | 4.2   | 22.9                                 |
| Magnetics (Wt%)                 | 0.01                                       | 0.44  | 0.01                                       | 0.41  | 0.07                                 |
| Magnetics Distribution (Wt%)    | 0.01                                       | 0.04  | 0.01                                       | 0.02  | 0.02                                 |
| <u>325 x 500M Size Fraction</u> |  |   |  |   |                                      |
| Weight Distribution (Wt%)       | 5.7  | 2.4   | 7.9  | 1.5   | 4.2                                  |
| Magnetics (Wt%)                 | 0.03                                       | 0.40  | 0.04                                       | 0.47  | 0.17                                 |
| Magnetics Distribution (Wt%)    | 0.00                                       | 0.01  | 0.01                                       | 0.01  | 0.01                                 |
| <u>500M x 0 Size Fraction</u>   |  |   |  |   |                                      |
| Weight Distribution (Wt%)       | 49.4                                       | 90.3  | 44.7                                       | 94.3  | 72.9                                 |
| Magnetics (Wt%)                 | 93.78                                      | 96.97                                       | 85.33                                      | 94.96                                       | 94.22                                |
| Magnetics Distribution (Wt%)    | 99.99                                      | 99.95                                       | 99.98                                      | 99.97                                       | 99.97                                |
| <u>Combined Size Fractions</u>  |  |   |  |   |                                      |
| Weight Distribution (Wt%)       | 100.0                                      | 100.0                                       | 100.0                                      | 100.0                                       | 100.0                                |
| Magnetics (Wt%)                 | 46.33                                      | 87.61                                       | 38.15                                      | 89.57                                       | 68.71                                |
| Magnetics Distribution (Wt%)    | 100.00                                     | 100.00                                      | 100.00                                     | 100.00                                      | 100.00                               |

Note: Magnetics (Wt%) determined from Davis-Tube Separations on all size fractions.

**TABLE 19**  
**DUPLICATE TEST RESULTS**  
**HEAVY-MEDIA CYCLONE COMPONENT TESTS**  
**(Pittsburgh No. 8 Seam Coal, Grade-K Magnetite)**

|  | <u>Test PHT #18 Results</u>               |  |                        | <u>Test PHT #19 Results</u>               |  |                        |
|--|---|--|------------------------|---|--|------------------------|
|  | <u>Sample 9A<br/>Cyclone<br/>Overflow</u> | <u>Sample 8A<br/>Cyclone<br/>Underflow</u> | <u>Recon.<br/>Feed</u> | <u>Sample 9A<br/>Cyclone<br/>Overflow</u> | <u>Sample 8A<br/>Cyclone<br/>Underflow</u> | <u>Recon.<br/>Feed</u> |
| <b><u>SLURRY COMPOSITION</u></b>         |   |  |                        |   |  |                        |
| Slurry Feedrate (GPM)                    | -   | -  | 36.2                   | -   | -  | 36.2                   |
| Slurry SG                                | 1.31                                      | 1.80                                       | 1.48                   | 1.32                                      | 1.80                                       | 1.50                   |
| Solids Content (Wt%)                     | 48.3                                      | 59.3                                       | 53.1                   | 48.6                                      | 59.5                                       | 53.4                   |
| <b><u>OVERALL SOLIDS PERFORMANCE</u></b> |   |  |                        |   |  |                        |
| Yield (Wt%)                              | 51.6                                      | 48.4                                       | 100.0                  | 50.9                                      | 49.1                                       | 100.0                  |
| Proportion (Wt%)                         | 100.0                                     | 100.0                                      | 100.0                  | 100.0                                     | 100.0                                      | 100.0                  |
| Ash Content (Wt%)                        | 42.49                                     | 87.15                                      | 64.11                  | 45.17                                     | 89.32                                      | 66.81                  |
| <b><u>TOP X 325M PERFORMANCE</u></b>     |   |  |                        |   |  |                        |
| Yield (Wt%)                              | 79.4                                      | 20.6                                       | 100.0                  | 78.8                                      | 21.2                                       | 100.0                  |
| Proportion (Wt%)                         | 25.3                                      | 7.0  | 16.5                   | 23.7                                      | 6.6  | 15.3                   |
| Ash Content (Wt%)                        | 6.19                                      | 58.38                                      | 16.94                  | 6.32                                      | 59.82                                      | 17.66                  |
| <b><u>325 X 500M PERFORMANCE</u></b>     |   |  |                        |   |  |                        |
| Yield (Wt%)                              | 76.3                                      | 23.7                                       | 100.0                  | 75.0                                      | 25.0                                       | 100.0                  |
| Proportion (Wt%)                         | 12.1                                      | 4.0  | 8.2                    | 11.3                                      | 3.9  | 7.7                    |
| Ash Content (Wt%)                        | 4.83                                      | 24.00                                      | 9.37                   | 4.96                                      | 26.24                                      | 10.28                  |
| <b><u>500M x 0 PERFORMANCE</u></b>       |   |  |                        |   |  |                        |
| Yield (Wt%)                              | 42.8                                      | 57.2                                       | 100.0                  | 43.0                                      | 57.0                                       | 100.0                  |
| Proportion (Wt%)                         | 62.5                                      | 88.9                                       | 75.3                   | 65.0                                      | 89.5                                       | 77.0                   |
| Ash Content (Wt%)                        | 64.46                                     | 92.35                                      | 80.41                  | 66.32                                     | 94.24                                      | 82.23                  |

Note: Both tests performed at 10:1 media-to-coal ratio, at 90 PSI feed pressure, with 0.12 square inch inlet, 1.0 inch vortex, and 0.875 inch apex in 4" Heavy-Media Cyclone.

**TABLE 20**  
**DUPLICATE FEED SAMPLE RESULTS**  
**HEAVY-MEDIA CYCLONE COMPONENT TESTS**  
**(Pittsburgh No. 8 Seam Coal, Grade-K Magnetite)**

|                                | <u>Test PHT #18 Results</u> |                    | <u>Test PHT #19 Results</u> | <u>Test PHT #20 Results</u> |                    |
|--------------------------------|-----------------------------|--------------------|-----------------------------|-----------------------------|--------------------|
|                                | <u>Actual Feed</u>          | <u>Recon. Feed</u> | <u>Recon. Feed</u>          | <u>Recon. Feed</u>          | <u>Actual Feed</u> |
| <u>SLURRY COMPOSITION</u>      |                             |                    |                             |                             |                    |
| Slurry SG                      | -                           | 1.48               | 1.50                        | 1.50                        | -                  |
| Solids Content (Wt%)           | 53.4                        | 53.1               | 53.4                        | 53.4                        | 53.4               |
| <u>OVERALL SOLIDS ANALYSIS</u> |                             |                    |                             |                             |                    |
| Proportion (Wt%)               | 100.0                       | 100.0              | 100.0                       | 100.0                       | 100.0              |
| Ash Content (Wt%)              | 69.82                       | 64.11              | 66.81                       | 67.01                       | 64.84              |
| <u>TOP X 325M ANALYSIS</u>     |                             |                    |                             |                             |                    |
| Proportion (Wt%)               | 13.4                        | 16.5               | 15.3                        | 15.1                        | 16.7               |
| Ash Content (Wt%)              | 19.36                       | 16.94              | 17.66                       | 17.64                       | 16.56              |
| <u>325 X 500M ANALYSIS</u>     |                             |                    |                             |                             |                    |
| Proportion (Wt%)               | 7.2                         | 8.2                | 7.7                         | 7.5                         | 8.1                |
| Ash Content (Wt%)              | 11.33                       | 9.37               | 10.28                       | 9.35                        | 9.09               |
| <u>500M X 0 ANALYSIS</u>       |                             |                    |                             |                             |                    |
| Proportion (Wt%)               | 79.4                        | 75.3               | 77.0                        | 77.4                        | 75.2               |
| Ash Content (Wt%)              | 83.64                       | 80.41              | 82.23                       | 82.23                       | 81.57              |

Note: All Tests performed with same feed batch at 40.0 Wt% Media Contamination.

## MARCY BALANCE SENSITIVITY TESTING

During June CCI conducted a sensitivity test on the Marcy Balance to assure that accurate specific gravity measurements were being obtained. CCI decided to conduct this sensitivity test since in many cases the measured specific gravities of the 4" heavy media cyclone overflow and underflow did not agree with the calculated specific gravities of the overflow and underflow. Before conducting the sensitivity test the Marcy Gauge was calibrated with water and known specific gravity test samples. The results of the calibration indicated that the Marcy Balance was producing accurate results. Next, researchers developed four means to determine the sensitivity of the Marcy Balance. First the Marcy cup was allowed to overfill the entire cup before removing it from the correct media stream. Any material that was deposited on the sides of the cup were not removed and the cup was then placed on the Marcy Balance (column #1-Table 21) and a reading was obtained. Second, the cup was then removed and the sides cleaned to remove any material that was deposited on the cup sides before another reading was obtained (column #2 - Table 21). Next the media in the cup was removed and the cup was cleaned. The cup was then filled only to the overflow holes allowing any material that was deposited on the sides of the cup to remain and another reading was taken (column #3 - Table 9). Lastly, the cup was removed and the sides cleaned to remove any material that was deposited on the cup sides before another reading was obtained (column #4 - Table 9).

As can be seen from Table 21 the small amount of material deposited on the sides of the cup had almost no influence in the specific gravity reading. However, overfilling the Marcy cup had a significant influence on the specific gravity reading. This is most likely do to the solids setting in the cup during the time the sample is taken until the cup is placed on the Marcy Balance. By the time the cup is placed on the Marcy Balance most of the solids have settled below the overflow holes concentrating the solids in the Marcy cup which falsely increases the specific gravity reading of the Marcy Balance. During future test work, efforts will be made not to overfill the Marcy cup, and calculated specific gravities will be used instead of measured specific gravities if the measured vs. the calculated specific gravities differ by a large percentage.

TABLE 21: Marcy Balance Sensitivity Test Results

| Overfilling Marcy and Not Cleaning | Overfilling Marcy and Then Cleaning | Not Overfilling Marcy and Not Cleaning | Not Overfilling Marcy and Then Cleaning | Nuclear Density Gauge |     |
|------------------------------------|-------------------------------------|--|---|-----------------------|-----|
| S.G.                               | S.G.                                | S.G.                                   | S.G.                                    | S.G.                  |     |
| 1.440                              | 1.430                               | 1.410                                  | 1.410                                   | 1.42                  |     |
| 1.435                              | 1.430                               | 1.400                                  | 1.400                                   | 1.43                  |     |
| 1.435                              | 1.430                               | 1.400                                  | 1.400                                   | 1.43                  |     |
| 1.435                              | 1.425                               | 1.405                                  | 1.405                                   | 1.43                  |     |
| 1.430                              | 1.430                               | 1.410                                  | 1.410                                   | 1.43                  |     |
| 1.430                              | 1.430                               | 1.410                                  | 1.405                                   | 1.42                  |     |
| 1.430                              | 1.430                               | 1.410                                  | 1.405                                   | 1.43                  |     |
| 1.433                              | 1.429                               | 1.406                                  | 1.405                                   | 1.427                 | AVE |

During this quarterly technical progress report two additional QA/QC issues were assessed. They included:

- Reconstituting the Grade-L magnetite magnetics and non-magnetics size fractions to assure that their reconstituted head agreed with the "as received" magnetite size consist.
- Assuring that the Grade-L magnetite size analysis did not change after numerous hours of integrated testing.

#### RECONSTITUTION OF GRADE-L MAGNETITE

During August concerns arose, regarding the Microtrac results of the "as received" magnetite vs. the 1.7 Amp Davis Tube magnetics of the magnetite in that the magnetics fraction of the magnetite was approximately 1 MVD finer than that of the "as received" magnetite. As a result, MTU's IMP performed Microtrac analysis on:

- The Grade-L "as received" magnetite.
- The 1.7 Amp Davis Tube magnetics from the Grade-L magnetite, and
- The 1.7 Amp Davis Tube non-magnetics from the Grade-L magnetite.

MTU's IMP then reconstituted the magnetics and non-magnetics fractions to obtain a reconstituted "as received" sample. The results are contained in Table 22.

Table 22: Reconstituted Grade-L Magnetite Comparison

| Size( $\mu$ ) | Cumulative<br>As Received<br>(Wt%) | Cumulative<br>Magnetics<br>(Wt%) | Cumulative<br>Non-Magnetics<br>(Wt%) | Cumulative<br>Reconstituted<br>Head |
|---------------|------------------------------------|----------------------------------|--------------------------------------|-------------------------------------|
| +88           | 0.0                                | 0.0                              | 0.0                                  | 0.0                                 |
| 88 x 62       | 0.0                                | 0.0                              | 0.0                                  | 0.0                                 |
| 62 x 44       | 0.0                                | 0.0                              | 0.0                                  | 0.0                                 |
| 44 x 31       | 0.0                                | 0.0                              | 0.0                                  | 0.0                                 |
| 31 x 22       | 0.0                                | 0.0                              | 0.0                                  | 0.0                                 |
| 22 x 16       | 1.1                                | 0.8                              | 3.5                                  | 0.9                                 |
| 16 x 11       | 8.6                                | 7.9                              | 13.7                                 | 8.2                                 |
| 11 x 7.8      | 24.5                               | 23.2                             | 27.0                                 | 23.4                                |
| 7.8 x 5.5     | 43.7                               | 42.6                             | 40.3                                 | 42.5                                |
| 5.5 x 3.9     | 58.9                               | 57.9                             | 50.5                                 | 57.6                                |
| 3.9 x 2.8     | 75.9                               | 76.8                             | 65.1                                 | 76.3                                |
| 2.8 x 1.9     | 91.0                               | 92.1                             | 82.6                                 | 91.7                                |
| 1.9 x 1.4     | 96.3                               | 96.6                             | 91.3                                 | 96.4                                |
| 1.4 x 0.9     | 99.3                               | 99.2                             | 97.3                                 | 99.1                                |
| -0.9          | 100.1                              | 100.1                            | 99.8                                 | 100.1                               |

As can be seen from Table 22, the reconstituted head results agree extremely well with the "as received" results. Table No. 22 also indicates that the non-magnetics fraction is coarser than the magnetics fraction which explains the 1 MVD size difference between the "as received" magnetite and the 1.7 Amp Davis Tube magnetics.



## GRADE-L MAGNETITE COMPARISONS

When removing the Grade-L magnetite from the Micro-Mag circuit a sample of the circulating media was obtained and analyzed for size and magnetic moment. This was done to assure that the magnetite quality did not change after numerous hours of processing during the primary integrated testing. Table 23 compares the results for the Grade-L magnetics before processing and after processing.

Table 23: Grade-L Magnetite Magnetics Comparison

| Size ( $\mu$ )  | As Received |       | After Processing |       |
|-----------------|-------------|-------|------------------|-------|
|                 | Vol.        | Cum.  | Vol.             | Cum.  |
| +22             | 3.1         | 100.0 | 3.4              | 100.0 |
| 22 x 16         | 10.7        | 96.9  | 10.1             | 96.6  |
| 16 x 11         | 17.6        | 86.2  | 16.4             | 86.5  |
| 11 x 7.8        | 20.1        | 68.6  | 19.2             | 70.2  |
| 7.8 x 5.5       | 18.3        | 48.5  | 18.0             | 50.9  |
| 5.5 x 3.9       | 15.8        | 30.2  | 17.3             | 32.9  |
| 3.9 x 2.8       | 10.0        | 14.5  | 11.1             | 15.6  |
| 2.8 x 1.9       | 2.7         | 4.5   | 2.7              | 4.5   |
| 1.9 x 1.4       | 1.5         | 1.7   | 1.5              | 1.8   |
| -0.9            | 0.3         | 0.3   | 0.3              | 0.3   |
| MVD             | 6.64        |       | 6.51             |       |
| D <sub>90</sub> | 12.78       |       | 12.72            |       |
| D <sub>50</sub> | 5.67        |       | 5.42             |       |
| D <sub>10</sub> | 2.40        |       | 2.34             |       |
| EMU/gm          | 77.24       |       | 77.02            |       |

As can be seen from Table 23, the magnetics fraction of the Grade-L magnetite quality after processing in the Micro-Mag circuit is identical to that of the as received.

## 5.7.3 CIRCUIT TESTING RESULTS

The main circuit testing and analytical tasks occurring this quarterly period included:

- Conducting eight primary integrated tests (PIT #1-#8). Five tests were conducted using the Pittsburgh No. 8 seam and the Grade-K magnetite and three tests were performed using the Pittsburgh No. 8 seam and the Grade-L magnetite.

- Conducted classifying cyclone tests using the Pittsburgh No. 8 and Lower Kittanning seams using a larger (0.5 inch) apex.
- Completed data analysis and developed partition curves for the Grade-K "closed-loop" heavy media cyclone tests.

#### PRIMARY INTEGRATED TESTS

The first five primary integrated tests (PIT #1-#5) were conducted using the Grade-K magnetite and the Pittsburgh No. 8 seam. These tests included operating the circuit:

- With 200M drain and rinse screens with a slight positive angle on the rinse screen with the underflow from the drain screen reporting to the primary magnetic separator (PIT #1).
- With 200M drain and rinse screens with a slight negative angle on the rinse screen with the underflow from the drain screen reporting to the primary magnetic separator (PIT #3).
- With 100M drain and rinse screens with a slight negative angle on the rinse screen with the underflow from the drain screen reporting to the primary magnetic separator (PIT #4).
- With 100M drain and rinse screens with a slight positive angle on the rinse screen with the underflow from the drain screen reporting to the primary magnetic separator (PIT #5).
- With no drain and rinse screens with the 2-inch heavy-media cyclone products reporting to the primary magnetic separator (PIT #2).

The other three primary integrated tests (PIT #6-#8) were conducted using the Grade-L magnetite and the Pittsburgh No. 8 seam. These tests included operating the circuit.

- With 100M drain and rinse screens with a slight negative angle on the rinse screen with the underflow from the drain screen reporting to the primary magnetic separator (PIT #6).
- With no drain and rinse screens with the 2-inch heavy-media cyclone products reporting to the primary magnetic separator (PIT #7).

- With 200M drain and rinse screens with a slight negative angle on the rinse screen with the underflow from the drain screen reporting to the primary magnetic separator (PIT #8).

A summary of the results from all 8 tests are illustrated in Table 24. The following conclusions and observations can be made from these results on the testing of the Grade-K and Grade-L magnetites.

- Large amounts of magnetite (80 to 500 lbs/ton) are being lost in the discharge of the rinse screen when 200M decks are used. A slight negative angle on the rinse screen helps reduce this loss but the losses are still very significant (80 lbs/ton).
- Only a small amount of magnetite is being lost in the discharge of the rinse screen when 100M decks are used. However, when coupled with the magnetite loss from the rare earth magnetite separator the total circuit magnetite losses are on the order of 4.1 to 12.1 lbs/ton.
- The tests that produced the best results regarding magnetite loss was when no drain or rinse screens were used. The total circuit magnetite losses for these tests were 3.8 lbs/ton for the Grade-K and 5.8 lbs/ton for the Grade-L.
- Large amounts of clarified water (30 to 36 GPM) must be used on the rinse screen to recover the magnetite.
- The magnetic content of the primary magnetic separator concentrate was at least 95% magnetics for all eight tests.
- It appears that slightly more magnetite is being lost when using the finer Grade-L magnetite (5.8 vs 3.8).

Table 24 - Primary Integrated Test Results

| Test No. | Magnetite Grade | D&R Screen Size (Mesh) | Rinse Screen Angle | Total Circuit Mag. Loss (lbs/ton) |
|----------|-----------------|------------------------|--------------------|-----------------------------------|
| PIT #1.  | K               | 200                    | Positive           | 512.0                             |
| PIT #2   | K               | No Screens             | N.A.               | 3.8                               |
| PIT #3   | K               | 200                    | Negative           | 108.6                             |
| PIT #4   | K               | 100                    | Negative           | 4.6                               |
| PIT #5   | K               | 100                    | Positive           | 4.1                               |
| PIT #6   | L               | 100                    | Negative           | 12.1                              |
| PIT #7   | L               | No Screens             | N.A.               | 5.8                               |
| PIT #8   | L               | 200                    | Negative           | 79.8                              |

#### CLASSIFYING CYCLONE TESTS

Two classifying cyclone tests were conducted in July and August using the Pittsburgh No. 8 and the Lower Kittanning seam coals. Both tests were conducted using a larger (0.5 inch) apex. From the results of the tests the following conclusions can be made.

- When processing the Pittsburgh No. 8 seam coal, the total circuit +325M recovery (95.9%) was very good. The total circuit -500M rejection of 89.1% was somewhat low but acceptable.
- When processing the Lower Kittanning seam coal, the total circuit +500M recovery of 90.5% and the total circuit -500M rejection of 86.7% were low.
- The deslime screen discharge % solids to the heavy-media cyclone sump was very good in both tests with the Pittsburgh No. 8 seam having 63.9% solids and the Lower Kittanning seam having 58.9% solids.

Another test will be performed in October with a coarser grind feeding the Micro-Mag circuit in an effort to improve the performance of the classifying circuit when processing the Lower Kittanning Seam.

## GRADE-K CLOSED-LOOP HEAVY-MEDIA CYCLONE TESTS

During this quarter the washability results of the four Grade-K "closed-looped" heavy media cyclone tests (PHT #23, #26, #30, #31) were received from CT&E and analyzed. These data were used to generate distribution curves to determine dense-medium cyclone separation efficiency. The preliminary results from the generated distribution curves are summarized in Table 25 and the preliminary partition curves are shown in Figures 11 thru 14.

The following conclusions and observations can be made from preliminary distribution curves generated for the "closed-looped" heavy-media cyclone tests (PHT #23, #26, #30, #31) using the Grade-K magnetite.

- The Eps for the 48M x 200M (0.077 vs 0.079), the 200M x 500M (0.120 vs 0.111), and the composite 48M x 500M (0.116 vs 0.113) were nearly identical with the cyclone operating at high or low pressure when 0% fines contamination was present.
- With 40% fines contamination present, the Eps for all size fractions were lower when the cyclone was operating at high pressure.
- As would be expected, the Eps were lower in all cases when no fines contamination was present.
- Considering the relative coarse size of the magnetite used, the Eps with 0% contamination were fairly respectable.
- In all cases, the cut point ( $D_{50}$ ) was extremely high (2.0-2.1) when you consider the circulating media was 1.40 S.G.

### Section 5.8 - Task 800: Analytical (Month 5-14)

As discussed in the last Quarterly Report the analytical requirements have been determined. They are:

- Custom Coals on site laboratory will perform % solids, ashing, wet screening, and sample preparation.
- MTU's IMP will perform density, magnetics/nonmagnetics separations, ashing on 500Mx0 nonmagnetics and microtrac analysis.
- CTE's Kentucky laboratory will perform all fine washability analysis.
- CTE's Pennsylvania laboratory will perform sulfur, sulfur forms, and Btu analysis.

TABLE 25: HEAVY-MEDIA CYCLONE PERFORMANCE RESULTS - GRADE-K MAGNETITE  
(PRELIMINARY)

| TEST NO. | OPERATING CONDITIONS |                     |                     | CYCLONE PERFORMANCE |      |                |      |                         |      |
|----------|----------------------|---------------------|---------------------|---------------------|------|----------------|------|-------------------------|------|
|          | MAGNETITE            | CONTAMINATION LEVEL | FEED PRESSURE (PSI) | 48 X 200 MESH       |      | 200 X 500 MESH |      | COMPOSITE 48 X 500 MESH |      |
|          |                      |                     |                     | Ep                  | D50  | Ep             | D50  | Ep                      | D50  |
| PHT #23  | Grade K              | 0%                  | 88                  | 0.077               | 2.09 | 0.120          | 2.28 | 0.116                   | 2.14 |
| PHT #26  | Grade K              | 0%                  | 19                  | 0.079               | 2.00 | 0.111          | 2.25 | 0.113                   | 2.08 |
| PHT #30  | Grade K              | 40%                 | 88                  | 0.086               | 1.95 | 0.155          | 2.23 | 0.136                   | 2.06 |
| PHT #31  | Grade K              | 40%                 | 19                  | 0.114               | 1.84 | 0.240          | 2.12 | 0.185                   | 1.95 |

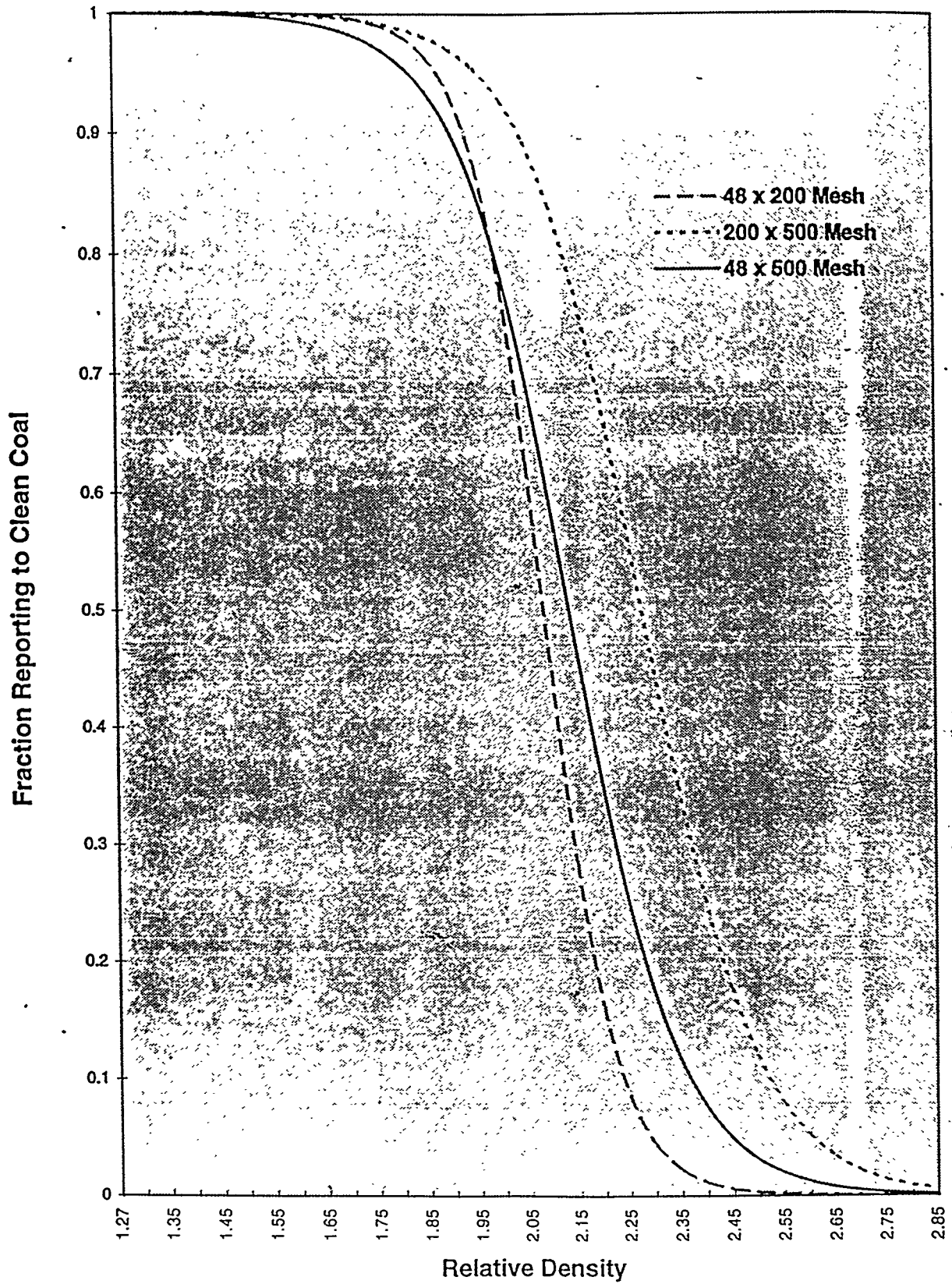


FIGURE 11  
Fitted Partition Curves for PHT #23  
(PRELIMINARY)

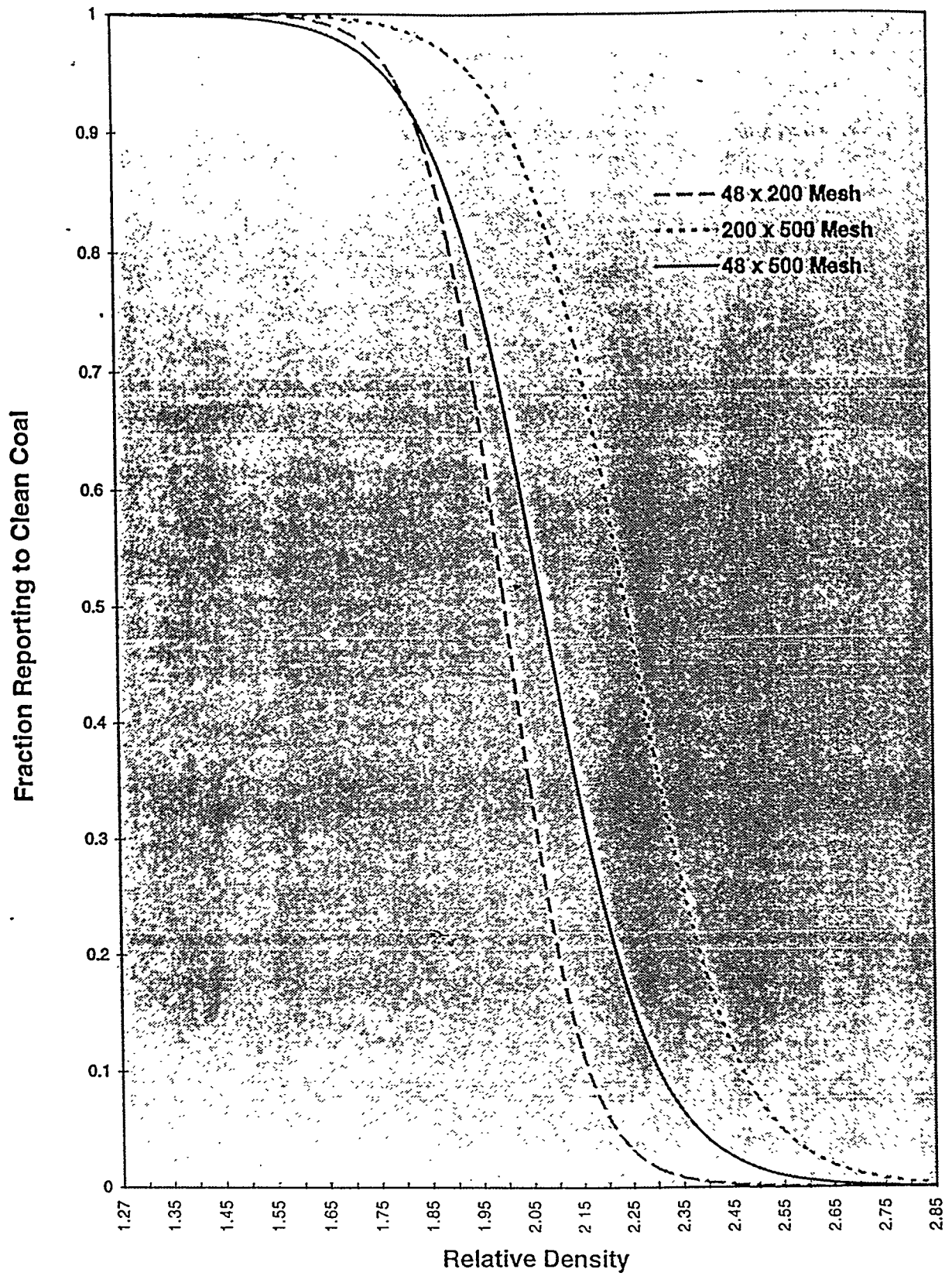


FIGURE 12

Fitted Partition Curves for PHT #26

(PRELIMINARY)



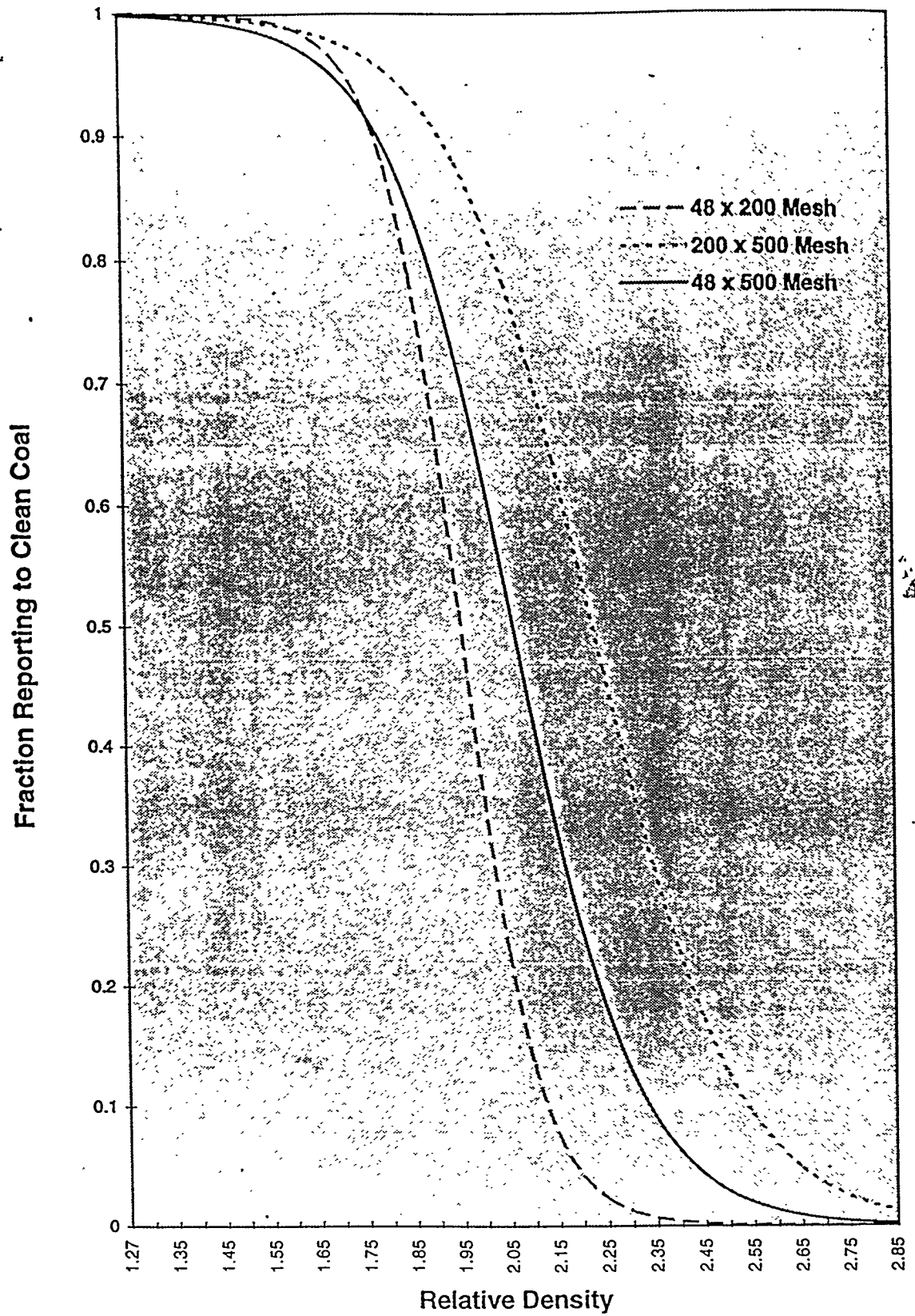


FIGURE 13

Fitted Partition Curves for PHT #30  
(PRELIMINARY)

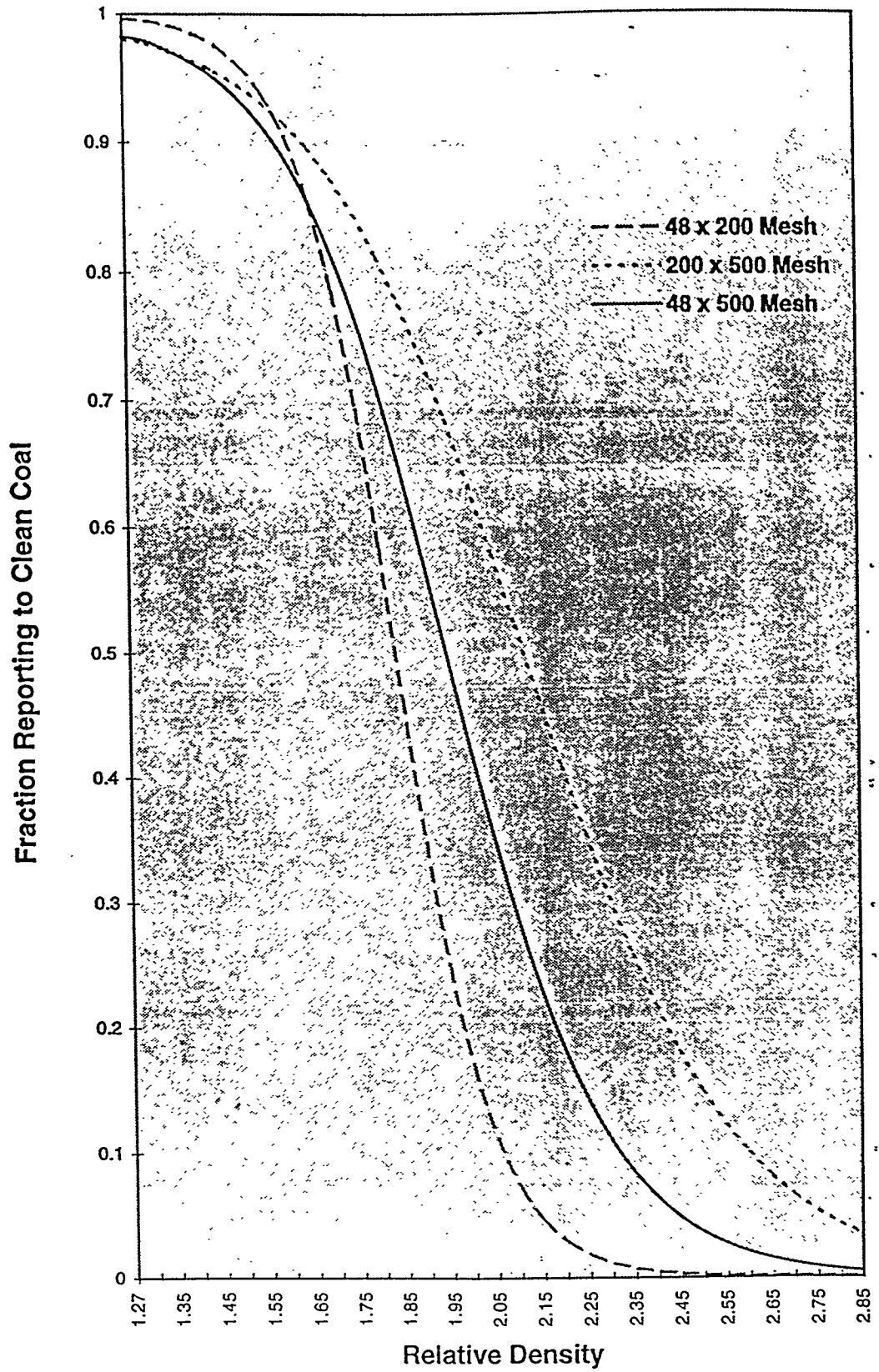


FIGURE 14

Fitted Partition Curves for PHT #31

(PRELIMINARY)

### Section 5.9 - Task 900: Circuit Decommissioning (Month 14)

The circuit decommissioning task has been deleted from Custom Coal's Contract as DOE has elected to leave to Micro-Mag circuit in place for possible future testing. As a result, the 20K that was budgeted for decommissioning the circuit will be used for additional testing. However, a Final Equipment Inventory and Hazardous Waste Report will still be submitted, and all equipment will be transferred to DOE possession, prior to Custom Coals leaving site.

### Section 5.10 - Task 1000: Data Evaluation (Months 5-15)

The data evaluation task will begin in January 1995 with the Laboratory Procedure Investigation and run through January 1996. It will include evaluation of the preliminary laboratory procedure studies done prior to the circuit commissioning, as well as evaluation of all the circuit commissioning and testing results. Custom Coals' Project Manager will keep up on all data evaluation and present it in a timely fashion, within the Monthly Technical Status Reports and Quarterly Technical Progress Reports. The data evaluation will also form the basis for the comments in the weekly schedule/status sheets.

### Section 5.11 - Task 1100: Final Reporting (Months 15-16)

Custom Coals anticipates submitting a Draft Final Report in mid January 1996. The report will contain:

- A chronology of the project events by task series.
- A summary of all testing results, sample analyses, and data calculations.
- A list of the major project conclusions with specific emphasis on the project objectives.
- A discussion of the project successes and failures with specific emphasis on methods of eliminating problems in future projects.
- An economic evaluation of the micronized magnetite project, including case studies for scale-up of the as-tested circuit.

After review by DOE's Technical Project Management Team, the Draft Final Report will be revised and resubmitted (assumed to occur at the end of January 1996).

## SECTION 6 - GOALS FOR NEXT QUARTERLY REPORTING PERIOD

The specific goals for the next quarterly reporting period (ie., October through December, 1995) are:

- Conduct primary integrated testing using the Grade-M magnetite and the Pittsburgh No. 8 Seam.
- Modify all five Micro-Mag magnetic separators to approximately one third their present size to better approximate commercial operation.
- Conduct final integrated testing using the Pittsburgh No. 8 seam and the Grade-K, L, & M magnetites with the reduced sized magnetic separators.
- Continue data evaluation on the "closed-looped" heavy media cyclone tests and the integrated testing.
- Prepare a paper on the Micro-Mag project for presentation at the AIME conference.
- Conduct 40 hours of long-duration testing using the Lower Kittanning seam and one grade of magnetite.
- Begin preparing the final report for the project.