FINAL REPORT

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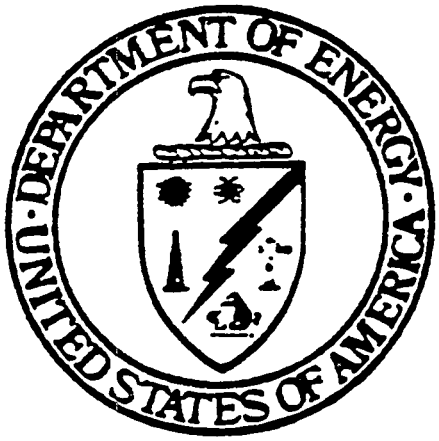
For

ENGINEERING DEVELOPMENT OF ADVANCED PHYSICAL FINE COAL CLEANING TECHNOLOGIES –

FROTH FLOTATION



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PITTSBURGH ENERGY TECHNOLOGY CENTER
Pittsburgh, Pennsylvania

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ICF KAISER ENGINEERS

With

Ohio Coal Development Office

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Consolidation Coal Company
Center for Research on Sulfur in Coal
EIMCO Process Equipment Company
Illinois State Geologic Survey
Kentucky Energy Cabinet Laboratory
Virginia Polytechnic Institute & State University

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ENGINEERING DEVELOPMENT OF ADVANCED FROTH FLOTATION

FINAL REPORT

MARCH 1995

U.S. DEPARTMENT OF ENERGY
CONTRACT NO. DE-AC22-88PC88881

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April 4 1995

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1.0 EXECUTIVE SUMMARY

In 1988, ICF Kaiser Engineers was awarded DOE Contract No. DE-AC22-88PC88881 to research, develop, engineer and design a commercially acceptable advanced froth flotation coal cleaning technology. The DOE initiative is in support of the continued utilization of our most abundant energy resource. Besides the goal of commercialability, coal cleaning performance and product quality goals were established by the DOE for this and similar projects. Primary among these were the goals of 85 percent energy recovery and 85 percent pyrite rejection. Three nationally important coal resources were used for this project: the Pittsburgh No. 8 coal, the Upper Freeport coal, and the Illinois No. 6 coal. Following is a summary of the key findings of this project.

1.1 Bench-Scale Test Results

Bench-scale testing was conducted in order to reduce the technical and engineering related design deficiencies of the proposed advanced froth flotation process. For bench-scale testing, the coarse fraction (1/4 in. x 48 mesh) of the Pittsburgh No. 8 seam coal was precleaned in a water-only cyclone while the Upper Freeport and Illinois No. 6 coals were precleaned in a heavy-media cyclone. The heavy-media cyclone achieved energy recoveries of 95 percent or greater while the water-only cyclone performance was poor, with an energy recovery of only 85 percent.

The clean coal from the coarse gravity-based cleaning circuit was then crushed to 48 mesh x zero and, in the case of heavy-media cyclone cleaning, combined with the natural 48 mesh x zero size fractions of the raw coal. The coarse water-only cyclone clean coal already contained the 48 mesh x zero material. The resulting 48 mesh x zero streams for all three coals were then cleaned in a water-only cyclone. For each coal, water-only cyclone energy recoveries were greater than 95 percent. Pyrite rejections were 28 percent and 31 percent for the Pittsburgh No. 8 and Upper Freeport coal seams, but only 13 percent for the Illinois No. 6 coal seam.

The clean coal from the water-only cyclone operation was classified into 48 mesh x 200 mesh and 200 mesh x zero size fractions for conventional froth flotation testing. Investigators evaluated "grab-and-run" flotation in an effort to produce a clean coal from the flotation "grab" stage of six percent ash or less for all three coals. The Upper Freeport "grab" product met the clean coal ash target while the Illinois No. 6 seam coal "grab" product clearly did not meet the six percent ash criteria. No firm conclusions were reached regarding the "grab" product for the Pittsburgh No. 8 seam coal as the "grab" product ash slightly exceeded six percent.

Grinding circuit evaluations conducted for this project included the comparison of the cleaning performance potential at two different coal grinds, 200 mesh and 325 mesh, using the Pittsburgh No. 8 seam coal. Each of these samples were then cleaned in a 2-inch diameter column flotation cell in order to compare the separation characteristics of the two coal grinds. The results from the column tests indicated that the 325 mesh x zero size fraction liberates significantly more pyrite than the 200 mesh x zero grind. At roughly identical energy recoveries of nearly 96

percent, 36 percent of the pyrite was rejected with the 325 mesh gri while only 25 percent was rejected with the 200 mesh grind.

Column flotation testing at the bench-scale level included extensi testing in a laboratory size column flotation unit followed by 100 pound per-hour testing in larger units. At the laboratory level, investigato evaluated whether multiple-stage column flotation could significantl outperform single-stage column flotation. In addition, a 54-point te matrix was developed using a composite Box-Behnken design and conducted single-stage column flotation. All data obtained during the single vers multiple-stage flotation testing form a relatively narrow band potential grade-versus-recovery results. Therefore, investigators rul out a multiple-stage approach for POC operations. The data from the point test matrix indicate that the best results between energy recove and pyrite rejection occurred between 55 and 63 percent pyrite rejecti with energy recoveries of up to 92 percent.

Using the best results from the 100 pounds-per-hour testing of each un operation and Bilmat, a computer-based material balance progra investigators next developed overall cleaning circuit performan projections in order to assess the potential for meeting the major co cleaning performance goals. For the Pittsburgh No. 8 seam coal, neith the energy recovery nor the pyritic-sulfur-rejection target of 85 perce was achieved, primarily due to the poor coarse water-only cyclo performance. The Illinois No. 6 seam coal projection indicated a percent pyritic sulfur rejection with a nearly 81 percent energy recover For the Upper Freeport seam coal, the projections indicated 78 perce pyrite rejection and 91 percent energy recovery were possible.

Clean coal and refuse slurries were subjected to dewatering tests usi pressure filtration, vacuum filtration, and belt filter press technique The target moisture for the clean coal was 30 percent while the refu moisture target was 35 percent. The bench-scale dewatering test resul indicated that the clean-coal-moisture goal could be achieved with t Pittsburgh No. 8 and Upper Freeport seam coals using pressure filtrati techniques. The Illinois No. 6 seam coal could only be dewatered to percent moisture. Neither the vacuum filtration techniques nor the be filter press could produce 30 percent clean coal moistures for any of t three coals.

Tests on the refuse samples of each coal indicated that the fine Upp Freeport seam refuse could be dewatered to less than 35 percent moistu using vacuum filtration, pressure filtration, or the belt filter pres Only vacuum filtration could meet the 35 percent target on the Illino No. 6 refuse, and only pressure filtration was successful on t Pittsburgh No. 8 seam refuse. Despite the lack of success of the be filter press on these two coals, the belt filter press was recommended f dewatering the refuse stream for all three coals, primarily due to t superior handleability of the belt press refuse cake.

Based on the bench-scale and 100 pounds-per-hour test results, t following conclusions were drawn for the Semi-Works flowsheet:

- The coarse water-only cyclone (1/4 inch x 48 mesh) continued to included in the plant design. However, a heavy-media cyclone wou

be used in the POC and, if successful, be considered for the final Semi-Works plant design.

- The fine (48 mesh x zero) water-only cyclone circuit was maintained in the Semi-Works plant design.

- Conventional froth flotation should be applied separately on the 48 mesh by 200 mesh and the 200 mesh x zero size fractions.

- The raw coal crusher, the precleaned or middlings coal crusher, and ball-mill were to be sized by the equipment manufacturers based on the maximum particle size, the Hardgrove grindability of the feed, the top size requirements for the crushed products, and the throughput tonnage.

- A multiple-stage column flotation circuit was not warranted due to the relatively slight improvement in grade-versus-recovery results when compared to single-stage column flotation results.

- A clean-coal thickener would need to be included in the design to concentrate the advanced froth flotation concentrate.

- A batch-type recessed plate pressure filter would achieve the lowest clean-coal-product moisture. However, a final decision regarding the dewatering of clean coal for the Semi-Works plant design will occur after POC testing is completed on a hyperbaric disk filter.

- Dewatering of the refuse thickener underflow will be accomplished using a belt-filter press.

1.2 Proof-Of-Concept (POC) Scale Test Results

Figure 1.01 presents a simplified block diagram of the POC flowsheet.

As can be seen from Figure 1.01, the 1/4 inch x 48 mesh was cleaned using a heavy-media cyclone with the objectives of recovering 97 percent of the feed coal's energy. The heavy-media-cyclone clean coal was crushed to 48 mesh by zero using a cagepactor crusher, combined with the raw 48 mesh by zero and fed to a water-only cyclone. The water-only cyclone was maximized to recover 97 percent of its feed energy. The water-only cyclone clean coal reported to the ball-mill where it was crushed to 200 mesh by zero and fed to the column flotation cell for final cleaning. Primary performance goals of the POC flowsheet were to achieve 85 percent energy recovery with 85 percent pyritic sulfur removal when compared to the raw coal feed of the plant.

The Pittsburgh No. 8 seam coal from Brooke County, West Virginia; the Upper Freeport seam coal from Somerset County, Pennsylvania; and the Illinois No. 6 seam coal from Salone County, Illinois were the three coals tested. Table 1.01 contains the washability head analyses on a dry basis for the three coals.

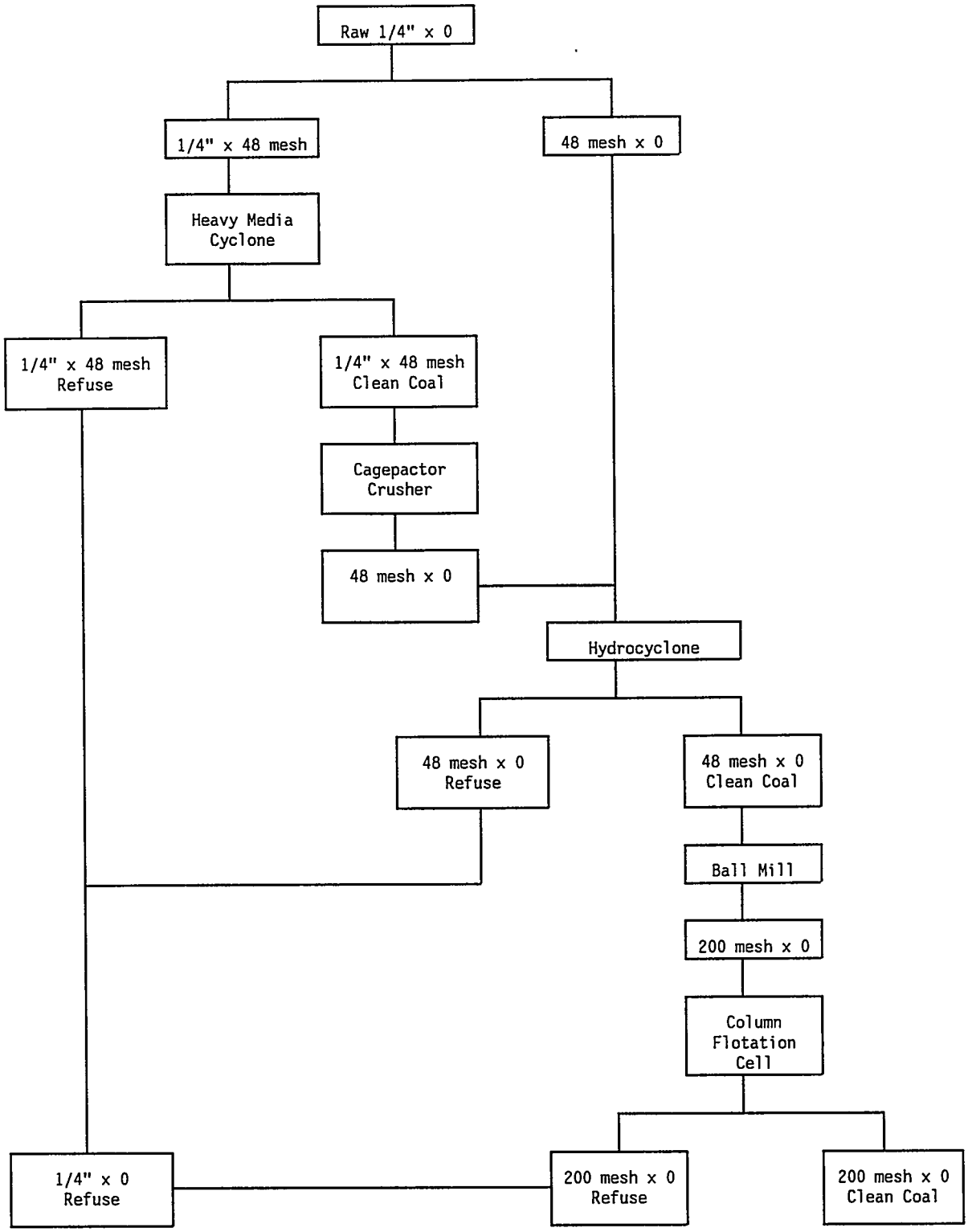

Figure 1.01 Simplified Block Diagram of the POC Process

Table 1.01
Head Analysis for Washability Samples

Coal Seam	% Ash	% Sulfur	% Pyritic Sulfur	Btu/lb
Pittsburgh No. 8	40.38	3.14	2.16	8,292
Upper Freeport	18.12	3.99	2.81	11,975
Illinois No. 6	36.23	4.11	2.75	8,866

Once the heavy-media cyclone, water-only cyclone, and grinding circuits were maximized, testing began to determine the best conditions at which to operate the advanced column flotation cell. The critical operating variables that were evaluated for the column cell included feed rate, aeration rate, frother rate, wash-water rate, frother type, and collector rate. A 16 point, resolution IV fractional factorial experiment was conducted on the Pittsburgh No. 8 seam coal to determine the best conditions for aeration rate, wash-water rate and frother type for the column cell. Results from the fractional matrix testing concluded that the following parameters should remain constant for the column cell throughout the remainder of the POC operations.

- MIBC reagent should be used as the frothing agent.
- An aeration rate of 140 SCFM should be maintained.
- A wash-water rate of 100 gallons per minute should be maintained.

With the heavy-media cyclone and water-only cyclone maximized, and with the best conditions for aeration rate, wash-water rate, and frother type determined for the column flotation cell, investigators conducted a Box-Behnken test matrix on each of the three coals. Figures 1.02, 1.03, and 1.04 show the energy recoveries as a function of ash rejection, pyritic sulfur rejection, and total sulfur rejection for the overall POC circuit while conducting the Box-Behnken test matrices for the Pittsburgh No. 8, Upper Freeport, and Illinois No. 6 coal seams.

After completing the Box-Behnken matrix for each of the three coals, all equipment was configured and all variables were set at the maximum values to conduct the 24-hour demonstration tests. The Pittsburgh No. 8 seam was processed for four days during the first and second week of the demonstration run. Both the Upper Freeport and Illinois No. 6 seams were processed for five days during both the first and second week of the demonstration runs. During the 24-hour demonstration runs, a complete set of samples were collected every eight hours for all the pertinent circuits in operation. Figure 1.05, 1.06, and 1.07 present the Bilmat-adjusted data for the average of all eight-hour sampling periods for the Pittsburgh No. 8, Upper Freeport, and Illinois No. 6 coal seams.

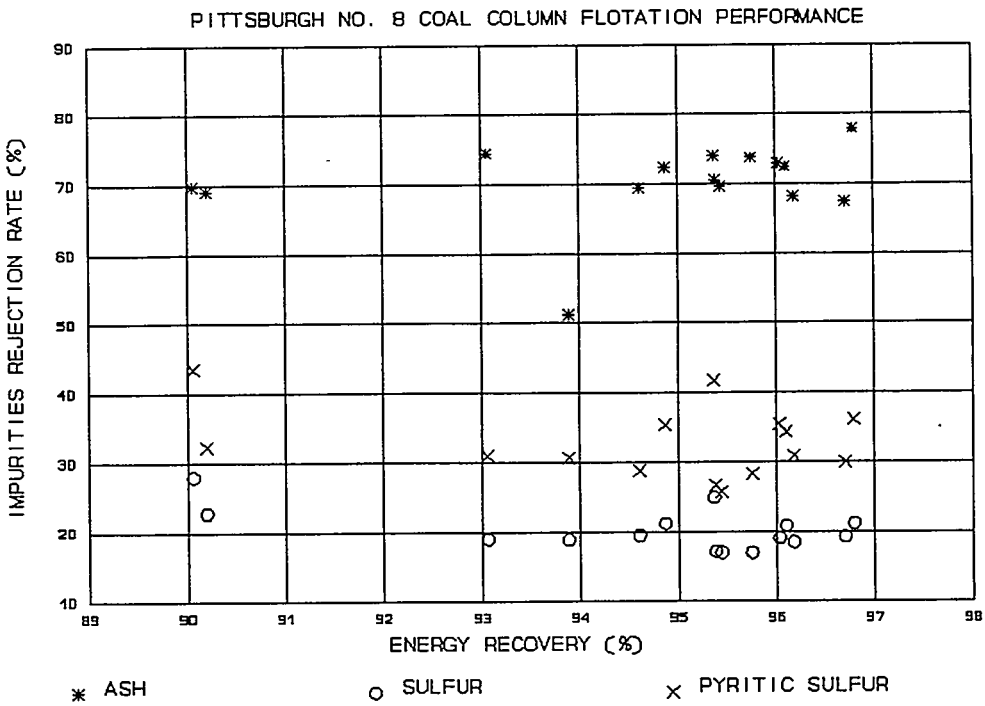

Figure 1.02 Pittsburgh No. 8 Seam Coal, Box-Behnken Matrix Results

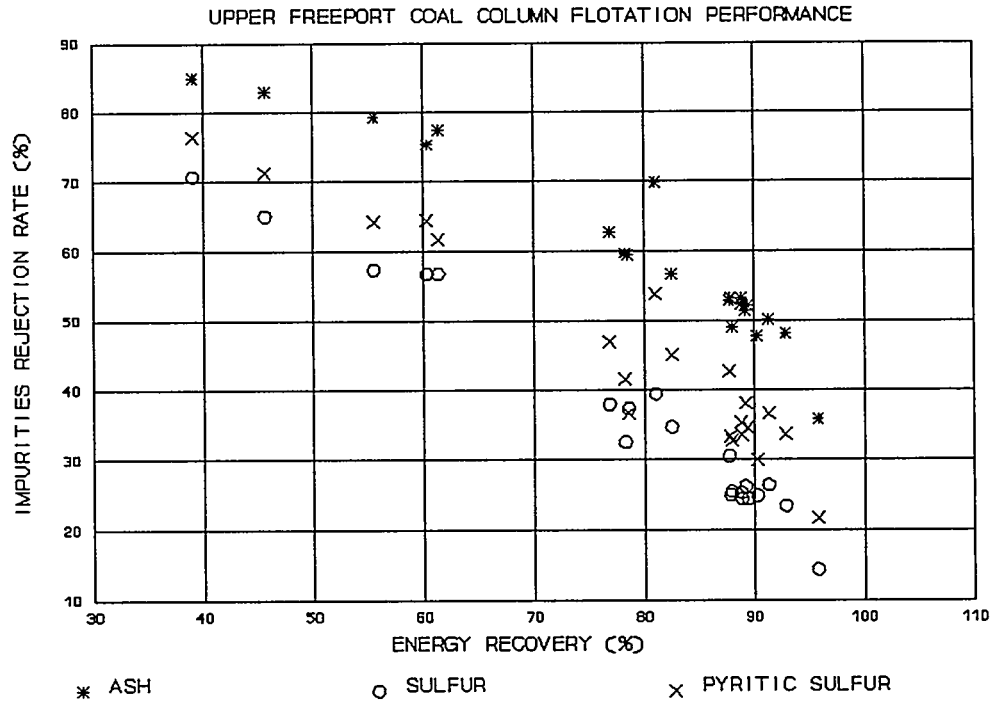

Figure 1.03 Upper Freeport Seam Coal, Box-Behnken Matrix Results

For the Pittsburgh No. 8 Seam, the POC recovered 89.5 percent of the r
coal's energy while removing 73.6 percent of the coal's pyritic sulfu
Performance evaluations for the Upper Freeport Seam indicated an overa
energy recovery of 87.5 percent, while 76.2 percent of the raw coal

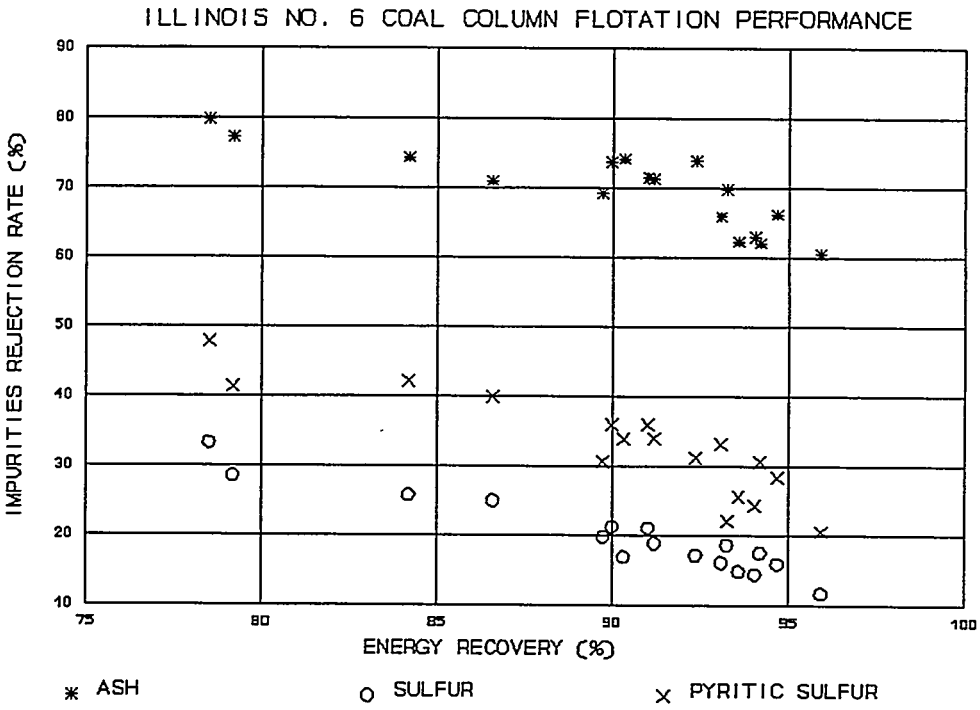

Figure 1.04 Illinois No. 6 Seam Coal, Box-Behnken Test Matrix Results

pyritic sulfur was removed. For the Upper Freeport Seam, the POC recovered 85.8 percent of the energy and removed 79.4 percent of the pyritic sulfur in the raw coal.

Table 1.02 presents the contributions of each coal-cleaning circuit to total energy loss and pyritic-sulfur removal for each of the three coals. These values are based on the average results obtained during the 24-hour demonstration runs. The heavy-media cyclone circuit for each coal removed the bulk of the pyritic sulfur while losing relatively low amounts of energy. Depending on the coal, the heavy-media cyclone circuit removed 60 to 70 percent of the total amount of pyrite that was removed. Meanwhile, the energy content in the heavy-media cyclone circuit refuse was only 32 to 36 percent of the total energy losses.

Since large amounts of pyrite have been removed prior to the water-only cyclone and the advanced froth flotation circuit, the ratio of pyrite rejection to energy loss is significantly lower for these circuits. For the Upper Freeport Seam, for example, the advanced froth flotation removed 25 percent of the total amount of pyrite that was rejected, and the energy content in the flotation tailings accounted for 71 percent of the total energy losses. Contributing to the lower ratios is the more-difficult-to-clean nature of fine- and ultrafine-particle streams.

Figure 1.05
Pittsburgh No. 8 Seam Coal
Average Performance
During 24-Hour Demonstration Run

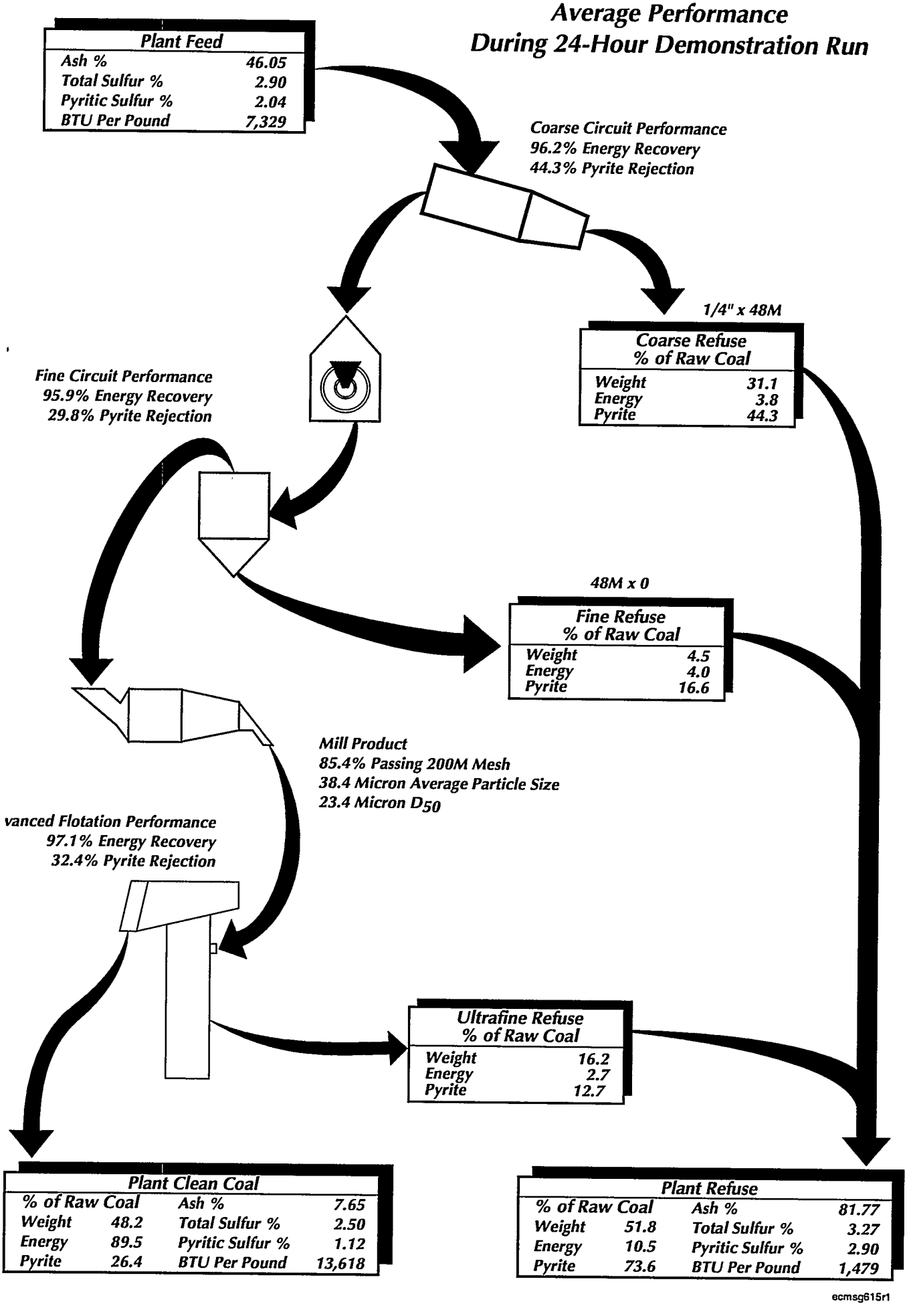

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Figure 1.06
Upper Freeport Seam Coal
Average Performance
During 24-Hour Demonstration Run

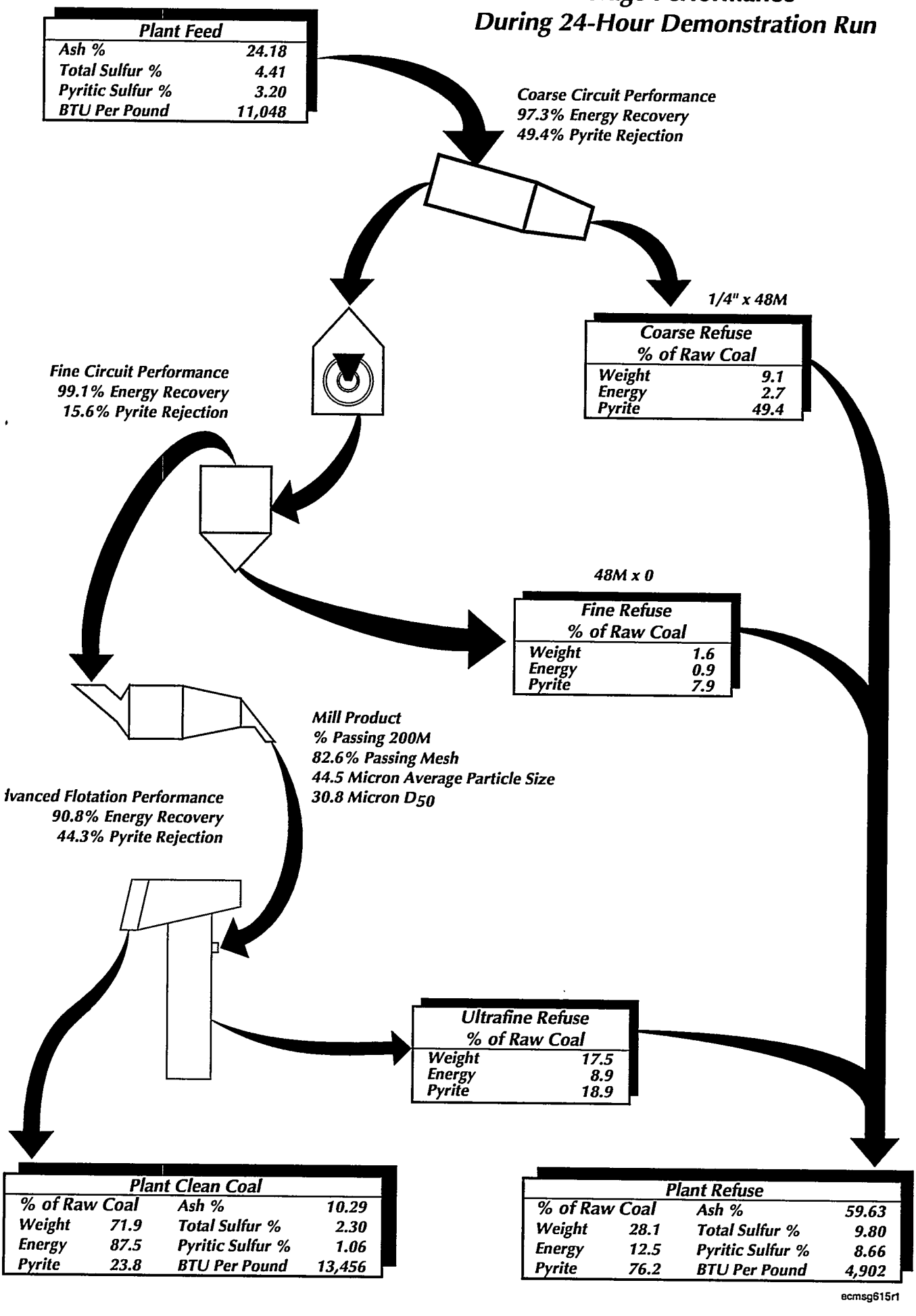

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Figure 1.07

Illinois No. 6 Seam Coal Average Performance During 24-Hour Demonstration Run

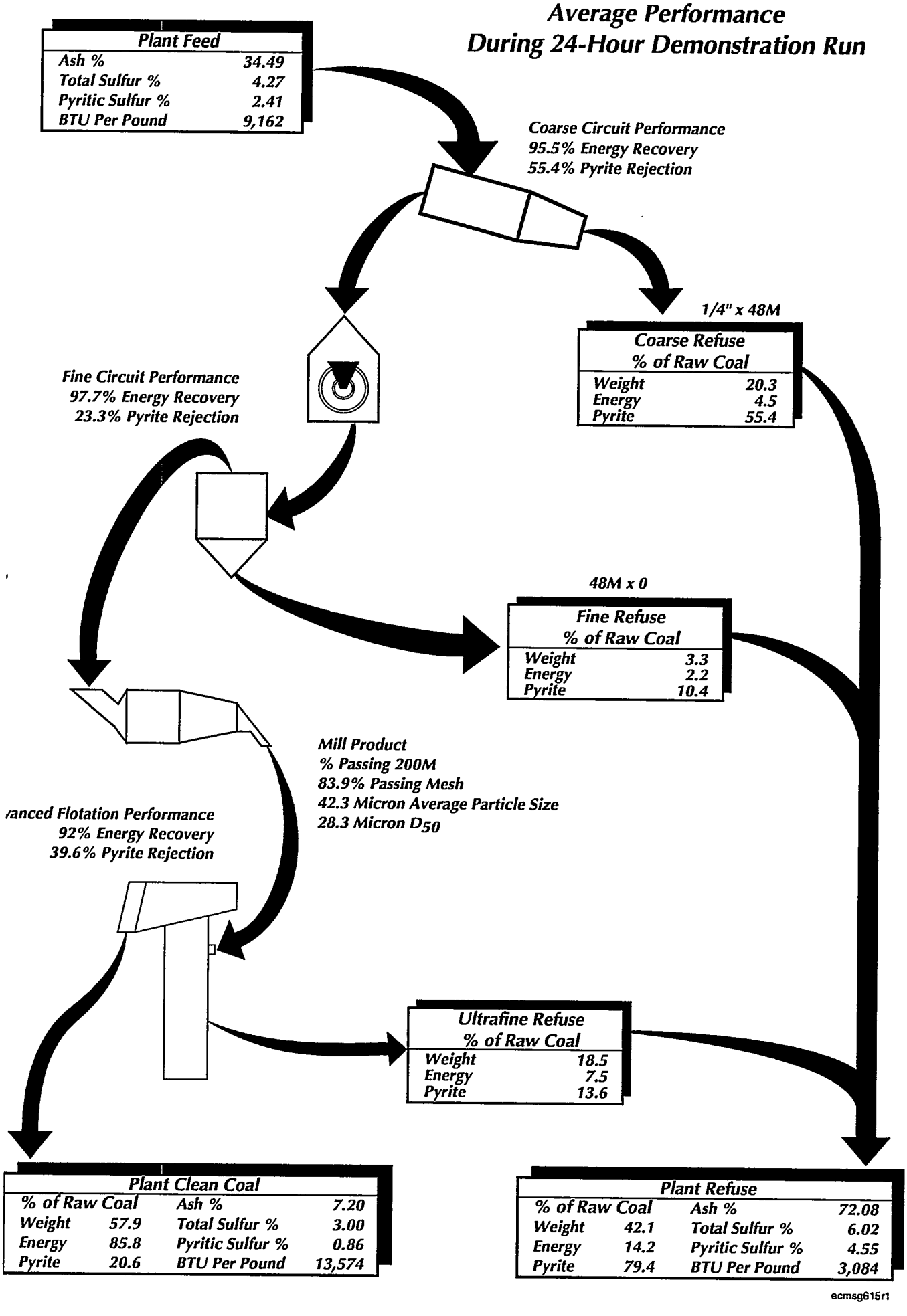

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Table 1.02
Contributions to Energy Loss and Pyritic Sulfur Removal*
During 24-Hour Demonstration Runs

Circuit (Size Cleaned)	Pittsburgh No. 8 Coal		Upper Freeport Coal		Illinois-No. 6 Coal	
	Energy Loss	Pyrite Removal	Energy Loss	Pyrite Removal	Energy Loss	Pyrite Removal
Heavy-Media Cyclone Circuit (+48 mesh)	3.8	44.3	2.7	49.4	4.5	55.4
Water-Only Cyclone Circuit (48 mesh x 0)	4.0	16.6	0.9	7.9	2.2	10.4
Advanced Froth Flotation Circuit (200 mesh x 0)	2.7	12.7	8.9	18.9	7.5	13.6

* Values represent the percentages of the raw coal energy content and pyritic sulfur content found in the refuse stream of each circuit.

Cumulative plant availability during 24-hour demonstration runs for the three coals was 94.9 percent. Individually, plant availabilities for the Pittsburgh No. 8, the Upper Freeport and the Illinois No. 6 coals were 98.0, 97.4, and 89.9 percent, respectively. No downtime encountered during the demonstration runs was attributed to the advanced process equipment.

1.3 Conceptual Design for 20 TPH Semi-Works Plant

The bench-scale and POC-scale test plans were designed to provide investigators with the information necessary to design and engineer a 20 tons-per-hour Semi-Works Facility that incorporates the proposed advanced froth flotation technology and achieves the objectives established for the process. The coal cleaning philosophy that was applied to the project was twofold: first, to remove sulfur and mineral matter at the coarsest size consistent with low subsequent energy losses; and to utilize multiple coal communition stages to liberate mineral matter and impurities from the desirable coal portion of the raw coal feed stream.

To accomplish this and to meet project goals, the Semi-Works facility includes three stages of coal crushing and grinding operations each followed by a cleaning operation designed to remove the liberated impurities generated by the communition efforts. Raw coal received at the facility will be crushed to 1/2 inch by zero. The crushed product is separated into two sizes and the 1/2 inch by 48 mesh size fraction is efficiently cleaned in a heavy-media cyclone circuit. The heavy-media cyclone will be configured to effect a high (1.85 to 1.90 S.G.) specific gravity of separation on the coal feed so that little energy is lost.

The heavy-media cyclone clean coal is crushed, in closed circuit, to 48 mesh by zero, combined with the raw 48 mesh by zero size fraction and cleaned in a water-only cyclone circuit to remove impurities liberated by the crushing stage or present in the raw fraction. Again, the water-only cyclone circuit is configured to minimize energy losses, yet remove both pyritic sulfur and mineral matter prior to fine grinding.

The heavy-media- and water-only-cyclone circuits represent commercial proven and available technologies that are practical and effective f their intended use in the process. Significant pyritic sulfur rejectio at low energy loss can be expected at this point in the process. T material removed from these operations would be, for many coals, t hardest materials and the most expensive to grind on a per-pound basis

The water-only cyclone clean coal is introduced into a closed, we grinding circuit utilizing classification ahead of a horizontal ball mi to prepare a proper ball-mill feed and improve circuit effectiveness. T mill circuit will produce a product of approximately 83 to 85 perce passing 200 mesh that will finally be cleaned in the advanced fro flotation circuit. Thickening, dewatering, and recovery techniques f all circuit products will use commercially available technologies.

The Semi-Works facility will be a fully automated continuous proces State-of-the-art instrumentations and control technologies are included the proposed design. Five samplers will be provided in order to monit the plant products as well as internal process streams.

The Semi-Works capital cost estimate of the plant proper is approximate $10,915,000. Another $750,000 will be required for the purchase of lan start-up modifications, and working capital.

1.4 200 TPH Commercial Plant Economic Analysis

Based on the capital cost of the Semi-Works plant, the cost for 200 a 500 tons-per-hour facilities were extrapolated. In addition, fixed a variable, first-year operating-and-maintenance costs were estimated f these commercial plants. Table 1.03 presents a summary of these costs f a 200 tons-per-hour (TPH) facility operating 7560 hours per year.

Table 1.03
Capital Requirements and 1st Year Operating and Maintenance Costs
for a 200 TPH Advanced Froth Flotation Plant (7560 Hours)

Construction Capital Requirement	$59,624,735	$59,547,893	$59,669,206
Working Capital Requirement	$467,723	$449,603	$478,500
Fixed Operating and Maintenance Costs	$5,892,451	$5,892,451	$5,892,451
Variable Operating and Maintenance Costs	12,080,238	$11,158,134	$12,613,895

In order to compare these values to those of existing facilities and evaluate them on an investment basis, these values were input into economic model developed by Eos Technologies, Inc. for the U.S. Departme of Energy. Based on the above costs and a set of economic assumption the model generates the clean coal price required for the investment generate a user-established, after-tax rate of return. Also, the cost remove sulfur, on a dollars per ton of SO_2 equivalent, is determine Table 1.04 presents these values for 200 and 500 TPH commercial faciliti as well as the economic assumptions on which the estimates are based.

Table 1.04
Advanced Froth Flotation Economics (Annualized Basis)

200 TPH Commercial Plant Operating 7,560 Hours per Year			
Cost Item	Pittsburgh No. 8	Upper Freeport	Illinois No. 6
Clean Coal Price ($/MMBtu)	1.49	1.50	1.55
Clean Coal Price ($/Ton)	40.65	40.27	41.96
Annualized Desulfurization Cost*	$326.82	$305.42	$304.60
200 TPH Commercial Plant Operating 3,456 Hours per Year			
Cost Item	Pittsburgh No. 8	Upper Freeport	Illinois No. 6
Clean Coal Price ($/MMBtu)	1.81	1.81	1.87
Clean Coal Price ($/Ton)	49.32	48.68	50.63
Annual Desulfurization Cost*	$477.08	$442.49	$435.09
500 TPH Commercial Plant Operating 7,560 Hours per Year			
Cost Item	Pittsburgh No. 8	Upper Freeport	Illinois No. 6
Clean Coal Price ($/MMBtu)	1.38	1.39	1.44
Clean Coal Price ($/Ton)	37.68	37.30	38.99
Annualized Desulfurization Cost	$275.27	$256.95	$259.84

ECONOMIC ASSUMPTIONS

Plant Life	20 Years	Inflation Rate	4.0 %
Royalties	None	Corporate Tax Rate	38.0 %
Financing	100% Equity	Rate of Return	10.0 %

* Annual Desulfurization Costs are per ton of SO_2 equivalent.

As the table indicates, plant size and operating schedule both significantly affect the costs of coal production and thus, the desulfurization costs. For the Pittsburgh No. 8 coal, for example, desulfurization costs for a 200 TPH (product) plant operating 7,560 hours per year are estimated at $327 per ton of SO_2 equivalent. For a 500 TPH plant with the same operating schedule, desulfurization costs drop to $275 per ton. On an average, desulfurization costs decrease by 15 percent for the 500 TPH plants.

Due to the large capital requirements for these advanced plants, operating schedule affects costs to a greater extent than plant size. A typical coal preparation facility operates five days per week, two shifts per day. Maintenance is conducted on the third shift. This operating schedule results in 3456 hours of operation per year and, as the cost estimates reveal, a gross under utilization of facilities. For the Illinois No. 6 coal, a 200 TPH plant operating 7560 hours per year can remove sulfur for about $305 per ton of SO_2 equivalent. When the same size plant operates, only 3456 hours per year, the desulfurization cost climbs to $435 per ton.

1.5 Conclusions

Based on the findings of this project, the following conclusions may be drawn.

- The proposed process technology is ready for commercializatio However, the product from the process may require reconstitution order to be marketable.

- The proposed technology can recover 85 percent of the energy in ea of the raw coals while removing 75 to 80 percent of the raw coal pyritic sulfur.

- Clean coal ash values of 7.2 to 10.3 percent, on a dry basis, we achieved with the proposed technology.

- Grinding to levels finer than 85 percent passing 200 mesh will required to remove 85 percent of the raw coal's pyrite whi maintaining 85 percent energy recovery.

- Based on raw coal costs of $0.80 per million Btu, clean coal pric of $1.50 per million Btu will be required for investments in t proposed technology to earn a 10 percent after-tax rate of retur

- Desulfurization costs, on a dollars per ton of SO_2 equivalent, $255 to $275 are estimated for a 500 tons-per-hour commerci facility incorporating the proposed advanced froth flotati process.

2.0 INTRODUCTION

In 1987, the United States Department of Energy's (DOE) Pittsburgh Energy Technology Center completed a study[1] of sulfur emissions from 1300 U.S. coal fired utility boilers. The study found that the bulk of sulfur emissions are attributable to coal produced in areas of Illinois, Indiana, Kentucky, Ohio, West Virginia, and Pennsylvania. These areas contain nationally important coal resources that, in many cases, contain high sulfur levels. Pyritic sulfur content of coals in these areas range from 55 percent to 80 percent according to the DOE study. Since physical coal cleaning can be a cost effective way of removing pyrite from coal, it follows that major reductions in sulfur emissions may be possible by advancing the state-of-the-art of physical coal cleaning technologies.

Partly in response to the findings of this study, the U.S. DOE began the Acid Rain Control Initiative. As part of this initiative, three promising physical coal cleaning technologies were identified for their potential for pyrite removal from coal. Subsequently, the DOE requested proposals from industry, academia, and the research community in order to develop these technologies. In 1988, ICF Kaiser Engineers, Inc. (ICF KE) was awarded DOE Contract No. DE-AC22-88PC88881, to research, develop, engineer and design a commercially acceptable advanced froth flotation technology. A similar project for selective agglomeration technology was completed by the Southern Company Services, Inc. in 1993. Coal Technology Corporation is scheduled to complete the engineering development of advanced cycloning technology in 1996.

The DOE established goals for the characteristics of the products and for the coal cleaning performance of the processes. Primary of these goals were the ability of the processes to recover 85 percent of the raw coal's energy while removing 85 percent of the raw coal's pyritic sulfur. In addition, substantial ash rejections were expected, thus resulting in a low-ash clean-coal product. Table 2.01 presents the goals for the characteristics of the process products. Three nationally important coals were to be used in each of the projects: the Pittsburgh No. 8 seam coal from Ohio, the Upper Freeport Seam coal from Pennsylvania, and the Illinois No. 6 seam coal from Illinois.

Table 2.01
DOE Established Goals For Product Characteristics

Clean Coal Ash (%)	Less than 6% (dry basis)
Clean Coal Moisture (%)	Less than 30% Surface Moisture
Refuse Moisture (%)	Less than 35% Surface Moisture

In order to accomplish these ambitious goals, ICF KE developed a coal cleaning approach that would utilize already commercial conventional coal cleaning operations followed by a novel application of fine coal grinding and, finally, advanced froth flotation. Commercial coal cleaning approaches could cost effectively remove coarse mineral matter and pyrite with little loss of the coal's heating value. Subsequently, the capacity of the required grinding circuit could be reduced, decreasing the capital, operating and maintenance costs of the proposed process.

In order to properly perform the work required for this project, ICF assembled a team of organizations. Table 2.02 presents this team. Ea of these team members provided their valuable expertise in the area areas where their experience proved most useful. The cooperation a effort by these organizations was greatly appreciated.

Table 2.02
Team Organized For Advanced Froth Flotation Development Project

Ohio Coal Development Office (OCDO)
CONSOL Inc. (CONSOL)
Babcock and Wilcox (B&W)
Virginia Polytechnic Institute (VPI)
EIMCO Process Equipment Company (EIMCO)
Center for Research on Sulfur in Coal
Illinois State Geological Survey
Kentucky Energy Cabinet Laboratory

The engineering and development effort for the advanced froth flotati process took a task-oriented approach. In Tasks 1 through 8, a proje plan was submitted, and a preliminary conceptual design and cost estima were developed for a 20 tons-per-hour (TPH) Semi-Works facili incorporating the advanced process. Next, critical areas of design-relat deficiencies were identified, and a bench-scale test plan was developed order to address those deficiencies that were most appropriately handl at a small scale. Additionally, component development efforts includ extensive column flotation evaluations at the bench-scale. In Task 7, t results of bench-scale and component development efforts were reporte and in Task 8, these results were applied to the original process a Semi-Works design; an updated process design and cost estimate we subsequently developed.

In Task 9, a proof-of-concept (POC) test module was designed in order address the design deficiencies that could not be appropriate investigated with bench-level testing. The POC was constructed as addition to the John P. Apel Ohio Coal Testing and Development Cent which is located between McConnellsville and Beverly, Ohio. Selected PO related photographs are presented in Figures 2.01 through 2.04. In Tas 10 through 13, the POC was fabricated and three project coals were test in the fully automated and integrated facility. The results of P testing were reported in a Task 14 report. This Task 15 report is t final report related to the advanced froth flotation process-developme effort.

2.1 Objectives of the Report

This report is an account of findings related to the Engineering a Development of Advanced Froth Flotation project. The results from benc scale and POC level testing are presented and the important results fr this testing are used to refine a conceptual design and cost estimate f a 20 TPH Semi-Works Facility incorporating the final proposed technolog

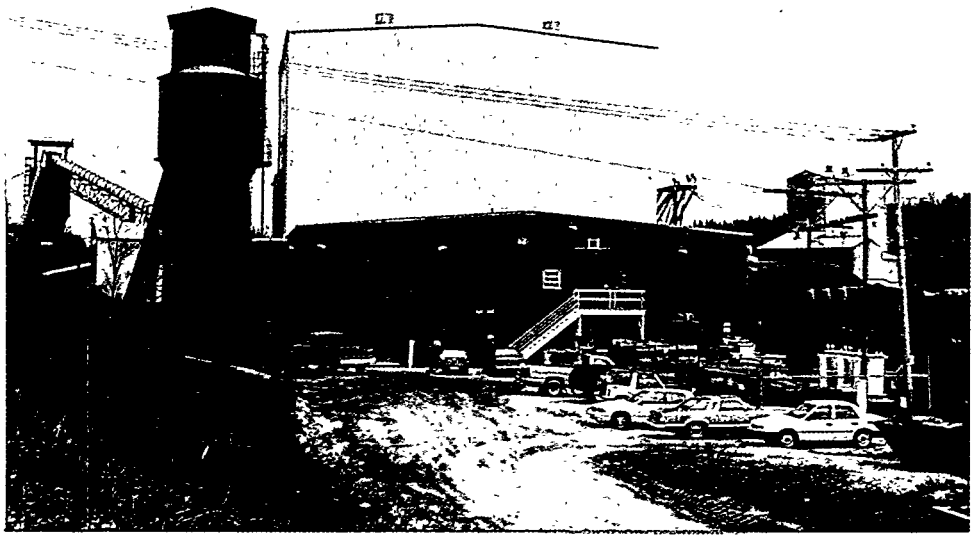

Figure 2.01 – John P. Apel Ohio Coal Testing and Development Center

Figure 2.02 – Advanced Froth Flotation Proof–of–Concept Module Addition

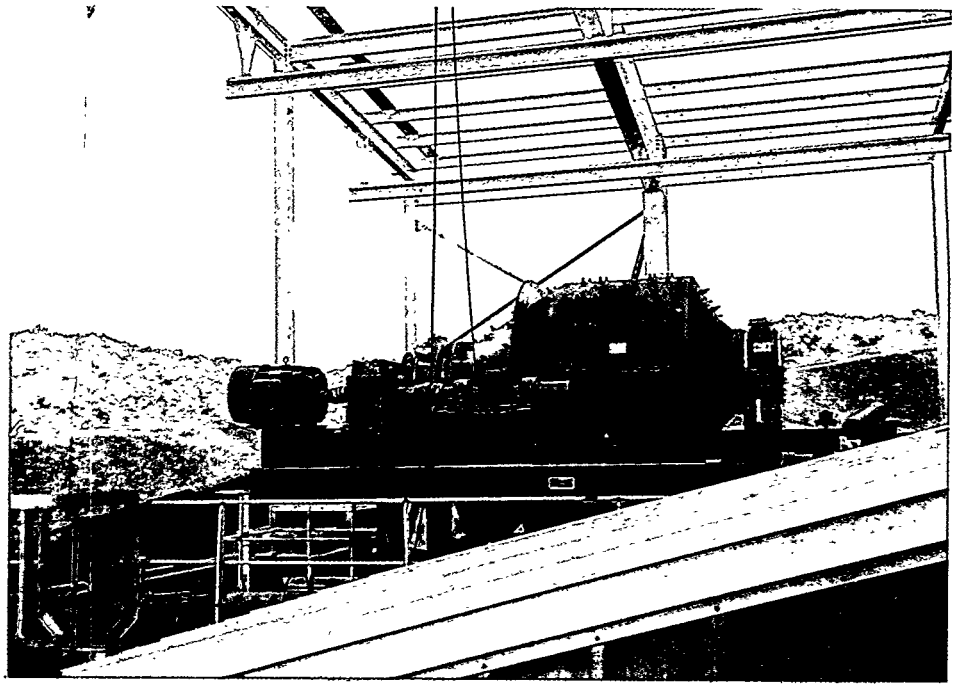

Figure 2.03 – Ball Mill Installed in the Proof–of–Concept Module (under construction)

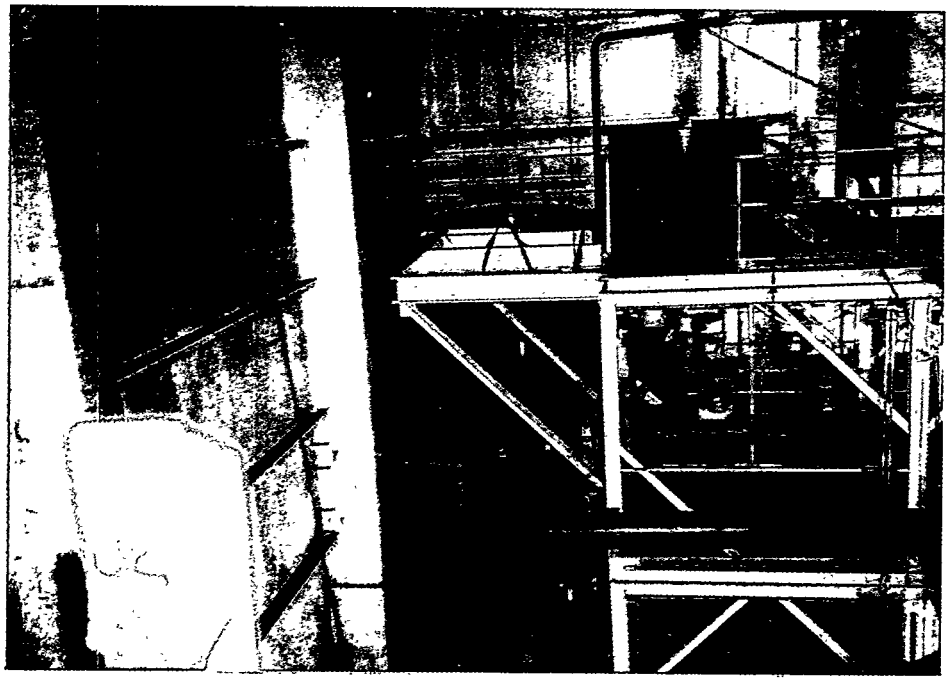

Figure 2.04 – Column Flotation Cell Installed in the Proof–of–Concept Module

A flowsheet, design drawings, equipment list, estimated capital costs, operating costs, and maintenance costs are presented for the Semi-Works facility. Economic analyses are developed for the investment potential of implementing 200 and 500 TPH commercial facilities incorporating the final proposed design. Finally, conclusions and recommendations are presented.

2.2 Scope of the Report

This report is a summary of the important findings related to all work conducted in order to develop the advanced froth flotation process. Detailed task related reports are available under separate cover for both the bench-scale test program and the POC-test program. In addition, separate topical reports are available for work conducted as part of this project, but not fully detailed in any of the previously mentioned reports. These are listed below:

- Topical Report No. 1 - Raw Coal Pyrite Liberation Study (Pittsburgh No. 8)
- Topical Report No. 2 - Controlled Comparison of Advanced Froth Flotation Technologies
- Topical Report No. 3 - Pyrite Liberation Study, Illinois No. 6 Seam Coal
- Topical Report No. 4 - Pyrite Liberation Study, Upper Freeport Seam Coal
- Topical Report No. 5 - Trace Element Removal Study
- Topical Report No. 6 - Kelsey Jig and Multi-Gravity-Separator Testing

Finally, a stand-alone "Executive Summary" of this report has also been issued.

2.3 Report Organization

This report is organized into seven sections. Section 1.0 is an executive summary providing all pertinent project information covered in this report.

Section 2.0 is a concise introduction which includes the objectives, scope, and organization of the final report.

Sections 3.0 and 4.0 present the results of bench- and POC-scale testing.

Sections 5.0 and 6.0 present the final conceptual designs of a Semi-Works plant and a 200 TPH commercial plant. The designs include: design philosophy, conceptual flowsheets, material balances, equipment lists, engineering drawings, cost estimates, and economic models.

Section 7.0 summarizes the results of the project and provides recommendations to industry.

3.0 BENCH-SCALE AND 100 POUNDS-PER-HOUR TESTING

Bench-scale and 100 pounds-per-hour testing were conducted in order to reduce the potential for technical and engineering related design deficiencies of the proposed advanced froth flotation process. At the bench-scale level, investigators determined that:

- The potential existed for each coal to be cleaned to a level consistent with the basic project objectives.
- Conventional froth flotation attempts should be conducted separately on 48 mesh by 200 mesh and 200 mesh by zero size fractions.
- Grinding to 325 mesh by zero improved the state of liberation of the coal compared to 200 mesh by zero grinding. Laboratory column flotation results indicated that this difference could be exploited in order to improve the chances of attaining the basic project objectives.
- A number of column flotation units being developed by various groups were equally promising for further study.
- Thickening and dewatering operations of the advanced froth flotation process could be accomplished using commercially available equipment.

Based on the bench-scale test results, investigators felt confident that the proposed advanced froth flotation process had a reasonable chance to succeed. Thus, larger 100 pounds-per-hour testing was then conducted on the major coal cleaning, grinding, and sizing operations envisioned for the process. During this testing, the product from each unit operation was saved, if needed, in order to become the feed for the next unit operation, following the proposed flowscheme of the overall process. At the end of these operations, investigators had a high level of confidence in the potential of the process, and what needed to be accomplished in order to design the fully integrated proof-of-concept (POC) module. The following is a review of the bench-scale and 100 pounds-per-hour testing grouped by major circuits envisioned for the final plant design.

3.1 Gravity-Based Precleaning

Commercial coal cleaning process philosophies for the most part utilize specific-gravity-based coal cleaning approaches in order to clean coal particles larger than 150 microns (100 mesh). On this size material, specific-gravity-based cleaning can be relied on to efficiently remove liberated mineral matter and pyrite. When operating at high specific gravities of separation, removal of mineral matter and pyrite can be accomplished with little loss of the coal's heating value.

On a 100 pounds-per-hour level, investigators evaluated gravity-based coal cleaning separately on two different size fractions: 1/4-inch by 48 mesh and 48 mesh by zero. For the plus 48 mesh size fraction, the originally proposed Semi-Works plant design included a water-only cyclone circuit. While a heavy-media cyclone circuit would more efficiently separate 1/4-inch by 48 mesh coal, there was concern that the high media specific

gravity required for this project would cause media viscosity problem For the most part, magnetite-based, dense-media systems are limited recirculating media densities of 1.30 to 1.75 specific gravit Investigators believed that separations on the order of 1.85 to 2 specific gravity would be required for the project, and this range is we suited to water-only cyclone operations.

For bench-scale testing, the coarse fraction of the Pittsburgh No. 8 se coal was precleaned in a water-only cyclone while the Upper Freeport a Illinois No. 6 coals were precleaned in a heavy-media cyclone. Table 3. summarizes the cleaning performance achieved during these tests. T heavy-media cyclone achieved energy recoveries of 95 percent or great while removing close to 30 percent or more of the pyritic sulfur of t unit operation feed. This was very encouraging and subsequently t investigators to utilize a heavy-media cyclone in the POC plant desig The water-only cyclone performance was poor with an energy recovery only 85 percent. This was due to the misapplication of a six inch wate only cyclone to the 1/4-inch by 0 coal feedstock. In commercial practic a minimum 14-inch diameter cyclone would be used for this size fractic

Table 3.01
Coarse Gravity-Based Cleaning Performance During 100 Pounds-Per-Hour Tests

Coal	Pittsburgh No. 8	Upper Freeport	Illinois No. 6
Unit Operation	Water-Only Cyclone	Heavy-Media Cyclone	Heavy-Media Cyclone
Size Fraction	1/4-inch x 0	1/4-inch x 48 mesh	1/4-inch x 48 mesh
Energy Recovery (%)	85.2	99.2	95.6
Pyritic Sulfur Rejection (%)	42.9	29.5	71.1
Ash Rejection (%)	23.6	30.2	49.1

The clean coal from the coarse-gravity-based cleaning circuit was th crushed to 48 mesh by zero and, in the cases of heavy-media cyclo cleaning, combined with the natural 48 mesh by zero size fraction of t raw coal. The coarse-water-only-cyclone clean coal already contained t 48 mesh by zero material. The crushing stage was applied to increase t state of liberation of the coal and impurities in the coarser si fraction.

The resulting 48 mesh by zero streams were then cleaned in a water-or cyclone. Table 3.02 presents the coal cleaning performance of the fi water-only cyclone cleaning circuit for each of the three coals. Ener recoveries for the circuit were greater than 95 percent for each of t coals. Pyrite rejections were 28 and 31 percent on the Pittsburgh a Upper Freeport seam coals, but only 12 percent on the Illinois No. 6 coa The fine water-only cyclone operation was maintained in the Semi-Wor plant design and included in the POC module. The clean coal from t water-only cyclone operation was classified into 48 mesh by 200 mesh a 200 mesh by zero size fractions for subsequent 100 pounds-per-ho conventional froth flotation testing.

Table 3.02
Fine Gravity-Based Cleaning Performance During 100 Pounds-Per-Hour Tests

Coal	Pittsburgh No. 8	Upper Freeport	Illinois No. 6
Unit Operation	Water-Only Cyclone	Water-Only Cyclone	Water-Only Cyclone
Size Fraction	48 mesh x 0	48 mesh x 0	48 mesh x 0
Energy Recovery (%)	95.5	97.9	99.0
Pyritic Sulfur Rejection (%)	28.2	31.1	12.5
Ash Rejection (%)	7.2	11.6	4.0

3.2 Conventional Froth Flotation Testing

To evaluate the application of conventional froth flotation techniques, laboratory flotation techniques were used to evaluate whether the 48 mesh by zero coal should be cleaned as one size fraction or whether split 48 mesh x 200 mesh/200 mesh x 0 flotation should be employed. Table 3.03 presents results on the Pittsburgh No. 8 seam coal that support the concept of split flotation. Based on these results, all remaining conventional flotation tests for this project were conducted using split flotation.

Table 3.03
Comparison of Split Feed to Single-Size Feed Conventional Froth Flotation Performance

Flotation Size	48 mesh x 0	Split 48 mesh x 200 mesh/200 mesh x 0
Performance Size	48 mesh x 0	48 mesh x 0 composite
Yield (%)	72.7	81.7
Energy Recovery (%)	93.8	98.3
Clean Coal Ash (%)	9.30	8.20
Total Sulfur (%)	3.70	3.78
Btu per pound	13,180	13,290

Once it was determined that split flotation should be used, 100 pounds-per-hour scale testing was conducted for each coal in order to determine whether the grab-and-run conventional flotation approach could be successful. In grab-and-run flotation, two stages of flotation were attempted. In the first stage, gentle flotation conditions were applied in order to produce a clean coal at or below the plant clean coal specification. Investigators applied the clean coal ash specification of 6 percent in order to judge the success or failure of this stage. The second stage of the grab-and-run would be operated such that a tailings stream of low energy content would be produced. If this approach was successfully applied, the first-stage froth concentrate could be immediately dewatered and directed to product, thus improving the handleability and the dewaterability of the final composite clean coal product. Also by removing the first-stage clean coal and the tailings stream, the subsequent grinding circuit throughput requirements would be reduced, improving the economics of the entire process.

Table 3.04 presents the clean-coal ash values produced in the first sta of conventional froth flotation for each size fraction of the three coal Based on these results, the grab-and-run flotation approach was abandon for the Illinois No. 6 coal since the grab product ash content for the t size fractions were well above the six percent target. The Upper Freepo results, on the other hand, clearly exceeded the target ash specificatio while the results on the Pittsburgh No. 8 seam were borderline in th regard. Based on these results, the grab-and-run flotation approach wou only be applied to the Upper Freeport coal for the remainder of benc scale testing. If time permitted, this approach could be tested on bo the Upper Freeport and the Pittsburgh No. 8 coals during POC operation

Table 3.04
"Grab" Product Ash Values From Conventional Froth Flotation

Coal	Pittsburgh No. 8		Upper Freeport		Illinois No. 6	
Size Fraction	48 x 200	200 x 0	48 x 200	200 x 0	48 x 200	200 x (
"Grab" Clean Coal Ash (%)	6.55	6.32	4.62	6.09	9.81	14.84

48 x 200 = 48 mesh by 200 mesh; 200 x 0 = 200 mesh by zero

With the conventional froth flotation circuit configuration determined f each coal, the sized product from the fine water-only cyclone circuit w next processed in 100 pounds-per-hour scale conventional froth flotatio utilizing the predetermined circuit configuration. The Upper Freepo middlings concentrate, and the Pittsburgh No. 8 and Illinois No. 6 co total concentrates were saved for further processing in the 100 pound per-hour grinding circuit. Table 3.05 presents the 100 pounds-per-ho conventional flotation performance results. The results confirmed th conventional froth flotation remained a viable option in regard minimizing energy loss while gaining some measure of impurities remova thus reducing the capacity requirements of downstream grinding a advanced froth flotation operations. Conventional froth flotation wou be applied to all three coals during POC testing.

3.3 Grinding Circuit Testing

Grinding circuit evaluations conducted for this project included t comparison of the cleaning performance potential with two different co grinds, 200 mesh and 325 mesh. On a small laboratory scale, a 325 mesh zero sample was produced from the Pittsburgh No. 8 seam coal, convention froth flotation products using a 2.5 gallon attritor mill. Using a spl of the same feedstock, a 200 mesh by zero sample was produced using a 2 gallon laboratory rod mill.

Each of these samples were then cleaned in a 2-inch diameter colu flotation cell in order to compare the separation characteristics of t two coal grinds. Table 3.06 presents the results of these tests. It clear from the data that the 325 mesh by zero coal grind is at increased state of liberation. At roughly identical energy recoveries nearly 96 percent, 36 percent of the pyrite was rejected with the 325 me grind while only 25 percent was rejected with the 200 mesh grind.

Table 3.05
Final 100 Pounds-Per-Hour Conventional Froth Flotation Performance

48 mesh by 200 mesh Size Fraction				
Coal	Pittsburgh No. 8	Upper Freeport		Illinois No. 6
Circuit	Rougher Only	Grab-and-Run		Rougher Only
		Grab	Scavenger	
Energy Recovery (%)	98.6	52.5	47.4	99.9
Pyritic Sulfur Rejection (%)	16.6	5.2		1.8
200 mesh by zero Size Fraction				
Coal	Pittsburgh No. 8	Upper Freeport		Illinois No. 6
Circuit	Rougher Only	Grab-and-Run		Rougher Only
		Grab	Scavenger	
Energy Recovery (%)	98.6	38.4	60.9	96.9
Pyritic Sulfur Rejection (%)	37.9	15.4		33.3

The Pittsburgh No. 8 and the Illinois No. 6 coals were the first two coals tested at the 100 pounds-per-hour scale. These coals were each ground to 325 mesh by zero in an effort to maximize the liberation of impurities. Based on conflicts with other DOE-sponsored test programs, however, the DOE and project investigators agreed to change the target grind for all three coals to 200 mesh by zero prior to the Upper Freeport coal grinding efforts at the 100 pounds-per-hour scale. The 100 pounds-per-hour grinding and advanced-froth-flotation testing on the Pittsburgh No. 8 and Illinois No. 6 coals were not repeated at the 200 mesh target grind. The conventional froth flotation concentrates from 100 pounds-per hour testing were used as the feed to mill circuits in all cases. These ground products were saved for column flotation testing, the last unit operation to be tested at 100 pounds-per-hour.

Table 3.06
Grind Size Comparison Using Pittsburgh No. 8 Seam Coal:
Laboratory Froth Flotation of 200 mesh x 0 and 325 mesh x 0 Grinds

Grind Size	200 mesh x 0	325 mesh x 0
Clean Coal		
Ash (%)	4.99	4.05
Total Sulfur (%)	3.30	3.19
Pyritic Sulfur (%)	0.91	0.74
Btu per Pound	13,587	13,567
Energy Recovery (%)	95.9	95.5
Pyritic Sulfur Rejection (%)	26.2	36.4
Ash Rejection (%)	49.7	56.9

3.4 Advanced Column Flotation Testing

Column flotation operations use relatively tall vessels and different bubble generation schemes than conventional froth flotation operations.

The increased vessel height serves to allow higher residence times whi also enabling deeper froth layers. Most column flotation ce manufacturers have by now also added froth washing capabilities where clean water flows are introduced into the froth layer in order to redu entrainment of fine clay particles in the froth concentrate. Bubb generation schemes used in column flotation usually are designed produce smaller bubbles, or microbubbles, that theoretically allow f improved process selectivity.

Figure 3.01 presents a schematic showing features of the microcel™ colu flotation unit developed by the Virginia Institute of Technology. R coal slurry enters the microcel™ through the feed inlet and is introduc at a point below the froth layer, and in a downward direction. Soli then encounter a flow of pulp and air bubbles moving upward, helping promote efficient bubble-to-particle contact. A downward flow of lig spray water is introduced, usually in the froth layer, to minimi entrainment of clay particles in the froth.

A centrifugal pump extracts a predominantly tailings stream from a poi near the bottom of the vessel to provide a liquid medium into which a and frother are introduced. The entire flow passes through external mounted static mixers, whose shearing force produces microbubbles that a then introduced into the column. The use of recirculated tailings as t liquid medium here and the agitation caused by the introduced stre allows for improved recovery of coal particles that have yet to attached to the rising volume of bubbles.

Column flotation testing at the bench-scale level included extensi testing in a laboratory size column flotation unit followed by 100 pound per-hour testing in larger units. At the laboratory level, investigato evaluated whether multiple-stage column flotation was preferential single stage. Also, a 54-point test matrix was developed using composite Box-Behnken design and conducted on single-stage colu flotation. The results from these two sets of tests allowed investigato to configure the 100 pounds-per-hour tests in order to optimize colu flotation performance.

Figure 3.02 presents flow schematics for the six different colu flotation circuit configurations evaluated in the laboratory. In t Rougher-Scavenger (RS) configuration, the tailings from the first sta unit are recleaned in a second stage. The concentrates from both stag are combined as circuit product. In the rougher-cleaner (R configuration, the first stage concentrate is repulped and then reclean in the second stage unit, which produces the circuit clean-coal produc The tailings streams from each stage are combined and rejected.

In the rougher-scavenger-scavenger cleaner (RSSC) circuit, the tailin from the rougher stages are recleaned in the second, scavenger stage. T concentrate from the second stage is then repulped and recleaned in t third, scavenger-cleaner, operation.

The rougher-scavenger-cleaner (RSC) configuration also has three stages cleaning. The rougher tailings are recleaned in the scavenger stage, a the concentrates from these two stages are combined, repulped, a recleaned in a cleaner stage. The cleaner produces the circuit produc

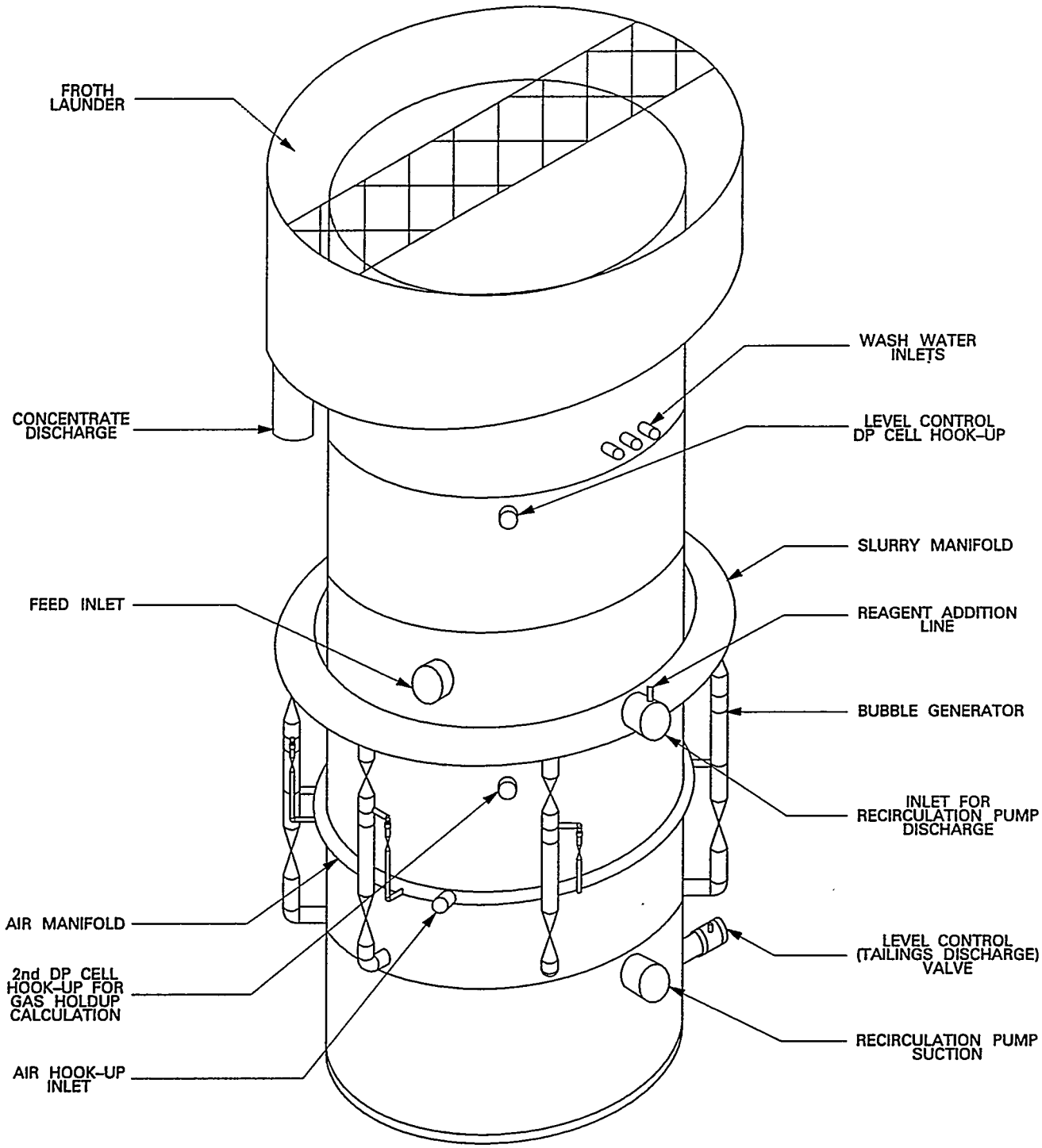

Figure 3.01 Typical microcel™ Column Flotation Configuration.

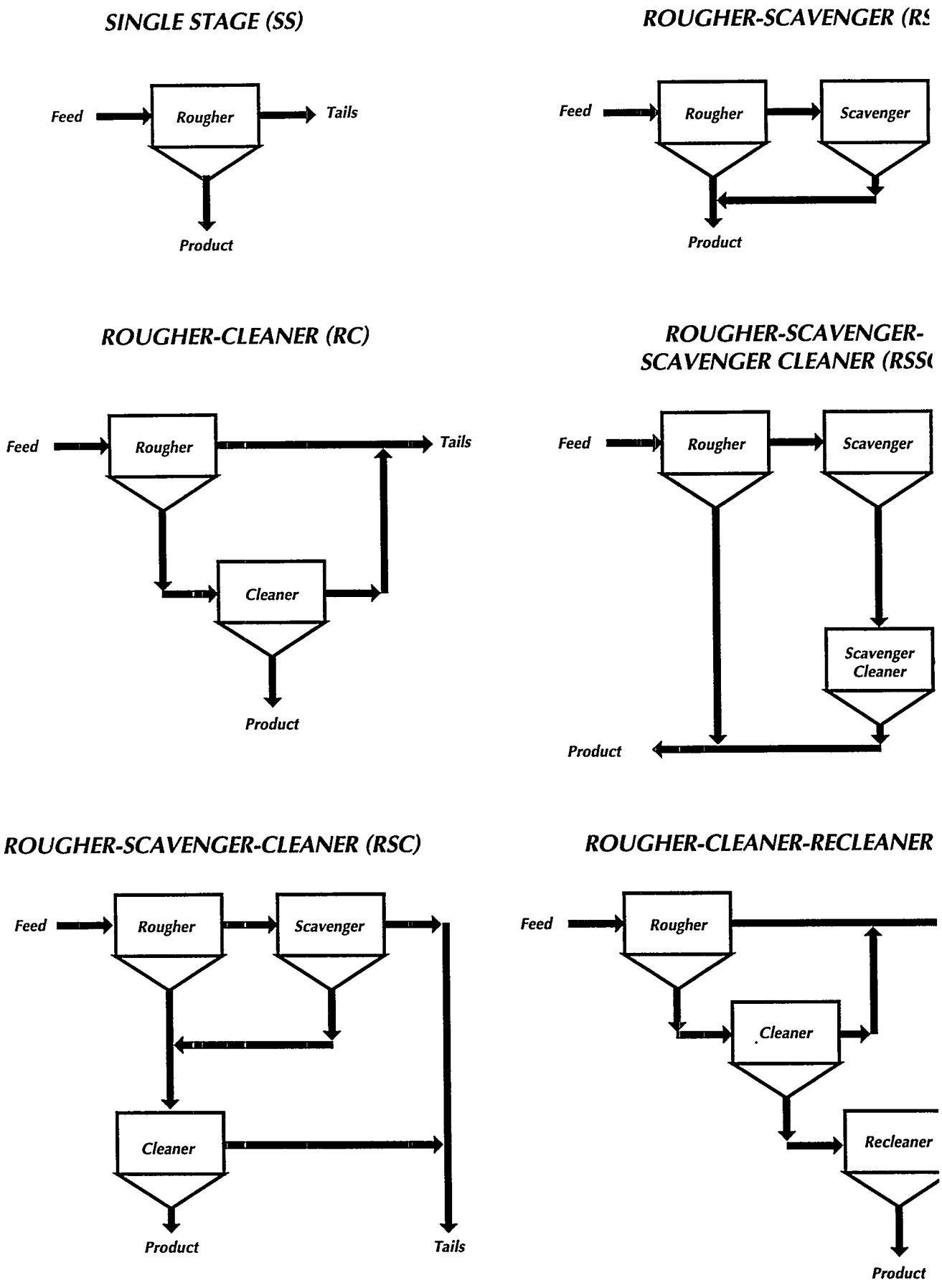

Figure 3.02

Schematic representations of the single and multiple stage column flotation circuits that were tested

Finally, in the rougher-cleaner-recleaner configuration, the rougher concentrate is repulped and recleaned in the cleaner stage. The cleaner stage concentrate is again repulped and then cleaned in recleaner stage.

Figure 3.03 compares, for the Pittsburgh No. 8 coal, the energy recovery versus pyritic sulfur rejection relationships for the six circuit configurations. These results were also typical of that produced for the Upper Freeport and the Illinois No. 6 coals.

The data for all of the circuit configurations form a relatively narrow band of potential grade-versus-recovery results. That is, for any level of energy recovery, pyrite rejection may vary by up to six percent depending on the circuit configuration utilized. While the single-stage performance results for the most part fall at the lower end of the grade-recovery band, investigators judged that there was not sufficient increases in pyrite rejections to warrant a multiple-stage column flotation approach.

The fact that all of the column circuits behaved essentially the same, in terms of trade-offs between energy recovery and pyrite rejection, can be explained by developing a complete understanding of the fine particle recovery mechanisms. In conventional flotation circuits, differences in performance can frequently be attributed to wide variations in the nonselective entrainment of fine particles of mineral matter into the froth product. Multiple cleaning stages are generally capable of reducing entrainment, thereby improving the final separation. However, since most flotation columns utilize a counter-current flow of wash-water to prevent entrainment of fines, multiple-column circuits have little advantage for improving performance. The use of wash-water also explains why various columns are capable of achieving similar results. When wash water is properly applied and bubble size distributions are similar, the effectiveness of the separation is primarily controlled by the characteristics of the coal and is relatively independent of the cell used to perform the separation. The results obtained in the present work suggest that single-stage column units are capable of achieving essentially the same metallurgical performance as multiple-stage circuit configurations.

Based upon the previous results, investigators next concentrated efforts on optimizing single-stage laboratory scale column flotation. For this phase of testing, a 54-point parametric test matrix was established using the composite Box-Behnken design principles. Table 3.07 presents the parameters varied during these tests and the levels for each parameter. The full test matrix and detailed results obtained from these tests appear in Appendix A. Feed for these tests was the precleaned Pittsburgh No. 8 coal produced during the 100 pounds-per-hour grinding tests.

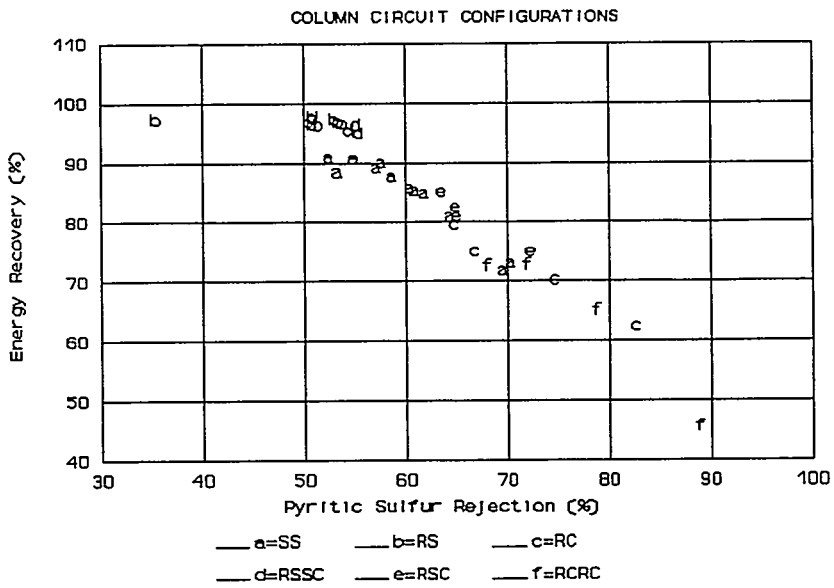

Figure 3.03 Performance Comparison, Single Versus Multiple Sta Laboratory Column Flotation

Table 3.07
Test Levels Utilized for Parametric Test Program

Parameter	Low	Medium	High
Feed Solids (%)	5	10	5
Frother Dosage (#/ton)	0.5	1.5	2.5
Collector Dosage (#/ton)	0.5	1.0	1.5
Feed Rate (ml/min)	50	150	250
Aeration Rate (ml/min)	500	1000	1500
Wash-water Rate (ml/min)	200	400	600

Figure 3.04 presents the energy recovery versus pyritic sulfur rejecti relationship revealed from the 54-point test matrix. The separati efficiency, for the separation of energy from pyrite, is also shown vers pyrite rejection. The separation efficiency curve indicates that the be trade-off between energy recovery occurs between 55 and 63 percent pyri rejection. In this range, energy recoveries up to 92 percent we achieved.

With these promising laboratory results in hand, investigators proceec with larger scale, 100 pounds-per-hour testing on the three coals. T different column flotation units were utilized for this stage of the te program. The Pittsburgh No. 8 seam coal was cleaned in an 11.5-ir diameter cell built by the Center for Applied Energy Research (CAER). T Upper Freeport and Illinois No. 6 coals were processed in a 7-inch squa column flotation unit built at Michigan Technological University (MTU After a number of shakedown and optimization tests conducted for ea coal, best-test conditions were established. Tests were conducted these conditions using ground product streams saved from the 100 pounc

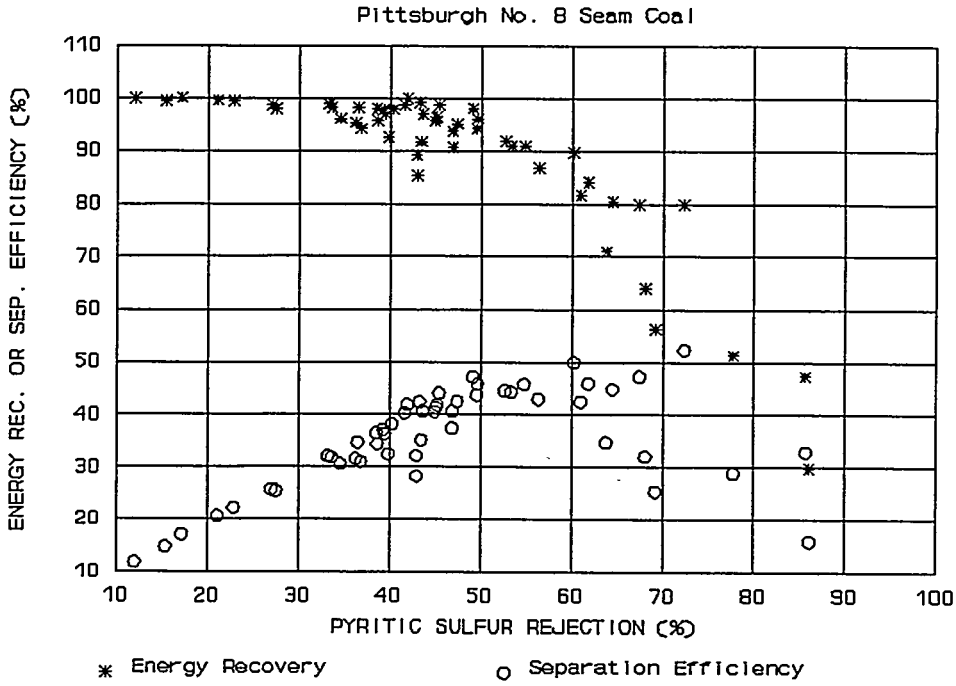

Figure 3.04 Laboratory Column Flotation, Parametric Study Test Results

per-hour grinding circuit tests. Table 3.08 presents the best results from these tests. These results were somewhat inferior to that achieved in the laboratory flotation units, but promising nonetheless.

Table 3.08
Best Column Flotation Performance from 100 Pounds-Per-Hour Testing

Coal	Pittsburgh No. 8	Upper Freeport	Illinois No. 6
Column Cell Design	CAER	MTU	MTU
Energy Recovery (%)	95.7	94.6	90.2
Pyrite Rejection (%)	40.4	61.2	54.1
Clean Coal			
Ash (%)	4.79	6.15	7.2
Pyritic Sulfur (%)	0.77	0.48	0.36
Btu per pound	13,588	14,664	13,016

During the bench-scale and 100 pounds-per-hour testing previously summarized, different designs of column flotation units were used for testing. In addition, a bench-scale, Round-Robin Test program was completed in order to test on a head-to-head basis competing designs that are either commercially available or in development. The Round Robin evaluation[2] resulted in the selection of the MTU and the CAER column flotation designs for scale-up and testing at the 100 pounds-per-hour level. The performance of these units, however, could not be maintained

when the units were scaled up from bench-scale to the 100 pounds-per-ho level.

Due to the difficulties experienced with the scale-up of the MTU and CA designs, investigators chose the microcel™ column flotation cell f installation at the POC facility. The microcel™ unit was developed by t Virginia Institute of Technology, and had been successfully scaled up fr 2-inch diameter bench-scale units to 10-feet diameter commercial unit Figure 3.05 presents a commercially applied microcel™ column flotati cell. The microcel™ ranked third in the Round Robin evaluation.

3.5 Cleaning Circuit Projections

Using the best results from the 100 pounds-per-hour testing of each un operation and Bilmat, a computer-based material balance progra investigators developed overall cleaning circuit performance projectio in order to assess the current potential for meeting the major co cleaning performance goals. Table 3.09 presents these performan predictions compared with the predictions based on washability analyses the coals. As expected, in each case, the actual coal cleaning resul did not match the theoretical performance limits established by t washabilities. For the Pittsburgh No. 8 seam coal, neither the ener recovery nor the pyritic sulfur rejection target of 85 percent w achieved. This can primarily be attributed to the poor coarse water-on cyclone performance discussed previously. Coarse coal performan problems were subsequently corrected at the POC level.

For the other two coals, one of the performance goals was surpassed each case by a substantial margin. The Illinois No. 6 projecti indicated a 91 percent pyritic sulfur rejection and nearly 81 perce energy recovery. For the Upper Freeport seam coal, the projectio indicated that 78 percent pyrite rejection and 91 percent energy recove were possible. Investigators felt confident that 85 percent ener recovery could be achieved at the POC level for each of the coals and th would result in pyrite rejection closer to 85 percent.

3.6 Thickening and Dewatering

Clean coal and refuse samples generated from the 100 pounds-per-ho testing were subjected to bench-scale testing in order to verify that t fine coal slurries could be adequately thickened and dewatered usi commercially-available equipment. The slurries were found to require bo cationic and anionic flocculant additions in order to settle the soli and produce a clear supernatant in a reasonable time period. T flocculants used were commercially available with prior applications coal cleaning plants. These results also indicated that conventional-ty thickeners could be utilized. The design criteria developed from the bench-scale tests were used to successfully size the clean coal thicken installed in the POC. The results also allowed verification that t existing refuse thickener was adequately sized for POC operations.

The clean coal and refuse slurries were also subjected to dewatering tes using pressure-filtration, vacuum-filtration, and belt-filter-pre techniques. The target moisture for the clean coal was 30 percent compared to a 35 percent target for the refuse. The plant refuse, becau

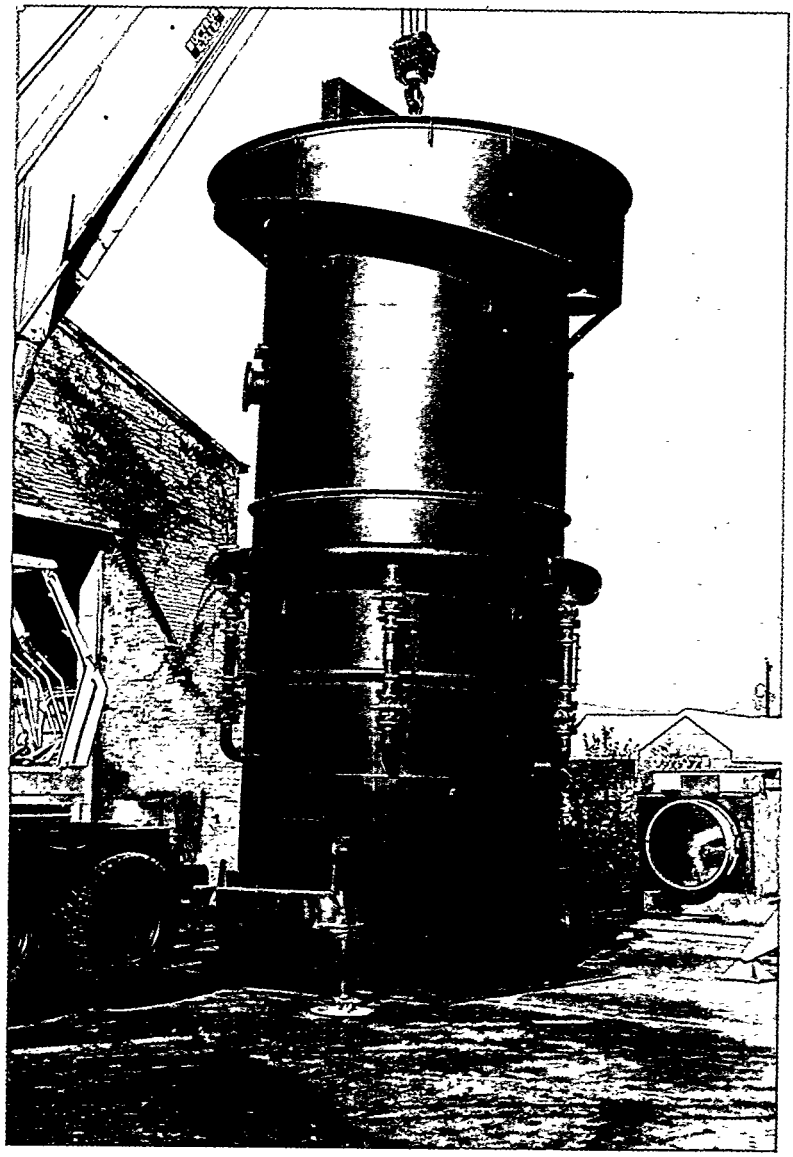

Figure 3.05 – Commercial microcel™ Column Flotation Cell

of coarse and intermediate size cleaning operations, was expected to be 1/4 inch by zero with little concern in meeting the refuse moisture target. The greatest concern was material handleability since very fine refuse tends to stick to chutework.

Table 3.09
Estimated Process Performance of 100 Pounds-Per-Hour Testing

Performance Parameter	Pittsburgh No. 8		Upper Freeport		Illinois No. 6	
	Bilmat Projection	Wash-ability Limit	Bilmat Projection	Wash-ability Limit	Bilmat Projection	Wash-ability Limit
Energy Recovery (%)	78.1	93.1	91.2	93.0	80.7	90.3
Pyrite Sulfur Rejection (%)	78.1	93.7	78.1	91.6	91.2	93.9
Separation Efficiency (%)	59.6	86.8	69.3	84.6	71.9	84.2
Ash Rejection (%)	89.5	-	75.7	-	87.7	-
Sulfur Rejection (%)	55.9	-	61.1	-	58.6	-

The bench-scale dewatering test results indicated that the clean-coal-moisture goal could be achieved with the Pittsburgh No. 8 seam coal and the Upper Freeport seam coal using pressure-filtration techniques. The Illinois No. 6 seam coal could only be dewatered to 38 percent moisture. Pressure filtration cycles for each of the three clean coals were reasonable at approximately 30 minutes.

The belt press filtration attempts could not produce 30 percent clean coal moistures for any of the coals. Likewise, vacuum filtration was unable to reach the target moisture level except in one case when a steam drying cycle was added during Upper Freeport seam coal testing.

Tests on the refuse samples of each coal indicated that the fine Upper Freeport Seam refuse could be dewatered to less then 35 percent moisture using vacuum filtration, pressure filtration or the belt press. Only vacuum filtration could meet the 35 percent target on the Illinois No. 6 refuse, and only pressure filtration was successful on the Pittsburgh No. 8 seam refuse. Despite the lack of success of the belt press on these two latter coals, investigators recommended the belt press for dewatering the fine refuse stream during POC operations. This was primarily due to the superior handleability of the belt-press refuse cake.

3.7 Application of Bench-Scale and 100 Pounds-Per-Hour Test Results to the Preparation of the Revised Conceptual Semi-Works Flowsheet

Based on the bench-scale and 100 pounds-per-hour test results, investigators revised the originally proposed Semi-Works flowsheet. The basic findings and the conclusions drawn from these findings are summarized below, grouped by the major circuits then envisioned for the Semi-Works plant and the subsequently constructed POC module.

3.7.1 Gravity-Based Coal Cleaning Operations

Investigators were increasingly uncomfortable with water-only cycl performance characteristics for the 1/4-inch by 48 mesh size fraction l continued to include the coarse water-only cyclone operation in the Ser Works plant design. A heavy-media cyclone would be used in the l module, however, and if successfully employed at the requi recirculating media conditions, would be considered for the final Ser Works plant design.

The fine water-only cyclone operation was successfully employed at the pounds-per-hour scale and was maintained in the Semi-Works plant desi The POC module would also contain this unit operation. Each of the ab discussed, gravity-based coal cleaning devices could be scaled up either the POC scale or the Semi-Works scale using established indus design principles.

3.7.2 Conventional Froth Flotation

Based on bench-scale and 100 pounds-per-hour testing, investigat decided that conventional froth flotation should be applied separately the 48 mesh by 200 mesh and the 200 mesh by zero size fractions.

3.7.3 Crushing and Grinding

The raw coal crusher and the precleaned or middlings coal crusher w sized based on the maximum particle size and the Hardgrove grindability the feed, the top size requirements for the crushed products, and throughput tonnage. In addition, the precleaned or middlings coal crus design must take into account the high surface moisture content of feed.

The Gundlach Crusher Company was contacted and given design parameters each of the three base coals and specific units were proposed. Since conflicting design criteria were obtained during the laboratory-bench-scale testing, a final verification of their applicability would attempted at the POC module testing.

The grinding circuit was a wet, closed-circuit system with integ classifying cyclones used to achieve positive control of the grou product top size while minimizing throughput requirements of the m proper. A wet grinding system has the advantage of lower po requirements compared to dry grinding while a reversed grinding circ configuration allows the preparation of a proper mill feed in regard percent solids.

While laboratory tests indicated that increased pyrite rejection possible without additional energy loss by grinding to 325 mesh microns) prior to advanced froth flotation, the project team and the agreed, near the end of bench-scale testing, to limit future communit efforts to a 200 mesh (75 microns) grind. Due to this change in tar grind, a tumbling ball-mill replaced the stirred ball-mill operation t was previously proposed for the Semi-Works plant design.

Laboratory test results provided key information that was required for the sizing of the POC ball-mill installation. The Hardgrove Grindability Index of the hardest project coal was provided to the ball-mill manufacturer. In addition, the manufacturer was supplied the coarsest size distribution encountered for the mill circuit feed during bench-scale testing. Finally, a circuit throughput rate of 3.4 TPH was established along with a target grind of 95 percent passing 200 mesh.

Investigators relied on the ball-mill manufacturer to size the ball-mill based on the supplied design criteria. It was hoped at the time that the subsequent ball-mill installation could be operated at reduced throughputs in order to produce a 325 mesh grind for one coal. The grinding circuit design for the final Semi-Works plant would be subject to the findings of the POC mill circuit test program.

3.7.4 Advanced Froth Flotation

The advanced froth flotation approach in this project utilized conventional feed slurry preparation. This began with the repulp of the grinding mill product to 4-6 percent solids. This slurry was delivered to a conditioning tank with two minutes retention time in which chemical reagents were added to condition the column feed. Task 6 results indicated that only conditioner (fuel oil, pine oil, or kerosene) would be required at this stage. Additionally, testing had indicated that a single stage flotation configuration was reasonably effective based on the slight performance improvement measured in multiple-stage configurations. A two-stage flotation system was proposed in the preliminary conceptual design.

Continuous testing of advanced froth flotation in Task 5 provided effective solutions to most required hardware and operational parameters related to advanced froth flotation. Additional POC testing would allow continued refinement of selected operational conditions such as reagent dosage, wash-water, and aeration rates.

3.7.5 Product and Refuse Dewatering

Laboratory and bench-scale testing results indicated that advanced froth flotation concentrate may be too dilute to introduce directly to a final dewatering device. For this reason, a clean coal thickener was included in the POC for verification tests. Clean coal dewatering tests indicated that a batch-type, recessed-plate pressure filter achieved the lowest product moisture of the units tested. These units were also the most costly. In order to achieve the project dewatering goal of 30 percent clean coal moisture, the pressure filter may be the only option. For the POC module, investigators planned to field test a relatively new dewatering unit, the hyperbaric disk filter, which had the potential to approach the clean coal moisture target. A final clean coal dewatering method for the Semi-Works plant would be based on the POC results.

Proper clean coal and refuse thickener performance required the addition of both anionic and cationic polymers. Dewatering of the refuse thickener underflow was accomplished in continuous belt filters as opposed to the batch-type pressure filters proposed in the preliminary conceptual design. Belt pressure filtration required polymer addition in order to improve throughput rates. While not achieving final moisture objectives, testing

indicated that the belt press was the only dewatering unit of those test that could produce a reasonably handleable cake. Combined with coars refuse products that would be generated in precleaning operations, tot plant refuse product moisture would not exceed 35 percent, thus meeti this dewatering objective. Finally, thickening and dewatering te results indicated that the above discussed performance levels could achieved on both the clean coal and refuse products while also produci clean, recyclable supernatant and effluent streams. Given that t related Coal Surface Control Project results[3] did not suggest a significant surface control schemes related to improving proce performance, no such advanced techniques were proposed in the PC Subsequently, the success of conventional thickening and dewateri techniques indicated that there was no need for water purification syste and these were not used in the POC.

4.0 PROOF-OF-CONCEPT (POC) SCALE TEST RESULTS

Based on the results and analysis of bench-scale testing, investigators felt confident that sufficient information was available to proceed with the development of a proof-of-concept (POC) test module. The basic objectives of the POC test module were to verify, on a larger and continuous basis, the findings of bench-scale testing and to try to resolve any remaining design deficiencies related to the advance froth flotation process. Results from POC testing could then be used to finalize the conceptual design for a 20 TPH Semi-Works plant incorporating this technology.

The POC plant was constructed as an addition to the State of Ohio's John P. Apel Ohio Coal Testing and Development Facility (OCTAD) located between Beverly and McConnellsville, Ohio. OCTAD is a 30-50 TPH coal cleaning research facility that contained much of the pre-cleaning circuitry required for the POC. A separate bay was added to OCTAD to house additional equipment required for the POC module. Additionally, modifications were made to OCTAD equipment and process streams in order to accommodate and tie in all required unit operations.

4.1 POC Configuration

Figure 4.01 presents the POC flowsheet, and distinguishes the equipment added to the OCTAD facility in order to complete the POC configuration.

4.1.1 Raw Coal Crushing and Sizing

Raw coal was crushed in three stages from as large as 6-inch by zero to 1/4-inch by zero and then stored in a 200 ton capacity raw coal bin. A weigh feeder metered the raw coal at pre-selected rates to a bucket elevator that raised the coal to the top of the plant and dropped the coal onto a raw coal screen utilized for oversize protection. The raw coal screen, fitted with 1/4" square opening panels, diverted coarse oversize to a two-roll crusher. The 1/4 inch x 0 screen underflow reported along with the roll crusher throughput to the raw coal sump.

4.1.2 Gravity-Based Cleaning and Intermediate Crushing

The raw coal pump pumped 1/4" x 0 material to a deslime sieve/screen combination for sizing at 48 mesh. The plus 48 mesh material was mixed with recirculating media and pumped to a 15-inch diameter heavy-media cyclone. The cyclone products passed over drain and rinse sieve/screen combinations in order to recover magnetite for reuse. The refuse screen discharge was dewatered in a vertical, basket-type centrifuge and reported to the refuse conveyor. The heavy-media cyclone clean coal was crushed to 48 mesh by zero in a double-cage, hammer mill. The mill product was recirculated to the raw coal sump, forming a closed crushing circuit whereby the deslime screen underflow, sized at 48 mesh by zero, was the eventual outlet.

The 48 mesh x 0 deslime screen underflow reported to the water-only cyclone feed sump and was pumped to two six-inch diameter water-only cyclones. The cyclone overflow reported to the classifying cyclone sump while the cyclone underflow reported to the refuse thickener.

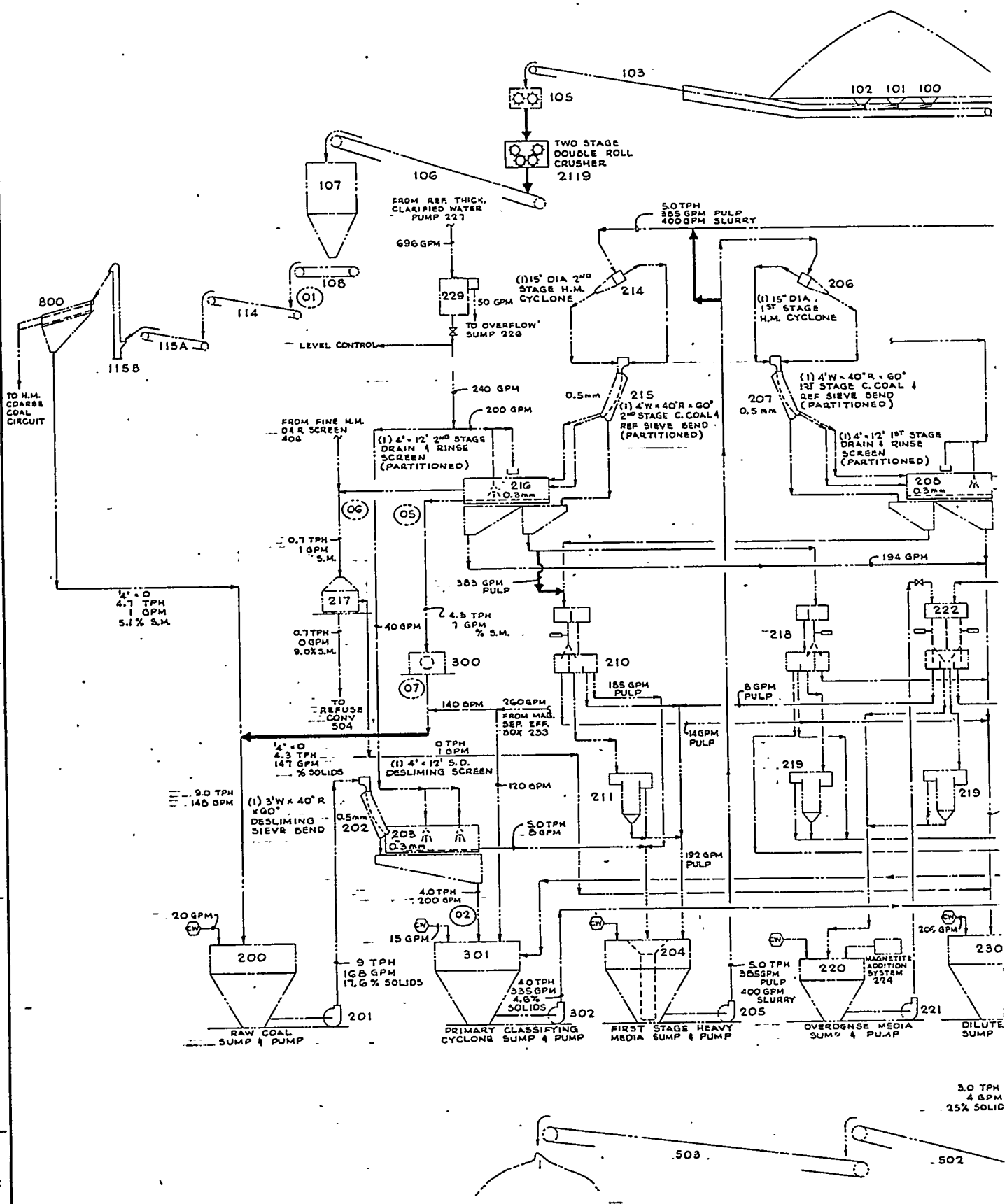

Figure 4.01 Flowsheet For Proof-Of-Concept Module

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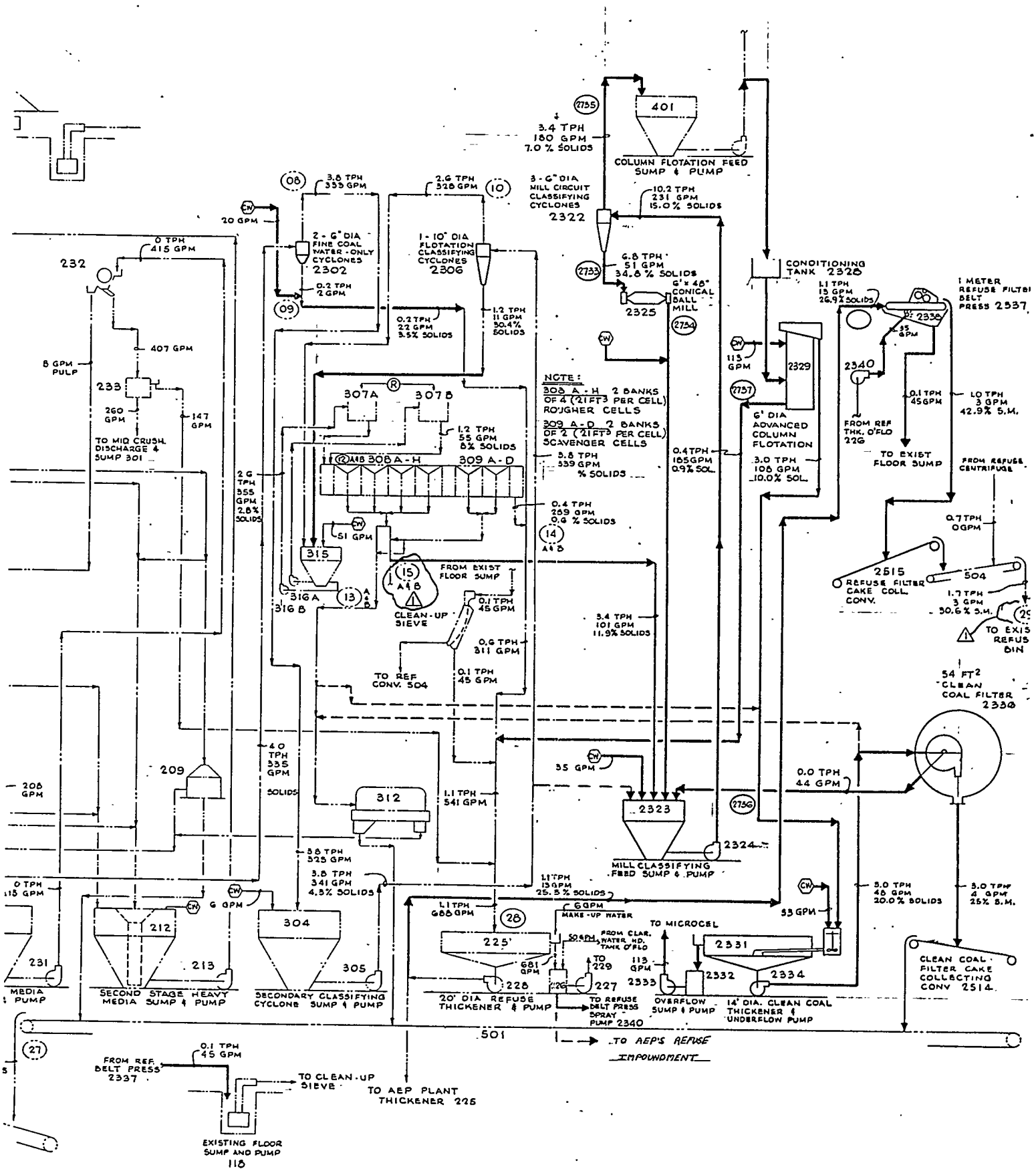

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			DRAWN BY B. HACKETT	7/1/91			FLOW SHEET
			CHECKED BY				ENGINEERING DEVELOPMENT OF ADVANCED PHYSICAL FINE COAL CLEANING TECHNOLOGIES
			APPROVED BY				
			APPROVED BY			JOB No. 88107 - 190	DWG. No. 10-50-0101 REVISION R- 1

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4.1.3 Conventional Froth Flotation

The classifying cyclone sump could pump either to the mill classifying cyclone sump, when by-passing conventional froth flotation, or to a ten-inch classifying cyclone modified to make a 200 mesh separation. The classifying cyclone overflow and underflow reported to separate sumps so that split froth flotation could be utilized. The 48 mesh x 200 mesh/200 mesh x 0 split flotation circuitry provided the option of grab-and-run flotation or normal single-stage flotation on each size fraction. In grab-and-run flotation, clean coal, middlings, and refuse streams were generated. In single stage flotation, only middlings and refuse streams were generated. Clean coal and refuse streams were directed to separate thickeners. The middlings stream, in either case, was directed to the mill classifying cyclone sump.

4.1.4 Fine-Grinding Circuit

Primary components of the fine-grinding circuit were three six-inch diameter classifying cyclones and a 6 feet diameter by 4 feet conical ball-mill. The ball-mill discharge combined with new feed in the mill classifying cyclone sump to effectively close the grinding circuit. The sump contents were pumped to the classifying cyclones to effect a 200 mesh size separation. The cyclone overflow reported to the column flotation feed sump, and the cyclone underflow reported to the conical ball-mill.

4.1.5 Advanced Froth Flotation

The column flotation feed sump contents were pumped to a conditioning tank where kerosene was added as a collector. The tank drained by gravity to the 6-feet diameter advanced column flotation cell where air and frother reagent were introduced into a re-circulated tailings stream. Clean coal exited the top of the column cell and reported to a clean-coal thickener. Refuse discharged near the bottom of the cell through an automatic level control valve. This flow reported to a refuse thickener.

4.1.6 Thickening and Dewatering

As described earlier, coarse (1/4" x 48 mesh) refuse reported to a basket-type centrifuge and discharged to a collecting conveyor. Clean-coal and refuse (48 mesh x 0) product streams were collected in separate thickeners. The clean-coal thickener underflow was pumped to either a high-G, solid bowl centrifuge, or a hyperbaric disk filter. Due to the inability to get the hyperbaric filter running continuously, it was only used during early stages of the Pittsburgh No. 8 seam coal testing and not during any of the demonstration runs.

The refuse-thickener underflow was pumped to the refuse thickener of a nearby commercial coal cleaning plant. The commercial plant refuse thickener underflow was pumped to fine refuse settling ponds. These ponds were periodically dredged and the settled solids were disposed of in an approved refuse impoundment system.

4.2 Test Coals

The three coals (Pittsburgh No. 8, Upper Freeport, and Illinois No. 6) that were tested for the POC were not acquired from the same mining operations as those tested during the bench-scale work. For the POC test work, the Pittsburgh No. 8 seam coal was obtained from the Windsor Coal company located in Brooke County, West Virginia. The Upper Freeport seam coal was supplied by Camelot Coal Company located in Somerset County, Pennsylvania, and the Illinois No. 6 coal was obtained from the Kerr-McGee Coal Corporation located in Saline County, Illinois. Different mining operations were used for the POC test coals due to mine closures, UMWA contract disputes, or logistic problems. Table 4.01 contains the washability head analyses of the three coals used for the POC testing. Complete washabilities for the coals may be found in Appendix B.

Table 4.01
Head Analyses for Washability Samples (Dry Basis)

Coal Seam	% Ash	% Sulfur	% Pyritic Sulfur	Btu/lb
Pittsburgh No. 8	40.38	3.14	2.16	8,292
Upper Freeport	18.12	3.99	2.81	11,975
Illinois No. 6	36.23	4.11	2.75	8,866

In addition, Appendix B presents washability data regarding weight recovery, ash, total sulfur, and pyritic sulfur for the three coals used for the POC testing.

4.3 POC Test Plan

The primary objective of the POC test plan was to demonstrate 85 percent energy recovery with 85 weight percent pyritic sulfur rejection on the Pittsburgh No. 8, Upper Freeport, and Illinois No. 6 coal seams based on run-of-mine coal quality. Other objectives include:

- Obtaining pyritic-sulfur rejection, ash rejection, and coal recovery data of conventional precleaning processes.
- Obtaining material balance data for scale-up design purposes.
- Demonstrating the ability to dewater fine coal product to 30 weight percent surface moisture and refuse product to 35 weight percent surface moisture.
- Demonstrating extended operability and reliability of the process facility.
- Measuring power requirements and reagent usage to estimate operating costs.
- Determining operating cost of the process in order to support estimates for commercial-scale plants.

All three coals were tested with minus 200 mesh material as feed to the column flotation cell. The Pittsburgh No. 8 seam coal was also to be tested on minus 325 mesh material as feed to the advanced column flotation cell, however, the ball-mill circuit was unable to produce this fine-size material.

Precleaning was conducted on all three coal seams with each unit operation maximized, if possible, to recover 97 percent (±1 percent) of the size fraction energy value. Specifically, the following unit operations were maximized:

4.3.1 Heavy-Media Cyclone (1/4 in. x 48 mesh)

The heavy-media cyclone circuit was maximized for all three coal seams by varying the circulating media gravity. Tests were conducted using four different circulating gravities for the Pittsburgh No. 8 and Upper Freeport coals. Based on experience gained from the first two test coals, it was only necessary to test three different circulating gravities on the Illinois No. 6 coal seam to maximize the performance of the cyclone.

4.3.2 Water-Only Cyclone Circuit (48 mesh x 0)

The water-only cyclone circuit was maximized for the Pittsburgh No. 8 seam coal by varying the water-only cyclones apex diameters, the vortex finder diameters, and the vortex finder lengths. Once the proper vortex finder diameter and length were determined for the Pittsburgh No. 8 seam coal, it was only necessary to vary the apex diameters on the Upper Freeport and Illinois No. 6 coals.

4.3.3 Split Conventional Flotation (48 mesh x 0)

Split conventional flotation (48 mesh x 200 mesh and 200 mesh x 0) was conducted on all three coal seams. Frother and collector dosages were varied in an effort to maximize this circuit. However, this circuit was eventually by-passed. The decision to by-pass this circuit is further discussed in Section 4.4, POC Operations Summary.

4.3.4 Ball-Mill/Classifying-Cyclone Circuit

Tests to optimize the ball-mill/classifying-cyclone circuit to produce the desired coal grind were conducted on the Pittsburgh No. 8 and Upper Freeport seam coals. Ball-mill RPM, media size, feed rate, and percent solids were varied. In addition, classifying cyclone feed rate, vortex finder diameter, and apex diameter were varied in an effort to obtain the desired size distribution of 95 percent minus 200 mesh at 20-25 micron mass mean particle size. Despite the many tests and numerous parameters that were varied, the circuit was unable to produce the desired size distribution. The inability to produce the target grind in the ball-mill circuit is further discussed in Section 4.4, POC Operations summary.

4.3.5 Advanced Column Flotation Circuit

Once the precleaning and grinding circuits were maximized, testing was conducted on the column flotation cell with the objective of obtaining at least 85 percent pyritic sulfur rejection at 85 percent total plant energy

recovery based on run-of-mine coal quality for each of the three coal seams. For the Pittsburgh No. 8 seam coal, a fractional factorial experiment matrix and a Box-Behnken design matrix were conducted on the column flotation cell. A total of 33 column flotation tests were conducted varying feed rate, air rate, frother rate, collector rate, and wash-water rate. On the Upper Freeport and Illinois No. 6 seam coals, only a Box-Behnken design matrix was performed. Twenty-one column flotation tests were conducted on the Upper Freeport seam coal and 19 column flotation tests were conducted on the Illinois No. 6 seam coal. During the column flotation testing on the Upper Freeport and Illinois No. 6 coal seams, feed rate, collector dosage, and gas hold-up were varied.

After evaluating all the column flotation test data for each of the three coals, the best unit operation parameters were determined and the plant was configured to match these parameters for the extended operability and reliability demonstration run. The extended demonstration run for the Pittsburgh No. 8 seam consisted of two back-to-back, four days-per-week, 24 hours-per-day operation for a total of eight 24-hour operating days. The extended demonstration run for both the Upper Freeport and Illinois No. 6 coal seams consisted of two back-to-back, five days-per-week, 24 hours-per-day operation for a total of ten 24-hour operating days. During the extended demonstration run, the following parameters were recorded:

- Mill classifying cyclone feed flowrate
- Column flotation cell feed flowrate
- Column wash-water flowrate
- Pressure readings on the mill classifying cyclones, water-only cyclones, and heavy-media cyclone
- All reagent rates
- Circulating media specific gravity on the heavy-media cyclone circuit
- Plant feed rate
- Number of sample increments collected for each sample

One of the secondary objectives of the test program was to demonstrate the ability to dewater fine coal to 30 weight percent surface moisture using a hyperbaric filter and to dewater refuse product to 35 weight percent surface moisture using a belt-filter press. However, neither the hyperbaric filter nor the belt-filter press was used during the 24-hour demonstration runs. The decision not to use these units is further discussed in Section 4.4, POC Operations Summary.

4.4 POC Operations Summary

Modifications to the OCTAD facility started the first week in August 1992 and were completed at the end of January 1993. A summary of the POC operations follows. A schedule of activities for the operating phase is shown in Table 4.02.

Table 4.02
POC Test Schedule

Activity	Begin	End
Start-up Activities	4 Feb 1993	2 March 1993
Pittsburgh No. 8 Seam Precleaning Maximization	2 March 1993	26 March 1993
Pittsburgh No. 8 Seam Column Testing	29 March 1993	24 August 1993
Pittsburgh No. 8 Seam Demonstration Run	31 March 1993	14 Sept. 1993
Upper Freeport Seam Precleaning Maximization	27 Sept. 1993	6 Oct. 1993
Upper Freeport Seam Column Testing	7 Oct. 1993	29 Oct. 1993
Upper Freeport Seam Demonstration Run	7 Nov. 1993	19 Nov. 1993
Illinois No. 6 Seam Precleaning Maximization	6 Dec. 1993	7 Dec. 1993
Illinois No. 6 Seam Column Testing	8 Dec. 1993	20 Dec. 1993
Illinois No. 6 Seam Demonstration Run	3 Jan. 1994	14 Jan. 1994

The test procedure used for the operating phase of the POC testing first consisted of allowing the test facility to stabilize to assure steady-state operation. For the heavy-media cyclone and water-only cyclone maximization tests, the test facility was allowed to stabilize 30 minutes before sampling the appropriate streams. The conventional flotation circuit was allowed to stabilize for 60 minutes before sampling was conducted. A longer stabilization time of 120 minutes was required for the grinding circuit to reach steady-state operation. The column flotation circuit was allowed to stabilize for 60 minutes if only the collector dosage was adjusted. If the grinding circuit was changed, or if the frother dosage to the column was adjusted, this circuit was given 120 minutes to stabilize. Once the various circuits reached steady-state operations, sampling was conducted per ASTM requirements. The heavy-media cyclone, water-only cyclone, and grinding circuits were sampled for 45 minutes while the conventional flotation circuits were sampled for 60 minutes. A minimum of 13 sample increments were collected for each sample stream.

The testing schedule developed for the POC was extremely aggressive. In many cases, three to four tests were performed during one day of testing generating numerous samples to be analyzed by the laboratory. The laboratory was required to have the samples that were collected from the previous day analyzed by 7:00 a.m. each morning in order to determine what testing should be conducted that day. At the beginning of the Pittsburgh No. 8 seam program, numerous analytical errors were suspected by the team members. As a result, it was decided to stop the test program to determine what could be done to improve the laboratory results and still maintain the overnight analytical results. The team came to the following conclusions.

- In many instances, the amount of material that was being collected was quite large, especially for the slurry samples. To solve this problem, it was decided to take less sample increments without compromising ASTM standards.

- The 8 mm thick plastic drum liners that were used to line the 55-gallon drums in which the samples were collected proved to be, in many cases, not strong enough to resist rough handling of the samples, resulting in the breakage of many of the drum liners. In addition, the plastic drum liners were bulky and presented handling difficulties for the laboratory technicians. To eliminate this problem, 20-gallon plastic drums were purchased that did not require drum liners.

- Certain sample preparation procedures were not being performed adequately. These procedures were evaluated and corrected by Standard Laboratory.

Once the above measures were implemented, a test was conducted to determine if the results from the laboratory were now accurate. This test consisted of collecting three sub-samples from six main samples from the POC process. Specifically, three sub-samples were collected from the following process streams:

- Deslime Screen Underflow (702)
- Water-Only-Cyclone Overflow (708)
- Water-Only-Cyclone Underflow (717B)
- Conventional Flotation Feed (712B)
- Conventional Flotation Concentrate (713B)
- Conventional Flotation Tailings (714B)

These samples were then shipped to Standard (STD), CONSOL Inc. (CONSOL), and American Electric Power (AEP) laboratories for comparison. As can be seen from Table 4.03, STD results do not compare favorably with CONSOL or AEP results. However, there is a good comparison between CONSOL and AEP results.

Based on this laboratory comparison, an engineer from ICF KE visited Standard Laboratory to observe their laboratory procedures. From the visit, it was determined that Standard Laboratory needed to change their QA/QC program. In doing so, Standard Laboratory began incorporating additional "check" samples of known quality into their QA/QC program, especially "check" samples that contained high percentages of ash, total sulfur, and pyrite sulfur. After these changes, laboratory results improved and the test program was resumed.

During testing on the Pittsburgh No. 8 coal, concerns regarding the steady-state operation of the various POC circuits were raised by team members. As a result, the test program was once again stopped to evaluate these concerns. Tests were conducted on the heavy-media cyclone, water-only cyclone, and ball-mill/classifying cyclone circuits to determine whether additional time was required for these circuits to reach steady-state operation. To evaluate this, the test facility was operated for four continuous hours. After each hour of operation, a complete set of samples was collected around the circuits in question. This resulted in four sets of samples taken at one hour intervals. Each of the four sets of samples was analyzed to determine if the performance of the circuits changed from one hour to the next hour. The performance of both the heavy-media cyclone and water-only cyclone were compared, using probable error plots, after one hour and after four hours of operation. The

probable error plots showed that the performance of both the heavy-media cyclone and the water-only cyclone were virtually the same after one hour of operation and after four hours of operation.

Table 4.03
Laboratory Comparison

Analysis	Sampler	STD/CONSOL	CONSOL/AEP	STD/AEP
ASH %	702	-1.14/(-)	1.07(-)	-0.07/(+)
	708	-0.85/(+)	0.31/(+)	-0.54/(+)
	712B	-2.58/(-)	0.57(+)	-2.02/(-)
	713B	-1.57/(-)	-0.41/(+)	-1.98/(-)
	714B	-3.71/(-)	0.52/(+)	-3.19/(-)
	717B	-2.23/(-)	1.10/(-)	-1.13/(-)
SULFUR%	702	0.29/(-)	0.05/(+)	0.34/(-)
	708	0.18/(+)	-0.01/(+)	0.08/(+)
	712B	0.34/(-)	-0.11/(+)	0.23/(-)
	713B	0.48/(-)	-0.16/(+)	0.32/(-)
	714B	0.20/(+)	-0.08/(+)	0.15/(+)
	717B	0.07/(+)	0.24/(-)	0.31/(-)
BTU PER POUND	702	194.0/(-)	-151.0/(-)	43.0/(+)
	708	249.0/(-)	17.0/(+)	266.0/(-)
	712B	172.0/(-)	24.0/(+)	148.0/(-)
	713B	-167.0/(-)	15.0/(+)	-182.0/(-)
	714B	480.0/(-)	-148.0/(-)	332.0/(-)
	717B	333.0/(-)	-325.0/(-)	8.0/(+)

STD - Standard Laboratories, Inc.
CONSOL - CONSOL Inc. Laboratory
AEP - American Electric Power Central Coal Lab

Samples taken of the ball-mill/classifying-cyclone circuit over the four hour period indicated that pyritic sulfur was being concentrated in the classifying-cyclone underflow. This was due to the nature of the separating device.

A classifying cyclone makes its separation based on particle size and specific gravity. Denser particles of the same size will be classified at a finer cutpoint in classifying cyclones. The difference between the specific gravity of coal and pyrite is approximately four specific gravity units. Therefore, if coal is being sized by the classifying cyclones at 74 microns, then the pyrite is being sized significantly finer. In essence, the ball-mill became a "holding tank" for liberated pyritic sulfur since the classifying cyclone underflow is recirculated to the ball-mill. To remedy this problem, a Krebs Varisieve was installed and used in conjunction with the classifying cyclones. Since the Varisieve

makes a separation based on size alone, fine pyrite could be bled away from the ball-mill and to the advanced flotation circuit.

With the conclusion of the testing for steady state, the unit operation testing restarted. Conventional flotation tests were conducted on the Pittsburgh No. 8, Upper Freeport, and Illinois No. 6 coal seams. Testing indicated that no "grab-and-run" product (product that met or exceeded the quality requirements of the final facility product) could be produced on either the 48 mesh x 200 mesh or the 200 mesh x zero size fractions for any of the three coals. Tests were also conducted on the 48 mesh x 200 mesh and the 200 mesh x zero to determine if 95 percent energy recovery could be realized. On the Pittsburgh No. 8 seam coal, only one test on the 48 mesh x 200 mesh size fraction produced the desired energy recovery. For the Upper Freeport coal seam, none of the tests on the 48 mesh x 200 mesh size fraction produced the desired energy recovery, while on the 200 mesh x zero size fraction, one test produced the desired energy recovery. Two tests on the 48 mesh x 200 mesh size fraction for the Illinois No. 6 coal seam produced the desired results. However, no tests on the 200 mesh x zero size fraction produced the desired energy recovery. Even though on a few of the tests it was possible to produce 97 percent energy recovery, the team decided to eliminate the conventional flotation cells from the flowsheet for the following reasons:

- Residual frother and collector in the froth products which eventually reported to the column flotation cell resulted in the inability to control the column flotation cell. In fact, the column cell, in most cases, was producing a froth product with no reagent addition.

- There was concern that the conventional flotation cells could not consistently produce the required 97 percent energy recovery.

- The large amounts of collector and frother being used was being concentrated in the facilities' clarified water resulting in operational problems with other circuits.

The desired grind from the ball-mill circuit of 95 percent minus 200 mesh and 90 percent minus 325 mesh was never achieved on any of the coals tested. Tests to improve the grind were conducted on both the Pittsburgh No. 8 and Upper Freeport coal seams by varying ball-mill rotational speed, ball charge, and feed rate. Ball-mill rotational speed and ball charge proved to have very little influence on the fineness of grind. However, the feed rate to the ball-mill had a significant impact on the fineness of the ball-mill grind. Testing revealed that to obtain 90 percent minus 200 mesh, less than one TPH would have to be fed to the column flotation cell. It was decided by the team that this low feed rate was not practical to demonstrate the POC properly. A more practical column feed rate of approximately 2 TPH was chosen. At this feed rate, a grind of 82 percent to 85 percent minus 200 mesh was achieved. Considering the results that were obtained from the ball-mill circuit, the test work that was originally planned on 90 percent minus 325 mesh was eliminated. The poor grinding results that were obtained from the ball-mill can be attributed to the larger than anticipated recirculating load from the classifying cyclones. A larger ball-mill would have been required to produce the desired grinding of 95 percent minus 200 mesh.

The advanced column flotation cell was tested in detail for the Pittsburgh No. 8 seam coal. A fractional factorial experimental matrix was conducted to determine the major parameters that influenced the operation of the column flotation cell. The major parameters were determined to be: feed rate, air holdup, and collector rate.

After the factorial tests determined the major parameters, a Box-Behnken test matrix was conducted on all three of the coals. The results of each Box-Behnken matrix was then analyzed and the best operating parameters were used for the demonstration operation for each of the three coals.

The clean-coal filter that was to be used in the POC was a hyperbaric-type disc filter. The filter was leased from KHD and was not suited for continuous 8 hour-per-day operation. After the filter was installed, numerous modifications to seals and the filter discharge system were completed. The discharge system on the filter, which originally consisted of a rotating valve, was replaced by a double knife gate system. This work was completed by POC operations staff with the support and guidance of KHD service personnel. The two knife gates on the filter discharge system form a separate chamber that could be pressurized and depressurized in isolation from the main filter chamber for the purposes of solids removal.

With both knife gates closed, dewatered coal is collected above the top knife gate while the discharge chamber is pressurized through a link with the vessel chamber. Using timer sequencing, the top gate opens allowing the coal to fall by gravity into the discharge chamber. The top gate closes, and the discharge chamber is depressurized before the bottom gate opens to allow the coal to discharge to a collecting conveyor. The bottom gate closes and the batch cycle is repeated.

Proper sealing around both knife gates is critical to the continuous, successful operation of this operation. Leakage of the lower seal during discharge-chamber pressurization or leakage of the top seal during filter cake discharge each result in high compressed-air consumption and, subsequently, a loss in chamber pressures. Reduction of chamber pressures normally result in higher cake moistures, and a downward spiral in performance is virtually unavoidable.

Generally after short periods of operation (five to 20 minutes), either or both of the seals would begin leaking. Leakage continued even with manpower-intensive efforts to keep the seals clean during cycling. With the seals leaking, the internal pressure within the filter decreased to as low as 1 bar (15 PSI) resulting in an increase in cake moisture. Eventually, the wet cake would bridge over the discharge chute plugging the unit. Representatives from KHD were at the site numerous times in an effort to repair the seal problems within the unit and the discharge system. Different valve seals were tried with little success. In fact, the valve seals on average may have lasted five hours before they would need replaced. The installation of new valves seals would require approximately eight hours. Under the best operating conditions with new valve seals, grab samples indicated that the filter cake surface moisture was in the range of 25 to 28 percent. After many weeks of work trying to correct the problems with the hyperbaric filter, it was decided by the team to discontinue its operation and use the Sharples solid bowl

centrifuge to dewater the clean coal. The resultant clean coal moisture using the Sharples centrifuge was in the 35 to 40 percent range.

A refuse belt-filter press was to be used in the POC testing to dewater the refuse thickener underflow. The start-up of the belt-filter press progressed smoothly after a larger anionic flocculant pump and a new cationic pump were installed. After the belt-filter press was operational, researchers discovered that the performance of the column flotation cell began to deteriorate. Upon further investigation, it was discovered that the feed to the column flotation cell was flocculated. The large amount of flocculant that was required for proper operation of the belt-filter press was resulting in residual flocculant being retained in the circulating clarified water, affecting the performance of the column flotation cell. To remedy the problem, the team decided to eliminate the belt-filter press from the POC circuit and pump the refuse thickener underflow to AEP's refuse impoundment.

During the 24-hour demonstration runs, a complete set of samples was collected every eight hours for all the pertinent circuits in operation. Samples of the plant feed, plant clean coal, and plant refuse were also collected. Specifically, the following samples were collected during the demonstration runs.

- Plant Feed
- Deslime Screen Underflow
- Heavy-Media-Cyclone Clean Coal
- Heavy-Media-Cyclone Refuse
- Water-Only-Cyclone Overflow
- Water-Only-Cyclone Underflow
- Clean Coal-Thickener Overflow
- Plant Clean Coal
- Refuse Thickener Feed
- Ball-Mill Feed
- Ball-Mill Discharge
- Column Flotation Feed
- Column Flotation Concentrate
- Column Flotation Tailings

In addition, all downtime and the reason for the downtime was recorded. Table 4.04 lists the number of minutes lost and the reason for the outage for all three coals.

The availability of the POC was calculated by subtracting downtime from total available minutes, multiplying by 100, and dividing by the total available minutes. The Pittsburgh No. 8 seam was processed for four days for both weeks of the demonstration run. Both the Upper Freeport and Illinois No. 6 seams were processed for five days during both weeks of the demonstration run. A total of 40,320 total minutes were thus available for operations. The availability of the POC for each coal seam was as follows: Pittsburgh No. 8 - 98.0 percent; Upper Freeport - 97.4 percent; and Illinois No. 6 - 89.9 percent. The POC availability for the combination of all three periods was 94.9 percent. The advanced process equipment, including the ball mill, the advanced flotation cell, and ancillary operations related to these units did not cause any of the downtime experienced during POC operations.

Table 4.04
Operational Downtime During 24-Hour Demonstration Runs

COAL SEAM	DATE	MINUTES LOST	DESCRIPTION
Pittsburgh No. 8	8/31/93	6	Miscommunication with operator.
Pittsburgh No. 8	9/02/93	2	Refuse belt misalignment switch.
Pittsburgh No. 8	9/03/93	56	Bucket elevator feed chute plugged.
Pittsburgh No. 8	9/07/93	69	Plant start-up.
Pittsburgh No. 8	9/07/93	5	Heavy-media pump not pumping.
Pittsburgh No. 8	9/08/93	3	Raw coal conveyor down.
Pittsburgh No. 8	9/10/93	89	D&R screen motor grounded.
Upper Freeport	11/07/93	36	Plant start-up.
Upper Freeport	11/07/93	10	Bucket elevator feed chute plugged.
Upper Freeport	11/08/93	116	Coal thickener full feed rate too high.
Upper Freeport	11/09/93	34	Bucket elevator plugged.
Upper Freeport	11/11/93	9	Bucket elevator feed chute plugged.
Upper Freeport	11/12/93	52	Bucket elevator feed chute plugged.
Upper Freeport	11/14/93	42	Plant start-up.
Upper Freeport	11/16/93	2	Raw coal belt misalignment switch.
Upper Freeport	11/17/93	35	Power failure (storm).
Upper Freeport	11/18/93	4	Bucket elevator feed chute plugged.
Upper Freeport	11/18/93	32	Cagepactor jog-button grounded.
Upper Freeport	11/18/93	5	Cagepactor jog-button grounded.
Illinois No. 6	01/02/94	18	Plant start-up.
Illinois No. 6	01/04/94	2	Timer tripped.
Illinois No. 6	01/04/94	4	Timer tripped.
Illinois No. 6	01/04/94	4	Timer tripped.
Illinois No. 6	01/04/94	5	Interlock shut down - no faults.
Illinois No. 6	01/05/94	2	Operator error.
Illinois No. 6	01/06/94	12	Power failure (very cold).
Illinois No. 6	01/09/94	72	Start-up and H.M. pump down.
Illinois No. 6	01/09/94	476	Cagepactor motor grounded.
Illinois No. 6	01/10/94	4	Raw coal belt - MCC fault.
Illinois No. 6	01/11/94	188	Raw coal pump plugged.
Illinois No. 6	01/11/94	21	Raw coal chute plugged.
Illinois No. 6	01/11/94	123	Oversize in raw coal pump.
Illinois No. 6	01/12/94	71	Oversize in raw coal pump.
Illinois No. 6	01/12/94	109	Oversize in raw coal pump.
Illinois No. 6	01/12/94	80	Heavy-media pump failed.
Illinois No. 6	01/12/94	169	Oversize in raw coal pump
Illinois No. 6	01/14/94	85	Oversize in raw coal pump.

4.5 POC Results Summary

Investigators developed a very ambitious test plan for the POC operations that included a step-by-step approach that basically followed the coal through the POC plant. For each coal, the heavy-media cyclone was first tested to determine the lowest specific gravity at which this unit could be operated while maintaining a target performance level of 97 percent energy recovery. Next, while operating the heavy-media cyclone at this pre-determined specific gravity, the water-only cyclone configuration was varied in order to achieve the highest pyrite rejection consistent, again, with a performance target of 97 percent energy recovery.

The heavy-media cyclone and the water-only cyclone operations were then operated at those pre-determined operating parameters, and conventional froth flotation testing was initiated. For reasons previously discussed in Section 4.4, conventional froth flotation was eventually dropped from the POC process for all three coals. Subsequently, grinding circuit testing was completed followed by advanced froth flotation testing. Finally with the maximized process configuration defined by the above described testing, demonstration testing was completed at or near the end of each coal's testing period. Following are the results of these tests for each coal.

4.5.1 Pittsburgh No. 8 Seam Coal Testing

The Pittsburgh No. 8 seam coal was the primary testing coal used for POC operations. Because of the ambitious test plan established for POC operations, certain tests could only be performed with one coal and the results of these specific tests were used to guide investigators in the conduct of related work on the other two coals. The Pittsburgh No. 8 Seam was thus used to verify the heavy-media cyclone hardware configuration, the water-only cyclone vortex configuration, and the air rate, wash-water rate, and frother type related to the advanced froth flotation process. Also, the clean-coal hyperbaric filter and the refuse filter press were only tested on this coal.

Table 4.05 presents the average Pittsburgh No. 8 raw coal quality of samples extracted during POC operations.

Table 4.05
Pittsburgh No. 8 Seam Coal, Average Raw Coal Quality

Analysis	Basis of Analysis	
	As-Received	Dry
Moisture (%)	6.92	-
Ash (%)	37.80	40.61
Total Sulfur	2.76	2.97
Pyritic Sulfur	1.92	2.06
Btu Per Pound	7,675	8,246

Heavy-Media Cyclone

The heavy-media cyclone maximization was a relatively simple process since the cyclone performance was previously verified during OCDO test operations. The heavy-media cyclone performance is independent of the feed coal characteristics as long as operations are within solids throughput limitations. Tonnage throughputs during all POC operations were at the low end of these limits.

The investigators' goal was to operate the recirculating media at the lowest specific gravity that recovered 97 percent of the energy that was introduced into the heavy-media cyclone. Four different recirculating media specific gravities were tested on the Pittsburgh No. 8 seam coal. Table 4.06 presents the results of these heavy-media cyclone maximization tests. At a 1.70 specific gravity, the cyclone recovered 97 percent of the feed coal's energy. Significantly, 70 percent of the feed ash was rejected to the cyclone reject, and the clean coal ash was 11.2 percent. Based on these results, a 1.70 recirculating media specific gravity was used for all remaining Pittsburgh No. 8 seam coal POC operations. Figure 4.02 presents the performance curve for the heavy-media cyclone at a 1.70 recirculating media specific gravity.

Table 4.06
Pittsburgh No. 8 Seam Coal, Heavy-Media Cyclone Performance

Run Number	Specific Gravity	Energy Recovery (%)
93030803	1.70	97.0
93030804	1.75	97.8
93030805	1.80	98.9
93030806	1.85	98.2

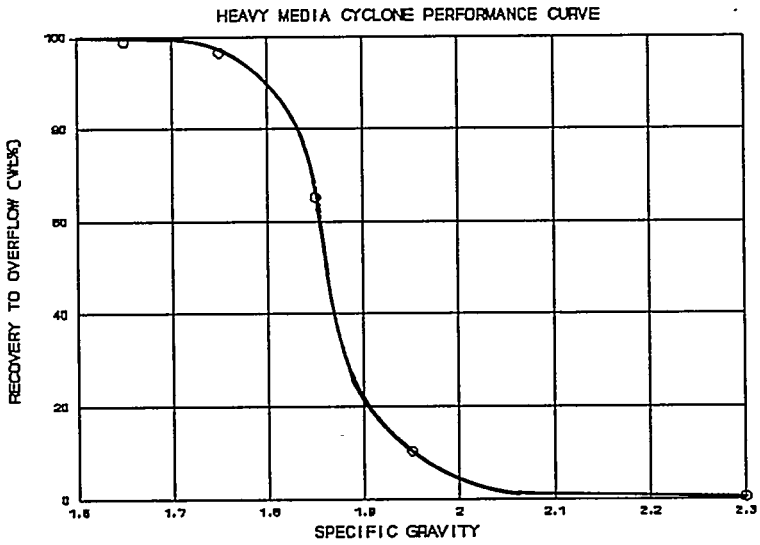


Figure 4.02 Pittsburgh No. 8 Seam Coal, Heavy-Media Cyclone Performance Curve

The Ep curve indicates excellent performance for the heavy-media cyclone and a high differential specific gravity, the difference between the recirculating and the separation specific gravities. While the low Ep of 0.03 was expected, the 0.18 differential specific gravity was somewhat surprising. The high differential explains the resulting high energy recovery that was achieved at the relatively low recirculating density. Based on these excellent results, investigators concluded that the existing cyclone hardware configuration would suffice for all three project coals.

Water-Only Cyclone

With the heavy-media cyclone recirculating media being controlled at a 1.70 specific gravity, the water-only cyclone was maximized next. The performance of a water-only cyclone can be varied by changing various cyclone hardware including the vortex finder length and diameter, the apex diameter, and the feed inlet size. For the Pittsburgh No. 8 seam coal, all except the feed inlet were varied in order to find the best combination of cyclone orifices. On the two subsequent base coals, only the apex diameter was varied.

Table 4.07 presents the cyclone configuration installed during the Pittsburgh No. 8 seam coal testing and select results for these configurations. Investigators targeted a 97 percent energy recovery for this unit operation. From these results, investigators selected the configuration installed during test 7 for the remainder of the Pittsburgh No. 8 seam coal testing. This configuration was selected due to the 98 percent energy recovery and the superior clean-coal ash result. The vortex installed during this test was used for all remaining POC operations.

Table 4.07
Pittsburgh No. 8 Seam Coal, Water-Only Cyclone Configurations and Performance Results

ID #	Run Number	Vortex Length (inch)	Vortex Diameter (inch)	Apex Diameter (inch)	Energy Recovery (%)	Clean Coal	
						Ash (%)	Total Sulfur (%)
1	93031002	7.0	3.0	1.0	98.0	20.0	2.64
2	93031701	14.0	2.5	1.0	89.6	17.6	2.80
3	93031901	10.5	3.0	1.0	99.9	21.3	2.94
4	93032201	14.0	2.5	1.0	49.1	19.4	2.48
5	93032202	14.0	2.5	1.0	*	19.7	2.56
6	93032302	7.0	3.0	1.0	77.6	17.0	2.67
7	93032501	7.0	3.0	0.625	98.0	15.8	2.93
8	93032502	7.0	3.0	0.050	*	17.6	2.81

* Yield determined by Ash balance greater than 100 percent, could not calculate

Figure 4.03 presents the water-only cyclone performance curve achieved with the selected cyclone configuration. The specific gravity of separation was 1.73 and the resulting Ep was 0.23. These were acceptable results and were consistent with general expectations of water-only cyclone performance on 48 mesh by zero sized material.

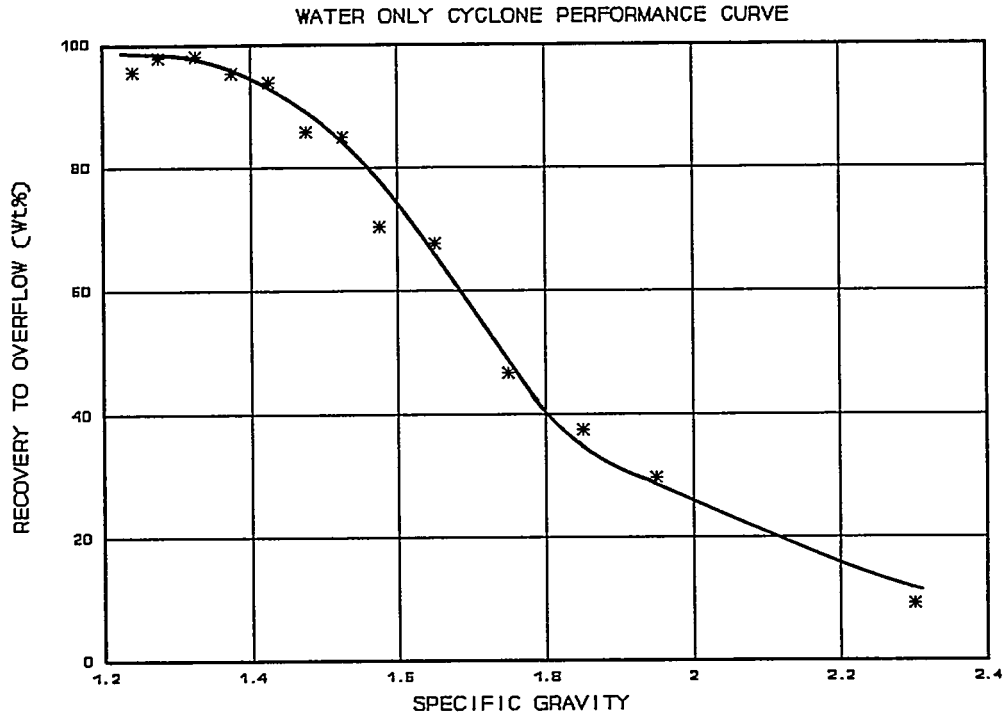


Figure 4.03 Water-Only Cyclone Performance Curve

Conventional Froth Flotation

From the bench-scale test results investigators concluded that split 48 mesh x 200 mesh/200 mesh x 0 froth flotation would be employed for all three coals in POC operations.

At the bench-scale, tests on the grab-and-run approach to conventional froth flotation on the Pittsburgh No. 8 seam coal were inconclusive, and investigators conducted POC scale tests in order to further investigate this possibility. Two runs were attempted, and the results are summarized in Table 4.08. In order to judge the success of grab-and-run flotation, investigators targeted a grab product quantity of 6 percent coal ash, which is consistent with the overall clean coal product quality target for this project. As you can see from the table, this ash level was not approached for the Pittsburgh No. 8 seam coal and thus the grab-and-run flotation approach was dropped from consideration.

Investigators next attempted to run rougher only conventional froth flotation in order to produce a middling product for further processing in the advanced grinding and flotation circuits, and a high ash refuse stream to be rejected from the process. Split flotation was again used and five tests were conducted. The results from these tests are summarized in

Table 4.09. On the 48 mesh x 200 mesh size fraction, investigators were successful in achieving the 97 percent energy recovery target in test number 4. Despite high flotation reagent dosages, however, this energy recovery target could not be realized on the 200 mesh x 0 size fraction. At this point in the test program, investigators re-evaluated the practicality of utilizing conventional froth flotation in this advanced process. Since the grab-and-run configuration was not successfully employed, and due to concerns that the high reagents dosages required in conventional froth flotation may affect downstream performance of the advanced column flotation cell, conventional flotation was dropped from further consideration for the Pittsburgh No. 8 seam coal. These and other problems with the conventional froth flotation operations of the POC were previously described in the POC operations summary section of this report.

Table 4.08
Pittsburgh No. 8 Seam Coal, Attempts At Grab-and-Run, Conventional Flotation

A Bank: 48 mesh x 200 mesh Size Fraction					
Run Number	Frother Dosage (ml/min)	Collector Dosage (ml/min)	Air Rate	Product Quality	
				Ash (%)	Sulfur (%)
93031001	1.8	2.3	Low	11.4	3.19
93031002	0.0	3.5	Low	10.1	3.45
B Bank: 200 mesh x 0 Size Fraction					
Run Number	Frother Dosage (ml/min)	Collector Dosage (ml/min)	Air Rate	Product Quality	
				Ash (%)	Sulfur (%)
93031001	1.8	2.3	Low	25.7	2.39
93031002	0.0	3.5	Low	20.1	2.26

Grinding Circuit

With the heavy-media cyclone and water-only cyclone operating at the predetermined conditions and the conventional froth flotation cells bypassed, investigators next attempted to maximize the grinding circuit configuration. During these tests, the mill classifying cyclone vortex and apex diameters, the mill cyclone inlet pressure, the mill circuit feedrate and the ball-mill charge were all varied. The detailed results from these tests are presented in Appendix B.

None of the variations that were tested were successful in achieving the target grind of 95 percent passing 200 mesh. Figure 4.04 presents the relationship between mill circuit feedrate and the product mean particle size. There was a strong relationship between these variables, unfortunately indicating that the target grind was only possible at very low ball-mill feedrates. This would, in turn, require a substantial reduction in the POC plant capacity. Investigators decided to maintain at least two tons-per-hour feed to the advanced column flotation unit.

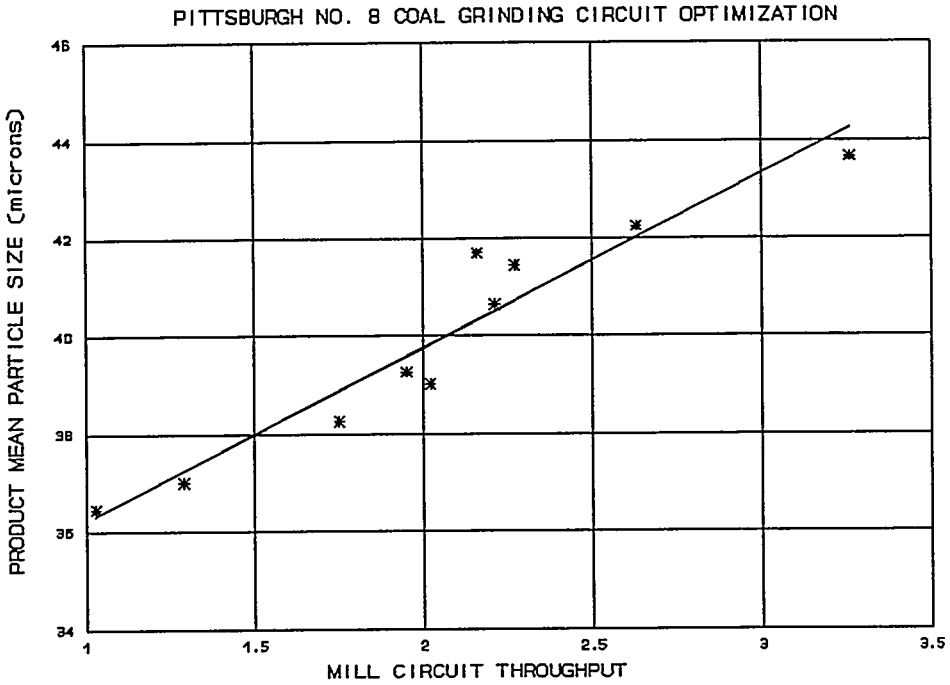


Figure 4.04 Pittsburgh No. 8 Seam Coal, Mill Circuit Performance

Table 4.09
Pittsburgh No. 8 Seam Coal, Conventional Single-Stage Froth Flotation Results

A Bank: 48 mesh x 200 mesh Size Fraction

Test I.D. #	Run Number	Frother Dosage (ml/min)	Collector Dosage (ml/min)	Energy Recovery (%)	Clean Coal	
					Ash (%)	Sulfur (%)
1	93032201	5.2	20	60.0	11.4	3.03
2	93032202	5.2	30	63.0	10.4	2.95
3	93032302	5.2	41	95.6	9.7	2.88
4	93032501	2.5	30	98.2	10.4	3.18
5	93032503	2.5	30	96.6	9.5	2.96

B Bank: 200 mesh x 0 Size Fraction

Test I.D. #	Run Number	Frother Dosage (ml/min)	Collector Dosage (ml/min)	Energy Recovery (%)	Clean Coal	
					Ash (%)	Sulfur (%)
1	93032201	5.2	15	33.5	26.2	2.02
2	93032202	5.2	20	60.7	30.2	2.08
3	93032302	5.2	60	89.9	24.2	2.42
4	93032501	2.5	40	55.8	15.0	2.00
5	93032503	5.0	40	84.3	18.3	1.96

Table 4.10 presents the circuit configuration selected for subsequent POC testing. The cyclone configuration was maintained for the remainder of POC operations with all three test coals.

Table 4.10
Pittsburgh No. 8 Seam Coal, Best Mill Classifying Cyclone Configuration

Vortex Diameter (inches)	1¼
Apex Diameter (inches)	5/8
Cyclone Feed Pressure (psig)	36

Advanced Froth Flotation

Investigators determined that the critical operating variables that should be evaluated during POC operations were: feed rate, aeration rate, frother rate, wash-water rate, frother type, and collector rate. In order to find the best conditions at which to operate the column flotation unit, a 16-point, resolution IV fractional factorial experiment was designed to evaluate the major interactions between these six variables. This factorial test matrix was used to determine the best conditions for aeration rate, wash-water rate, and frother type during the Pittsburgh No. 8 coal testing. These identified conditions would then become standard for all remaining column testing during POC operations including that of the two subsequent coals.

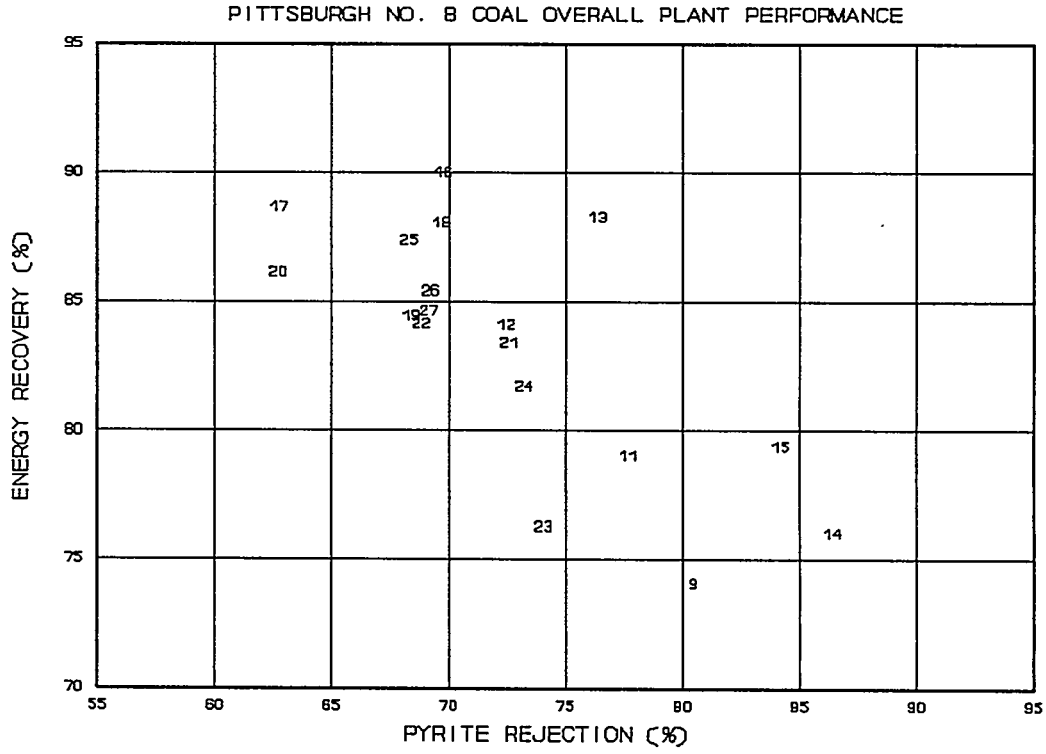


Figure 4.05 Pittsburgh No. 8 Seam Coal, Column Flotation Factorial Matrix Results

While conducting the factorial matrix, samples were collected such that total plant performance could be evaluated. All data from the factorial matrix and the subsequent Box-Behnken test matrices were metallurgically balanced using the commercially available Bilmat Material Balance program developed by the Canadian Center for Mineral and Energy Technology. Figure 4.05 presents the energy recovery versus pyrite rejection relation ship for the overall plant. Complete test data for these tests may be found in Appendix B. Test points number 16 and 13 on the figure were considered suspect as major data adjustments were required to balance the data set. Of the remaining tests, test number 18 appeared to result in the best balance between energy recovery and pyrite rejection. Table 4.11 presents the conditions at which test 18 was conducted.

Table 4.11
Pittsburgh No. 8 Seam Coal, Best Operating Region Based on Factorial Matrix Results

Column Cell Feed Rate (TPH)	4
Aeration Rate (SCFM)	140
Frother Rate #/ton	1.4
Wash-water Rate (GPM)	130
Frother Type	MIBC
Collector Rate #/TON	0.5

Based on the results of the factional matrix testing, investigators concluded that MIBC frother reagent should be used throughout the remainder of POC operations and an aeration rate of 140 SCFM should be maintained. While test 18 utilized a wash-water rate of 130 gallons per minute, investigators observed generally slight performance changes between this level and 40 gallons per minute. Therefore, a rate of 100 gallons per minute was used for the remainder of POC operations. With these three parameters set for the remainder of POC operations, including the next two coals, a second experiment was designed to determine the best operating levels for frother rate, collector rate, and feed rate.

Statistical analyses of the test data obtained during the factorial matrix was carried out using a commercially available software package from the Stat-Ease Corporation known as Design-Expert. This program was subsequently used to design the Box-Behnken test matrix for the Pittsburgh No. 8 coal. In this second, statistically-designed test matrix, column feed rate, frother rate and collector rate were each varied at three levels. All other operating variables were held constant during these tests. Table 4.12 presents the Box-Behnken test matrix experimental conditions. The statistical matrix design program suggested that three tons-per-hour should be the center point for feed rate. Due to concerns of poor mill grind, however, investigators modified this variable's center point to two tons-per-hour as shown in the table. This would allow a finer coal grind and, subsequently, increased pyrite liberation.

Table 4.12
Pittsburgh No. 8 Coal, Box-Behnken Text Matrix

Run Number	Column Feed Rate (tph)	Collector Dosage (lb/ton)	Frother Dosage (lb/ton)
1	1.0	1.00	1.12
2	2.0	0.50	1.92
3	2.0	1.50	1.12
4	3.0	1.50	1.52
5	3.0	1.00	1.12
6	2.0	1.00	1.52
7	1.0	1.00	1.92
8	2.0	1.00	1.52
9	1.0	1.50	1.52
10	1.0	0.50	1.52
11	3.0	0.50	1.52
12	2.0	1.50	1.92
13	3.0	1.00	1.92
14	2.0	0.50	1.12
15	2.0	1.00	1.52

With other unit operations operating at the best predetermined conditions, the Box-Behnken matrix was implemented for the Pittsburgh No. 8 seam coal in the advanced froth flotation cell. During these tests, sampling was conducted throughout the plant so that performance of each major circuit and overall plant performance could be evaluated. All test runs were performed in random order to minimize experimental bias. Several replicate tests were also conducted to provide a check on the reproducibility of test procedures and assay determinations.

In order to obtain a fully consistent data set prior to statistical analyses, analytical data were evaluated and adjusted using the BILMAT material balance program.

Figure 4.06 shows the energy recoveries as a function of ash rejection, pyritic sulfur rejection, and total sulfur rejection for the column flotation cell. Complete data for these tests appear in Appendix B. Although the flotation tests were conducted over a wide range of operating conditions, most of the experimental data points were found to fall within a single grouping of data. These results indicate that several different combinations of operating parameters can be used to achieve the same level of separation performance. This implies that other factors (e.g., column capacity, operating cost, maintenance considerations, etc.) should be used to select the preferred column operating point. In any case, the Box-Behnken test data indicate that a clean coal concentrate can be readily obtained at a 75 percent ash rejection, 35 percent pyritic sulfur rejection and 95 percent energy recovery.

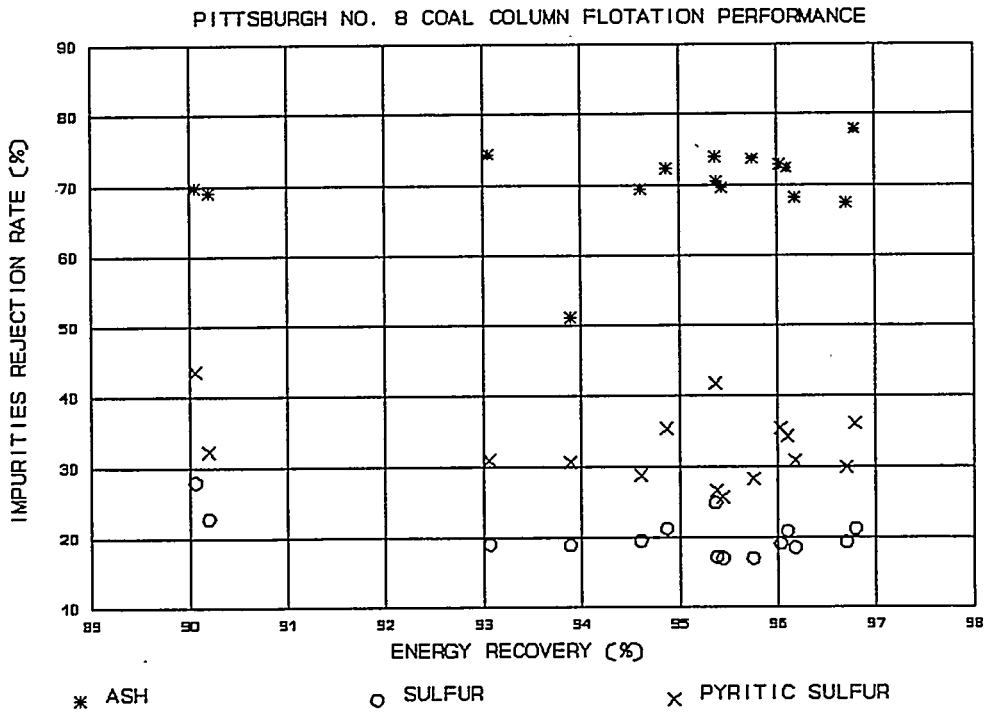


Figure 4.06 Pittsburgh No. 8 Seam Coal, Box-Behnken Matrix Results

For mathematical modeling purposes, the test levels for each variable were coded as -1, 0 and +1 to represent the lower, middle and upper settings. The coded factors were obtained using the expression:

Coded Factor = 2 [Uncoded Value - Middle Value] / [Upper value - Lower Value]

For example, feed rate settings of 1, 2 and 3 TPH would be represented by the following coded factors using this nomenclature system.

Low = 2 [1-2] / [3-1] = -1
Middle = 2 [2-2] / [3-1] = 0
Upper = 2 [3-2] / [3-1] = +1

Bilmat-adjusted data sets were input into the Design-Expert software package. The first step in the statistical analyses involved the development of empirical relationships between the column operating parameters and column response (e.g., energy recovery, ash rejection, pyritic sulfur rejection). Only quadratic or linear models were selected since they reduced model complexity and generally provided good correlations. In general, the fitting coefficients obtained from the linear regression models were found to be statistically more significant than those obtained using the quadratic models. The linear coefficients tended to provide a better indication of the overall magnitude of the influence of each test variable on column performance; however, as indicated by higher correlation coefficients, the quadratic regression model typically provided a better overall fit to the experimental data. For this reason, the quadratic expression was deemed to be the most appropriate model for constructing the response surface plots.

Full details of the statistical analysis of the column flotation matrices for all three coals is presented in the Task 14 Report[4] related to this project. The coefficients for the linear regression model are summarized for the Pittsburgh No. 8 coal in Table 4.13. These coefficients have been reported in terms of coded factors so that their magnitudes can be easily compared. According to these data, energy recovery was found to increase with feed rate, frother dosage and collector dosage. Ash rejection increased with feed rate and collector dosage, but decreased with frother dosage. In contrast, pyritic sulfur rejection increased with frother dosage, and decreased with feed rate and collector dosage. These results indicate that changes in feed solids rate had the largest impact on energy recovery, ash rejection and pyritic sulfur rejection.

Table 4.13
Pittsburgh No. 8 Seam Coal, Coded Coefficients for the Linear Regression Model

Test Variable	Units	Low Value	High Value	Energy Recovery	Ash Rejection	Pyritic Rejection
Main	***	***	***	+94.695	+70.23	+32.68
Feed Rate	tph	1.0	3.0	+1.516	+3.28	-2.68
Frother	lb/ton	1.12	1.92	+0.389	-1.04	+1.17
Collector	lb/ton	0.50	1.50	+1.055	+0.26	-1.49

The next step in the statistical analysis involved the development of quadratic regression models relating energy recovery, ash rejection and pyritic sulfur rejection as functions of the independent variables of the Box-Behnken test matrix. These expressions are presented below.

Energy Recovery = $72.743 + 12.449\,(\text{Feed Rate}) + 7.4415\,(\text{Frother}) + 3.8987\,(\text{Collector}) - 1.7746\,(\text{Feed Rate})^2 - 2.8724\,(\text{Frother})^2 - 1.6483\,(\text{Collector})^2 - 0.94375\,(\text{Feed Rate})\,(\text{Frother}) - 2.4000\,(\text{Feed Rate})\,(\text{Collector}) + 4.1500\,(\text{Frother})\,(\text{Collector})$

Ash Rejection = $118.56 - 12.537\,(\text{Feed Rate}) - 33.651\,(\text{Frother}) - 27.167\,(\text{Collector}) - 1.5775\,(\text{Feed Rate})^2 + 0.56250\,(\text{Frother})^2 + 19.520\,(\text{Collector})^2 + 16.481\,(\text{Feed Rate})\,(\text{Frother}) - 2.9250\,(\text{Feed Rate})\,(\text{Collector}) - 3.6250\,(\text{Frother})\,(\text{Collector})$

Pyritic Rejection = $84.19 - 23.411\,(\text{Feed Rate}) - 7.3731\,(\text{Frother}) - 48.838\,(\text{Collector}) + 3.8787\,(\text{Feed Rate})^2 - 4.6172\,(\text{Frother})^2 + 16.465\,(\text{Collector})^2 + 5.6750\,(\text{Feed Rate})\,(\text{Frother}) - 3.4100\,(\text{Feed Rate})\,(\text{Collector}) + 12.988\,(\text{Frother})\,(\text{Collector})$

In these expressions, feed solids rate is reported in units of TPH and the dosages of collector and frother are given in units of lb/ton. As compared to the linear regression models, these quadratic expressions tended to provide a much better fit between the predicted responses and the experimentally-measured responses.

From the quadratic models, three separate response-surface plots were constructed for each of the dependent variables, representing feed rates of 1.0, 2.0 and 3.0 TPH. These plots are presented in Appendix B. At the lowest feed rate, an increase in either frother or collector dosage increased the energy recovery. The increase in recovery with increasing collector dosage can be attributed to an enhancement in coal hydrophobicity produced by the collector adsorption. The increase in recovery with frother dosage can be attributed to either (i) a decrease in bubble size which improved the flotation kinetics or (ii) an increase in froth stability which improved the ability of the column to carry particles into the froth launder. However, as the feed rate increased from 1.0 to 3.0 TPH, the energy recovery actually increased and became relatively insensitive to changes in reagent conditions. Since higher feed rates typically reduce coal recovery, other phenomena are believed to be responsible for the increase in recovery with increasing feed rate. It is possible that the higher feed rates to the grinding circuit resulted in a slightly coarser grind size which responded better to froth flotation. Unfortunately, no particle size measurements were taken during the parametric study to evaluate this possibility.

Response surface plots for ash rejection and pyritic sulfur rejection obtained during the parametric testing indicates that the relationship between column response and the various operating parameters is non-linear and very complex. In general, the best overall rejections of mineral matter were typically obtained at the highest and lowest collector dosages. These trends appear to contradict previous work which indicated that high collector dosages would be detrimental to pyrite rejection. The data also indicate that mineral matter rejection increased with frother dosage, particularly at the highest feed rate of 3.0 TPH. This trend became much less pronounced at the middle feed rate of 2.0 TPH, and nearly disappeared (or reversed slightly) at the lowest feed rate of 1.0 TPH. An increase in either the frother or collector dosage would normally increase the coal recovery and decrease the overall rejection of mineral matter. Unfortunately, no direct correlation could be established in the present work between energy recovery and the rejections of ash and pyritic sulfur for the Pittsburgh No. 8 coal. An explanation for these unexpected trends could not be found.

The project team assembled at the POC facility in order to discuss the results from the Box-Behnken experiment and to establish the operating conditions for the 24-hour demonstration run. Table 4.14 presents the teams recommendation, which was subsequently implemented. Gas holdup was substituted for frother dose as a controlled variable for the Pittsburgh No. 8 demonstration run.

Table 4.14
Pittsburgh No. 8 Seam Coal, Column Operating Conditions Established for the Demonstration Run

Plant Feed Rate (tph)	Column Feed Rate (tph)	Collector Dosage (lb/ton)	Gas Hold-up Rate (%)
3.1	2.0	1.0	24

Gas holdup is the fraction of the volume between two different levels in the column cell that is comprised of air. Gas holdup is a function of the

physical characteristics of the slurry (which may be simplified to percent solids for all practical purposes in column cell applications), the gas rate, and bubble size. If the gas rate and the slurry characteristics remain constant, gas holdup is directly proportional to frother dosage. Investigators decided, immediately prior to the Pittsburgh No. 8 coal 24-hour demonstration run, to control gas holdup rather than frother dosage in the column cell. This was admittedly a risk since both column flotation test matrices varied frother dosage rather than gas holdup rate. Investigators felt, however, that since some difficulty in maintaining consistent frother rates had been experienced during the column cell testing, column flotation performance may be more consistent by controlling gas holdup in an automated, closed-loop control scheme. This was judged a good alterative to simply setting a single frother pump speed, and then assuming that frother addition, on a pounds per ton basis, would remain constant.

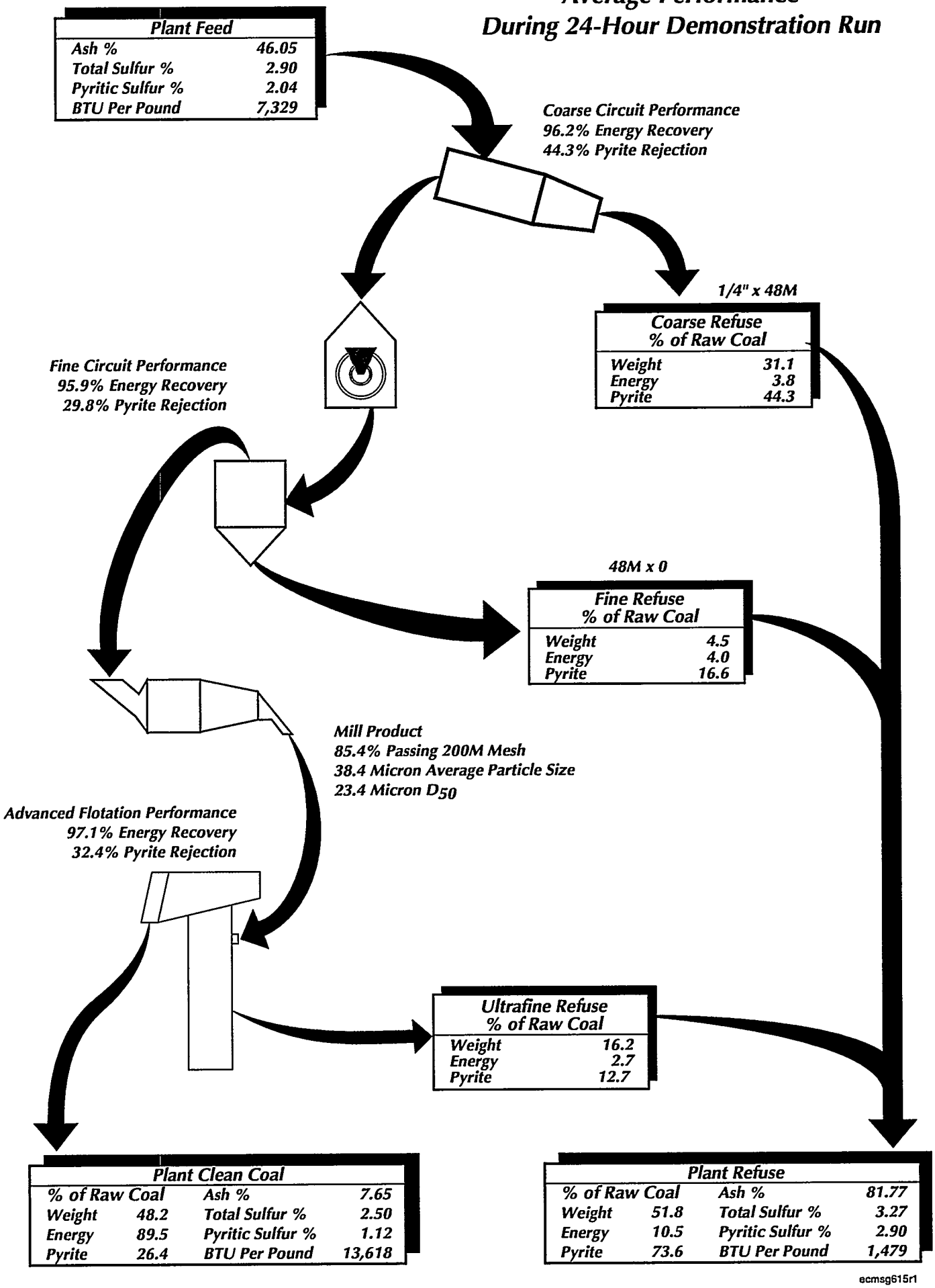
24-Hour Demonstration Run

After completing the Box-Behnken experiments on the key operating parameters of the column flotation operation, investigators had all the information required in order to configure the POC for the 24-hour demonstration tests. For the Pittsburgh No. 8 seam coal, the plant was operated continuously for two 4-day periods separated by a 3-day weekend. Sampling periods for the demonstration tests were eight hours long and three samples were collected each day. Thus, over the eight days of operation 24 complete sets of data were obtained. Each set of data included the information necessary to verify the performance of each coal cleaning device as well as the total plant performance. Detailed logs were taken in order to account for any plant downtime so that plant availability could be assessed. All equipment was configured and all variables were set at the maximum values as described previously in this section.

The analytical data from the demonstration tests were entered into the Bilmat Material Balance program in order to establish an estimated material balance for each test and an average for the entire eight day period. This program adjusted the values of all analytical results in order to arrive at a strict metallurgical balance for all measured parameters. For the Pittsburgh No. 8 seam coal, only small ash value adjustments were made, on average, for all measured process streams except for the column flotation feed. This average value was reduced by eight percent. All other ash values were adjusted, on average, by two percent or less. This indicates a very good fit of the ash data and investigators thus feel confident in the final results.

Figure 4.07 presents the Bilmat-adjusted data for the average of all 24 sampling periods. Data for each of the test periods are provided in Appendix B. The coarse and fine gravity-based coal cleaning circuits performed as expected with energy recoveries of 96.2 and 95.9 percent. Pyrite rejection in the coarse cleaning circuit was 44.3 percent while 29.8 percent pyrite rejection was achieved in the fine-cleaning circuit. The average grind for the mill-circuit feed and product samples are shown graphically in Figure 4.08. Similar data for all 24 test periods are presented in Appendix B. The mill circuit feed sample had a mean particle size of 193 microns and a D_{50} of 161 microns. The mill-circuit product

Figure 4.07
Pittsburgh No. 8 Seam Coal
Average Performance
During 24-Hour Demonstration Run



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particle size averaged 85 percent passing 200 mesh with a D_{50} of 23 microns.

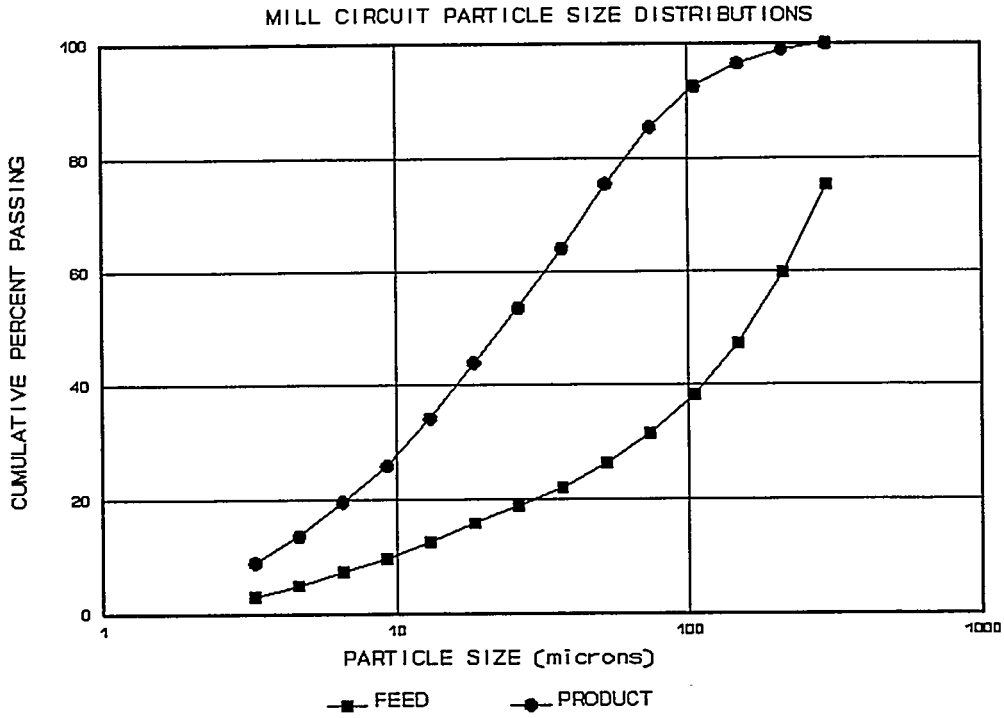


Figure 4.08 Pittsburgh No. 8 Seam Coal, Average Mill Circuit Feed and Product Size

The energy recovery in the advanced column flotation cell was 97.1 percent and 32.4 percent of the pyrite was rejected. Overall, the plant recovered 89.5 percent of the raw coal's energy and rejected 73.6 percent of the pyritic sulfur of the raw coal. This performance obviously does not meet the target of 85 percent energy recovery, 85 percent pyrite rejection. Contributing to the non-performance was the coarser grind from the ball-mill circuit. Also, it is obvious that, had the energy recovery been lowered to the target of 85 percent, more pyrite would have been rejected. In fact, by throwing away 5 percent of the raw coal, energy recovery would drop to 85 percent, and pyrite rejection would increase to 74.9 percent. This would be an inefficient way of removing sulfur, compared with lowering the specific gravity of the heavy-media cyclone circuit for instance. It follows then, that at the target energy recovery of 85 percent, at least 74.9 percent pyrite rejection can be achieved. Unfortunately, this still does not meet the project target.

Table 4.15 compares the basic performance targets established for this project and the results achieved for the Pittsburgh No. 8 seam coal. Energy recovery was the only parameter for which the target was achieved. Laboratory grinding and froth flotations results (Table 3.06) indicated that finer mill-circuit grind will likely improve the pyritic sulfur rejection results and the product ash. It is not likely, however, that the project goals would have been reached even if the target coal grind had been achieved. In order to reach the targets for the Pittsburgh No. 8 seam coal, it may be necessary to grind to 325 mesh or finer.

Unfortunately, though investigators had hoped to attempt a 325 mesh grind during this project, the mill circuit purchased for the POC operation could not achieve this grind, and this part of the project was not carried out.

Operation of a hyperbaric disk filter during the Pittsburgh No. 8 seam phase of the POC operations indicated that the clean-coal product moisture target of 30 percent may be attainable. The hyperbaric filter produced a clean-coal cake with moisture values ranging between 25 percent and 30 percent. Unfortunately, operating problems with this system would not allow continuous operation and also required excessive manpower to maintain and operate the filter. For these reasons, the operation of the hyperbaric disk filter was abandoned before any demonstration runs were initiated. The clean-coal moisture in Table 4.15 resulted from the operation of the high-g centrifuge, which is not recommended for the final Semi-Works plant design.

Table 4.15
Pittsburgh No. 8 Seam Coal, Demonstration Run Project Goals Versus Average Results

	TARGET	ACTUAL (AVERAGE)
Energy Recovery (%)	85	89.5 (85[1])
Pyritic Sulfur Rejection (%)	85	73.5 (74.9[1])
Clean-Coal Ash (%)	6	7.7
Clean-Coal Moisture (%) - dry basis	30	36.4
Refuse Moisture (%)	35	10.0[2]

[1] By rejecting 5 percent of the raw coal, these results would be achieved.

[2] Plus 48 mesh refuse only; minus 48 mesh refuse was slurried to impoundment.

The reject moisture presented on Table 4.15 is that of the coarse heavy-media cyclone reject only. The 48 mesh x 0 refuse streams reported to the refuse thickener and the thickener underflow was pumped to the thickener of a nearby coal cleaning plant. As previously stated, the belt press designed to dewater the refuse and allow a closed-water circuit could not be operated due to the high chemical dosages required. The flocculants used were interfering with the advanced column flotation performance, and the operation was subsequently abandoned for the POC operations as well as the Semi-Works plant design.

4.5.2 Upper Freeport Seam Coal Testing

The Upper Freeport seam coal was the second coal tested at the POC. The coal was received from Camelot Coal Company of Somerset County, Pennsylvania. Because of a mine closing, the Upper Freeport seam coal that was used for bench-scale testing was not available at the time of POC testing.

Table 4.16 presents the average raw coal quality for samples extracted during POC testing. Results from unit operations and plant performance testing follows.

Table 4.16
Upper Freeport Seam Coal, Average Raw Coal Quality

Analysis	Basis of Analysis	
	As-Received	Dry
Moisture (%)	8.16	---
Ash (%)	21.51	23.42
Total Sulfur (%)	4.11	4.47
Pyritic Sulfur (%)	2.78	3.03
Btu Per Pound	10,262	11,174

Heavy-Media Cyclone

Four tests were conducted on the heavy-media cyclone at specific gravities ranging from 1.70 to 1.85. Table 4.17 presents the results from this work. The data indicates that a 1.75 specific gravity will result in greater than 97 percent energy recovery, the goal for the unit operation. This specific gravity was used for all remaining Upper Freeport seam testing.

Table 4.17
Upper Freeport Seam Coal, Heavy-Media Cyclone Performance

Run Number	Specific Gravity	Energy Recovery (%)
93092301	1.70	96.2
93092302	1.75	99.1
93092303	1.80	99.7
93092304	1.85	97.6

Water-Only Cyclone

The water-only cyclone vortex finder configuration was determined during Pittsburgh No. 8 seam testing. Two tests were conducted on the water-only cyclone during Upper Freeport seam testing in order to determine the proper apex diameter. Table 4.18 presents the results from these tests. Using a 3/4" diameter apex resulted in a 97.8 percent energy recovery on the Upper Freeport seam coal, and this apex was used for the remainder of testing on this coal. The lower energy recovery found in the test using a 5/8-inch apex could not be explained.

Table 4.18
Upper Freeport Seam Coal, Water-Only Cyclone Configurations and Performance Results

Run Number	Vortex Length (inches)	Vortex Diameter (inches)	Apex Diameter (inches)	Energy Recovery (%)
93100402	7.0	3.0	5/8"	88.5
93100401	7.0	3.0	3/4"	97.8

Conventional Froth Flotation

Bench-scale testing indicated that, for the Upper Freeport seam coal, a 48 mesh x 0 plant clean coal may be possible. At the POC level, investigators set a target for the success of the grab-and-run conventional flotation of 6 percent clean coal ash of the grab product. This value matches the overall clean coal product ash goal.

Table 4.19 presents the results of testing the grab-and-run circuit on the Upper Freeport seam coal. The 48 mesh x 200 mesh size fraction was cleaned in the "A" bank of flotation cells and the 200 mesh x 0 size fraction was cleaned in the "B" bank. Data for the coarser size fraction indicate that a 6 percent clean coal ash could not be produced. For the fine, 200 mesh x 0 size fraction, similar flotation conditions resulted in a 8 percent product ash during one test and a 5 percent product ash during the second test. With no good explanation for this changing performance, investigators decided that the grab-and-run, conventional flotation philosophy would not be employed for the Upper Freeport seam coal.

Table 4.19
Upper Freeport Seam Coal, Attempts at Grab-and-Run, Conventional Flotation

A Bank: 48 mesh x 200 mesh Size Fraction					
Run Number	Frother Dosage (ml/min)	Collector Dosage (ml/min)	Air Rate	Grab Product Quality	
				Ash (%)	Sulfur (%)
93092901	1.3	0	Low	9.2	3.01
93092902	0.9	0	Low	9.8	2.79
B Bank: 200 mesh x 0 Size Fraction					
Run Number	Frother Dosage (ml/min)	Collector Dosage (ml/min)	Air Rate	Grab Product Quality	
				Ash (%)	Sulfur (%)
93092901	0.3	0	Low	8.0	3.39
93092902	0.3	0	Low	5.1	1.83

With this decided, one more conventional flotation test was conducted in order to determine the results when attempting to maximize energy recovery for the Upper Freeport seam coal. Again, split flotation was employed. Table 4.20 presents the results from this test. For the coarse size fraction, the target energy recovery could not be achieved. The target of 97 percent energy recovery was achieved for the 200 mesh x 0 size fraction, but the frother dosages applied during this test affected the control of the column flotation cell. Excess froth was being produced in the column cell even though no reagents were being added. Conventional flotation was thus eliminated for this coal.

Table 4.20
Upper Freeport Seam Coal, Conventional Single-Stage Froth Flotation Results

A BANK: 48 mesh x 200 mesh Size Fraction					
Run Number	Frother Dose (ml/min)	Collection Dose (ml/min)	Energy Recovery (%)	Clean Coal	
				Ash (%)	Sulfur (%)
93092303	9.8	6.5	88.0	12.31	2.80
B BANK: 200 mesh x 0 Size Fraction					
Run Number	Frother Dose (ml/min)	Collection Dose (ml/min)	Energy Recovery (%)	Clean Coal	
				Ash (%)	Sulfur (%)
93092303	6.5	4.0	99.9	16.19	2.0

Grind Circuit Testing

With the heavy-media cyclone and the water-only cyclone operating at the pre-determined conditions, and the conventional flotation cells bypassed, eight tests were next conducted on the grinding circuit. Feedrate to the grinding circuit was varied during these tests by changing the plant feedrate and holding all other conditions constant. During one test, the ball-mill speed was reduced to 18 rpm as compared to nearly 28 rpm during all other tests. Figure 4.09 compares the mill circuit throughput and the grinding circuit product mean particle size. Complete microtrac data for the mill product sample is presented in Appendix B. As expected, there is a very strong relationship between the two parameters: increased mill

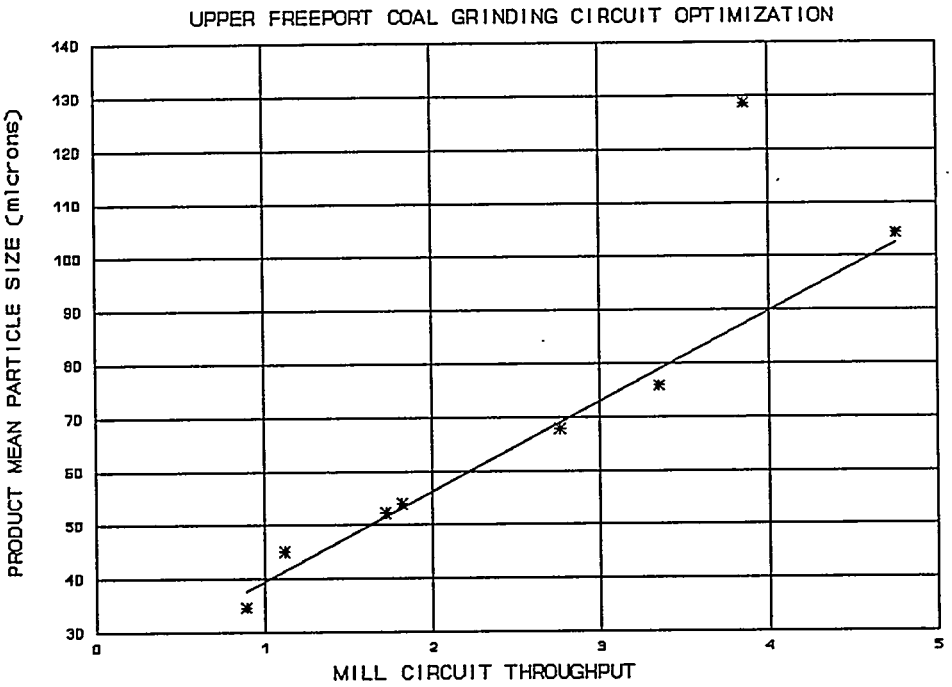


Figure 4.09 Upper Freeport Seam Coal, Mill Circuit Performance

throughput increased the product particle size. The speed change did not affect this relationship, though the higher speed was maintained during the remainder of POC testing, in order to maintain consistency between the coals.

Unfortunately, as with the Pittsburgh No. 8 seam coal, the target grind for the project was not achieved at even the lowest tested circuit throughput rate. With only 0.9 TPH throughput, the circuit produced a product of 89 percent passing 200 mesh as compared to a target of 95 percent. Again, investigators were presented with a dilemma: either the target grind had to be relaxed or the POC would have to be operated at very low throughput, compromising the target of 2 tons-per-hour plant production rate. Since the economics of the circuit could be greatly affected by the production rate, investigators decided not to substantially decrease column feedrate targets in order to improve grinding performance.

Advanced Column Flotation

A Box-Behnken test matrix was established for the Upper Freeport seam coal varying the column flotation feedrate, the collector dosage, and the air gas holdup rate. Gas holdup rate is the measure of the air volume present between two levels in the column, and, for a specific input air volume is related directly to the frother dosage. Frother dosage is increased to increase gas holdup.

The Box-Behnken test matrix for the Upper Freeport coal is given in Table 4.21. Appendix B provides a summary of the test data, operating conditions and performance calculations for this series of tests.

Figure 4.10 presents the relationship between energy recovery and ash and pyritic sulfur rejection for the advanced column flotation unit. All of the data points fall along unique grade-recovery curves that represent the tradeoff between energy recovery and product quality. Maximum separation efficiencies were found to occur at about 90 percent energy recovery, where ash and pyritic sulfur rejection rates of 50 percent and 38 percent can be expected. A number of test points fall in this area, indicating that the test matrix conditions were centered in the region most likely to produce maximum column flotation performance. Also, various combinations of the variables can result in similar performance so some economic considerations can be accounted for in deciding the best operating conditions for the variables.

In the same manner as that described previously in the "Advanced Froth Flotation" section of 4.5.1 (Pittsburgh No. 8 coal), statistical analysis of the Upper Freeport coal flotation data resulted in the development of both linear and quadratic regression models. The coded efficients for the linear regression model are provided in Table 4.22. In this case, energy recovery was found to decrease with increasing feed rate, and increase with increasing air holdup and collector dosage. Ash rejection increased with feed rate, and decreased with air holdup and collector dosage. Pyritic sulfur rejection followed the same trend. The statistical analyses also indicate that air holdup is the dominant factor controlling column recovery, ash rejection and pyritic sulfur rejection. In contrast

to the Pittsburgh No. 8 results, feed solids rate was found to have only a small impact on column performance for this particular coal.

Table 4.21
Upper Freeport Coal, Box-Behnken Text Matrix

Run Number	Feed Rate (tph)	Collector Dosage (lb/ton)	Air Holdup (%)
1	2.50	0.20	18
2	2.50	1.00	24
3	1.00	0.60	24
4	1.00	0.20	21
5	1.00	0.60	18
6	1.00	1.00	21
7	4.00	0.60	18
8	2.50	0.20	18
9	2.50	1.00	24
10	2.50	0.20	24
11	2.50	0.60	21
12	2.50	1.00	18
13	2.50	0.20	18
14	2.50	1.00	24
15	2.50	0.20	24
16	2.50	0.60	21
17	4.00	0.20	21
18	4.00	1.00	21
19	2.50	1.00	28
20	2.50	0.60	21
21	4.00	0.60	24

The general trends observed for upgrading of the Upper Freeport coal are in good agreement with those typically observed for the column flotation of fine coal. For example, an increase in feed solids rate generally produces a lower coal recovery because of inadequate bubble surface area for the attachment of hydrophobic particles. This also improves the quality of clean coal since middlings particles containing mineral matter are less likely to attach under these conditions. Likewise, an increase in air holdup typically enhances coal recovery by increasing the availability of bubble surface area. This also lowers the quality of the clean coal because of the increased likelihood that middlings particles would also be collected. An increase in collector dosage also enhances the collection of middling particles, leading to an improved coal recovery and poorer clean coal quality. These phenomena are responsible for the trade-off between energy recovery and product quality observed in Figure 4.10.

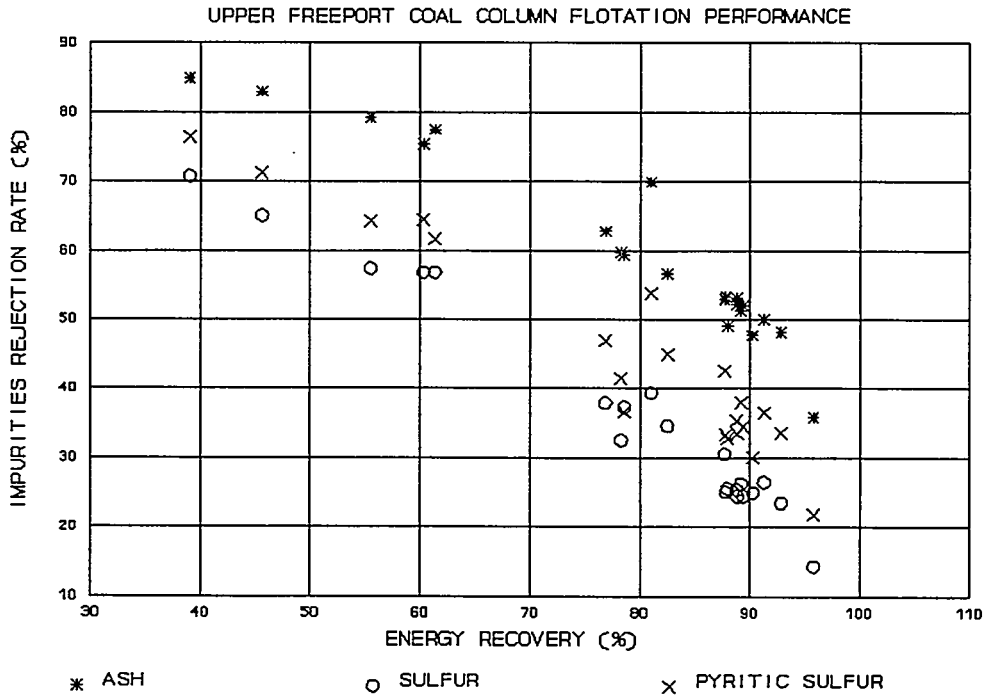


Figure 4.10 Upper Freeport Seam Coal, Box-Behnken Matrix Results

Table 4.22
Upper Freeport Seam Coal, Coded Coefficients for the Linear Regression Model

Test Variable	Units	Low Value	High Value	Energy Recovery	Ash Rejection	Pyritic Rejection
Main	***	***	***	+78.53	+59.71	+44.48
Feed Rate	tph	1.0	4.0	-3.28	+2.22	+0.46
Air Holdup	%	18	24	+13.84	-12.62	-13.14
Collector	lb/ton	0.20	1.00	+6.22	-4.98	-6.72

Response surface plots for the Upper Freeport coal were constructed using the quadratic regression models and are presented in Appendix B. Separate plots were constructed for predicting energy recovery, ash rejection and pyritic sulfur rejection as functions of collector dosage, air holdup and feed rate. The quadratic expressions are given by:

Energy Recovery = $-604.67 - 5.1711\,(\text{Feed Rate}) + 59.520\,(\text{Air Holdup}) + 69.211\,(\text{Collector}) - 1.2128\,(\text{Feed Rate})^2 - 1.2674\,(\text{Air Holdup})^2 + 25.242\,(\text{Collector})^2 + 0.36000\,(\text{Feed Rate})\,(\text{Air Holdup}) + 2.4833\,(\text{Feed Rate})\,(\text{Collector}) - 4.2938\,(\text{Air Holdup})\,(\text{Collector})$

Ash Rejection = $568.69 - 1.6964\,(\text{Feed Rate}) - 44.244\,(\text{Air Holdup}) - 1.7203\,(\text{Collector}) + 0.75778\,(\text{Feed Rate})^2 + 0.94102\,(\text{Air Holdup})^2 - 19.755\,(\text{Collector})^2 + 1.389\times10^{-2}\,(\text{Feed Rate})\,(\text{Air Holdup}) - 1.5042\,(\text{Feed Rate})\,(\text{Collector}) + 0.79722\,(\text{Air Holdup})\,(\text{Collector})$

$$\text{Pyritic Rejection} = 575.03 + 3.1976\,(\text{Feed Rate}) - 45.484\,(\text{Air Holdup}) - 35.623\,(\text{Collector}) + 0.94898\,(\text{Feed Rate})^2 + 0.96544\,(\text{Air Holdup})^2 - 23.335\,(\text{Collector})^2 - 0.33833\,(\text{Feed Rate})\,(\text{Air Holdup}) - 0.88333\,(\text{Feed Rate})\,(\text{Collector}) + 2.3344\,(\text{Air Holdup})\,(\text{Collector})$$

where feed solids rate is reported in units of TPH, collector dosage in units of lb/ton, and air holdup is reported as a percentage. In general, the quadratic expressions provided a much better fit to the experimental data than the linear models.

Response surface plots were constructed for feed rates of 1.0, 2.5 and 4.0 TPH. In general, the observed trends are consistent with those predicted by the linear regression model. An increase in air holdup sharply increased coal recovery due to the increased availability of bubble surface area passing through the column. The impact of air holdup was most notable at the higher feed rates where the increased population of floatable particles tended to overload the carrying capacity of the air bubbles. An increase in collector dosage also improved coal recovery, particularly when the air holdup was low. The increase in recovery with increasing dosage can be attributed to an enhancement in coal hydrophobicity produced by the collector adsorption. However, collector dosage had a smaller effect on column performance than air holdup. This implies that aeration rate and frother dosage (the main factors which control the air holdup) have a stronger effect on column performance than parameters which change the coal hydrophobicity (i.e., collector dosage). This suggests that the Upper Freeport coal sampled used in the present work was already sufficiently hydrophobic.

The response surface plots indicate that, as expected, factors which tended to improve coal recovery had the reverse effect on the rejections of ash and pyritic sulfur. These general trends are consistent with the recovery-grade curves shown previously in Figure 4.10. The ash and pyritic sulfur rejections tended to increase with increasing feed solids rate and decrease with increasing collector dosage and/or air holdup. These observations are consistent with those obtained from previous studies which suggest that high reagent dosages are often detrimental to achieving high rejections of pyritic sulfur.

Based on the Box-Behnken test results, investigators established the optimum column flotation condition for the 24-hour demonstration run. These conditions are presented in Table 4.23.

Table 4.23
Upper Freeport Seam Coal,
Column Operating Conditions Established for the Demonstration Run

Plant Feedrate (TPH)	Column Feed Rate (TPH)	Collector Dosage (#/ton)	Gas Holdup (%)
2.3	2.0	1.0	21

24-Hour Demonstration Run

The POC module was configured based on the previously described unit operations optimization tests and readied for the 24-hour demonstration run. Ten 24-hour days of operation were completed on the Upper Freeport

seam coal as planned. The sampling program was as described for the Pittsburgh No. 8 seam coal in Section 4.5.1. Over the ten days of operation, 30 complete sets of samples were collected and submitted to the laboratory for analysis. The results from the laboratory were input into the Bilmat Material Balance program in order to estimate a metallurgical balance around the plant and for the major cleaning circuits in the plant.

One of the thirty data sets was thrown out due to the extremely high adjustments required. The complete data sets for the remaining tests are provided in Appendix B.

As with the Pittsburgh No. 8 seam coal, for the most part, only small adjustments were made on the remaining ash data. Out of the nine samples used for the plant balance, the average adjustment was greater than three percent of the measured value on only two samples, the column reject and the refuse thickener feed. As with the Pittsburgh No. 8 seam coal, the ash adjustment data again indicate reasonable accuracy of the original data set. Investigators are thus confident that the adjusted data provides good estimations of actual plant and equipment performance.

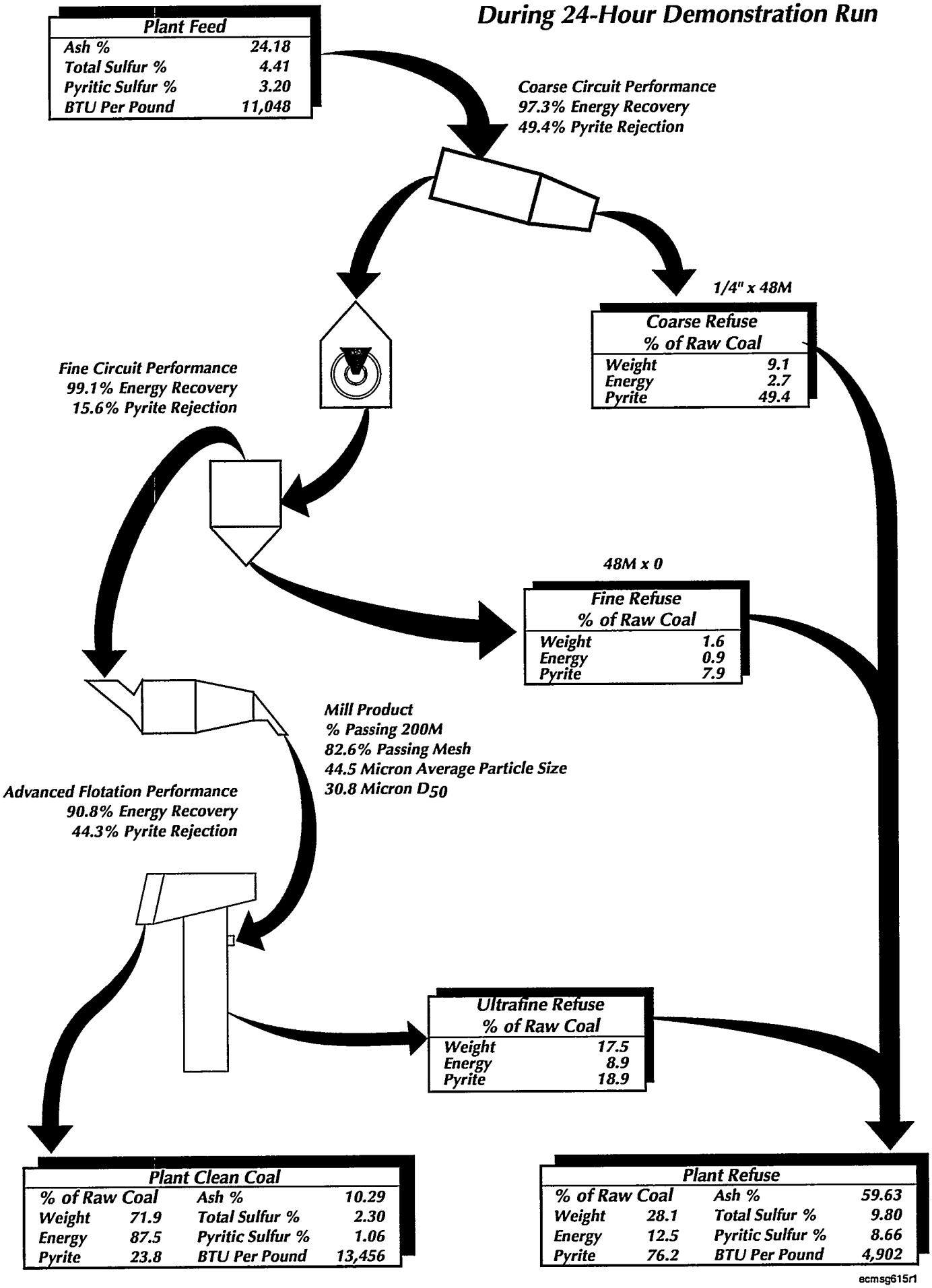
Figure 4.11 presents the average qualities and performance calculations for the ten-day period. Overall, the process recovered 87.5 percent of the energy and rejected 76.2 percent of the pyritic sulfur of the raw coal feed. By throwing away enough raw coal to result to an 85 percent energy recovery, 77 percent of the pyritic sulfur would have been rejected. As with the Pittsburgh No. 8 coal, the 85/85 performance goals were not achieved.

Of the energy lost in the overall process, 22 percent was lost with the heavy-media-cyclone reject, seven percent was lost with the water-only cyclone reject, and 71 percent was lost with the column flotation reject. Corresponding proportions of rejected pyritic sulfur were 65 percent, 10 percent, and 25 percent. The high energy loss with a relatively small pyrite rejection in the advanced column flotation cell possibly indicates marginal improvement in the state of liberation of this coal when grinding from a 48 mesh top size to a 200 mesh top size. In order to achieve the overall pyritic sulfur rejection goal (of 85 percent), 27.7 percent of the raw coal's pyrite would have to be removed by the column or 65 percent of the pyrite in the column feed (compare to 44 percent actual).

Figure 4.12 presents the average particle size distribution for the mill-circuit feed and the column-flotation feed during the 24-hour demonstration run. Similar data for the 29 sample periods are presented in Appendix B. The mean particle size of the mill-circuit feed was 165 microns and the mean particle size of the column-flotation feed was 45 microns. The column flotation feed was 82.6 percent passing 200 mesh compared to a target of 95 percent passing.

Grinding finer would certainly improve the chances of meeting the 85/85 cleaning performance goals. It is unclear, however, whether the target grind for this project, 95 percent passing 200 mesh, is fine enough to meet the cleaning performance goals.

Figure 4.11
Upper Freeport Seam Coal
Average Performance
During 24-Hour Demonstration Run



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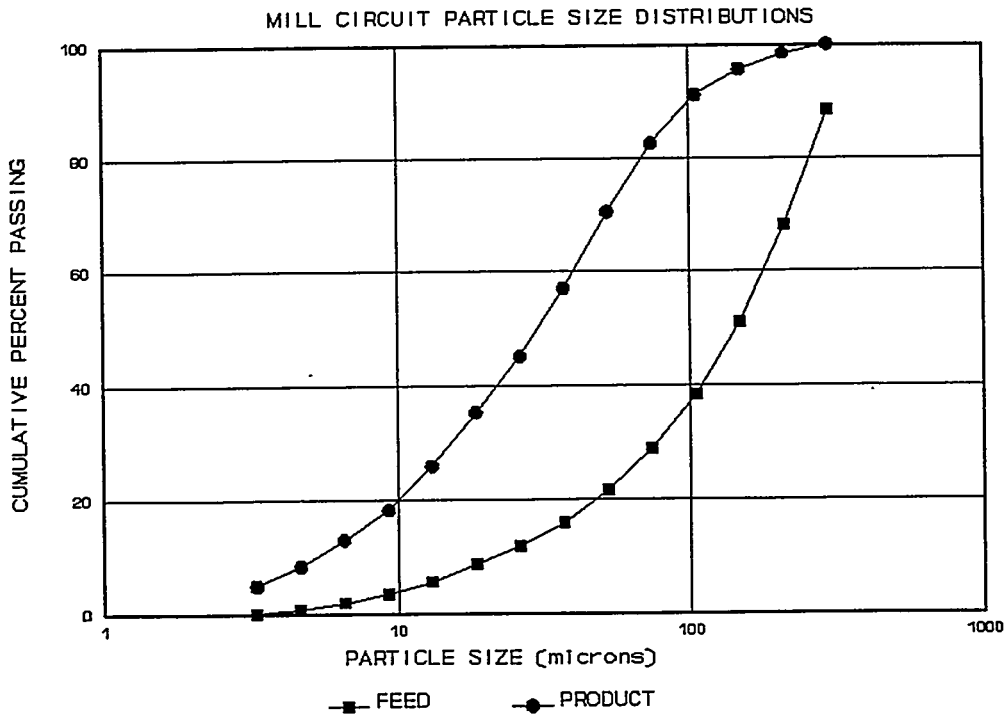

Figure 4.12 Upper Freeport Seam Coal, Average Mill Circuit Feed and Product Size

4.5.3 Illinois No. 6 Seam Coal

The Illinois No. 6 coal was the third and final project coal tested at the POC facility. The coal was supplied by the Kerr-McGee Coal Corporation of Saline County, Illinois. One barge shipment of about 1500 tons was procured from Kerr-McGee for POC testing. Table 4.24 presents the average quality of raw coal samples extracted during POC tests. Important results of POC testing follows.

Table 4.24
Illinois No. 6 Seam Coal, Average Raw Coal Quality

Analysis	Basis of Analysis	
	As-Received	Dry
Moisture (%)	15.18	---
Ash (%)	30.34	35.77
Total Sulfur (%)	3.34	3.93
Pyritic Sulfur (%)	2.01	2.37
Btu Per Pound	7,672	9,046

Heavy-Media Cyclone

The heavy-media cyclone was tested at three specific gravities ranging from 1.70 to 1.80 specific gravity. As with the previous coals, the goal

established for this unit was to identify the lowest circulating media specific gravity that would result in a 97 percent energy recovery. Table 4.25 presents the recoveries for each specific gravity tested. The target energy recovery was not achieved at any of the three specific gravities tested. Because of visually observed clay buildup in the recirculating media and possible related troubles with the heavy-media- pumping system, a higher specific gravity was not attempted for this coal. The results subsequently justified this decision as the energy recovery uncharacteristically remained constant or dropped when the specific gravity was increased. The clean coal ash values, which also remained constant or dropped when the media specific gravity was increased, provided additional evidence that further increases in the media specific gravity was unwarranted. Based on this data, investigators selected a 1.75 specific gravity for all remaining Illinois No. 6 seam testing.

Table 4.25
Illinois No. 6 Seam Coal, Heavy-Media Cyclone Performance

Run Number	Specific Gravity	Energy Recovery (%)	Clean Coal Ash (%)
93112901	1.70	95.0	11.90
93112902	1.75	95.1	11.34
93112903	1.80	90.7	11.69

Water-Only Cyclone

Based on experience with the two previous coals, conventional froth flotation held little promise for inclusion with the advanced froth flotation process. Poor performance and operating problems associated with the required high frother reagent dosages led investigators to remove conventional frother flotation from the process for both the Pittsburgh No. 8 and the Upper Freeport coals. For this reason as well as to improve the operations schedule, the water-only cyclone and the conventional froth flotation units were sampled during the same test runs during Illinois No. 6 seam optimization tests.

Table 4.26 presents the water-only cyclone performance results using 5/8-inch and 3/4-inch cyclone apexes. The larger cyclone apex resulted in a higher energy recovery as well as an improved clean-coal-ash content. Since the target recovery was achieved with the 3/4-inch apex, this was used for the remainder of Illinois No. 6 coal testing. As with the Upper Freeport coal, the lower energy recovery in the test with the smaller apex is contrary to normal expectations. This cannot be explained with available data.

Conventional Froth Flotation

Conventional froth flotation results for the Illinois No. 6 seam coal are presented in Table 4.27. While the energy recovery target of 97 percent was exceeded on the coarser-size fraction and approached on the finer size fraction, it was already decided that conventional froth flotation would be removed from the proposed Semi-Works design. A review of the data in the table illustrates very good reasons for eliminating conventional froth flotation. On the coarse size fraction (48 mesh x 200 mesh), only 2.5 to

3.4 percent of the pyritic sulfur is rejected along with similar percentages of feed solids. The primary philosophy of using conventional coal cleaning approaches in this project were to try to make some "cream" coal to coarsen the plant product; to remove significant amounts of liberated impurities with low cost conventional cleaning; and to reduce grinding circuit capacity, and thus capital requirements. Once grab-and-run flotation was discounted, and after precleaning in the water-only cyclone, none of these objectives could be accomplished in the coarse flotation stage.

Table 4.26
Illinois No. 6 Seam Coal,
Water-Only Cyclone Configurations and Performance Results

Run Number	Vortex Used	Apex Diameter (inch)	Energy Recovery (%)	Clean Coal	
				Ash (%)	Total Sulfur (%)
93120201	7/3[1]	5/8	92.9	22.13	3.21
93120202	7/3[1]	3/4	98.6	18.82	3.01

[1] Seven inch length, 3-inch diameter Vortex finder used for all tests.

Similarly for the finer size fraction, once grab-and-run flotation was discounted, the only real feasible benefit was ash removal prior to the grinding circuit and advanced froth flotation. This benefit would be somewhat dubious, as the ash would be easily diverted away from the ball-mill by the grinding-circuit classifying cyclones. Also, since the critical sizing parameter for the advanced froth flotation column is related to froth carrying capacity, no real benefit could be realized by minus 200 mesh ash removal.

Table 4.27
Illinois No. 6 Seam Coal, Conventional Single-Stage Froth Flotation Results

A Bank: 48 mesh x 200 mesh Size Fraction					
Run Number	Frother Dosage (ml/min)	Collector Dosage (ml/min)	Energy Recovery (%)	Clean Coal	
				Ash (%)	Sulfur (%)
93120201	3	13	99.7	15.03	3.70
93120202	3	25	99.3	12.45	3.42
B Bank: 200 mesh x 0 Size Fraction					
Run Number	Frother Dosage (ml/min)	Collector Dosage (ml/min)	Energy Recovery (%)	Clean Coal	
				Ash (%)	Sulfur (%)
93120201	9	8	92.4	13.30	2.88
93120202	9	16	93.3	8.79	3.01

Grinding Circuit

No formal mill circuit testing was conducted for the Illinois No. 6 coal. Data from the previous coals indicated that grinding performance was mainly a function of feedrate and thus the same circuit configuration was eventually used for all three coals.

Advanced Froth Flotation

The heavy-media cyclone and the water-only were operated at the condition determined during the previously described maximization tests, and a Box-Behnken experimental program was conducted on the advanced column flotation operation.

The Box-Behnken test matrix for the Illinois No. 6 coal is given in Table 4.28. The same operating variables were examined in this series of tests as examined for the Upper Freeport coal, i.e., feed solids rate, collector dosage and air holdup. However, a slightly narrower range of feed solid rates (i.e., 1 to 3 TPH) and somewhat higher range of collector dosages (i.e., 0.5 to 1.5 lb/ton) were examined for the Illinois No. 6 coal. The test data, operating conditions and performance calculations for this series of tests are summarized in Appendix B.

Table 4.28
Illinois No. 6 Coal, Box-Behnken Text Matrix

Run Number	Feed Rate (tph)	Collector Dosage (lb/ton)	Air Holdup (%)
1	2.00	1.50	24
2	2.00	1.00	21
3	2.00	0.50	18
4	2.00	1.50	24
5	2.00	0.50	18
6	1.00	1.00	24
7	3.00	1.00	24
8	3.00	1.50	21
9	2.00	1.00	21
10	2.00	0.50	24
11	3.00	1.00	18
12	1.00	0.50	21
13	3.00	0.50	21
14	2.00	1.50	18
15	2.00	1.00	21
16	1.00	1.50	21
17	1.00	1.00	18
18	2.00	1.50	18
19	2.00	0.50	24

Figure 4.13 presents energy recovery versus ash and pyrite rejection for the column flotation cell. The data form unique grade-recovery curves for each of the measured characteristics. Between 90 and 95 percent energy recovery, where the column will need to operate in order to achieve an overall plant energy recovery of 85 percent, pyrite rejection of 28 to 35

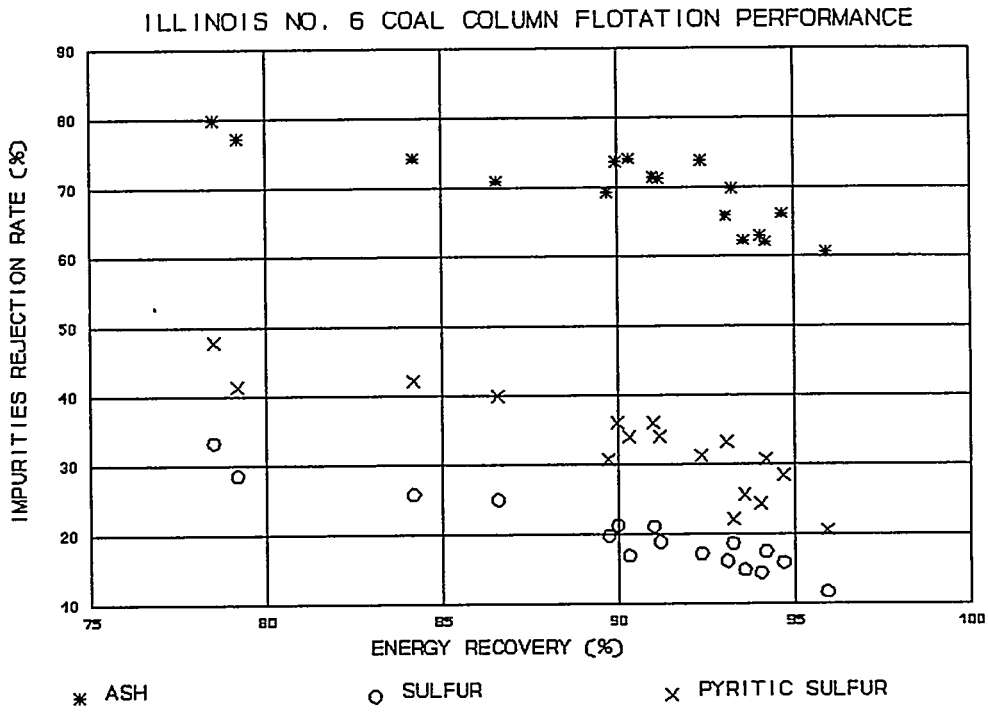

Figure 4.13 Illinois No. 6 Seam Coal, Box-Behnken Test Matrix Results

percent resulted. These results could be obtained at several different combinations of operating conditions. This again suggests that other conditions such as reagents costs, column capacity, maintenance considerations, etc. should be considered in the selection of the preferred operation point for the advanced column flotation circuit.

As with the other two coals, linear and quadratic regression models were developed for predicting energy recovery, ash rejection and pyritic sulfur rejection. Table 4.29 provides a summary of the coded coefficients for the linear regression model. As shown the statistical analyses indicate that energy recovery decreased with feed rate, and increased with air holdup and collector dosage. These trends were expected for the reasons given previously within this report. The rejections of both ash and pyritic sulfur also decreased as the air holdup and collector dosages increased. These trends were also anticipated and were considered to be normal in view of the characteristic recovery-rejection curves. However, an increase in feed solids rate was actually found to have an adverse impact on the rejections of ash and pyritic sulfur. This finding is contrary to that obtained during the testing of other fine coals by column flotation. These unexpected trends may be related to variations in the population of middlings particles for each coal brought on by differences in their liberation characteristics. It is also worth noting that air holdup was again found to be the primary factor controlling the performance of the column in terms of energy recovery and pyritic sulfur rejection. This variable also had a large influence on ash rejection, although collector dosage was found to have a slightly larger influence.

Table 4.29
Illinois No. 6 Seam Coal, Coded Coefficients for the Linear Regression Model

Test Variable	Units	Low Value	High Value	Energy Recovery	Ash Rejection	Pyritic Rejection
Main	***	***	***	+90.04	+69.72	+33.58
Feed Rate	tph	1.0	3.0	-0.30	-0.14	-2.67
Air Holdup	%	18	24	+4.02	-2.66	-7.09
Collector	lb/ton	0.50	1.50	+3.21	-4.03	-4.10

Response surface plots for the Illinois No. 6 seam are provided in Appendix B for energy recovery, ash rejection and pyritic sulfur rejection, respectively. These plots were constructed using the following quadratic regression models.

Energy Recovery = $-66.61 - 12.387\,(\text{Feed Rate}) + 12.631\,(\text{Air Holdup}) + 42.026\,(\text{Collector}) + 1.0781\,(\text{Feed Rate})^2 - 0.2484\,(\text{Air Holdup})^2 - 1.1825\,(\text{Collector})^2 + 0.35417\,(\text{Feed Rate})(\text{Air Holdup}) + 0.33500\,(\text{Feed Rate})(\text{Collector}) - 1.6042\,(\text{Air Holdup})(\text{Collector})$

Ash Rejection = $38.98 - 32.709\,(\text{Feed Rate}) + 2.5091\,(\text{Air Holdup}) - 20.945\,(\text{Collector}) - 6.0101\,(\text{Feed Rate})^2 - 8.555\times10^{-2}\,(\text{Air Holdup})^2 - 6.7696\,(\text{Collector})^2 - 0.47667\,(\text{Feed Rate})(\text{Air Holdup}) + 1.2050\,(\text{Feed Rate})(\text{Collector}) + 1.1449\,(\text{Air Holdup})(\text{Collector})$

Pyritic Rejection = $244.28 - 2.7668\,(\text{Feed Rate}) + 16.812\,(\text{Air Holdup}) - 0.58762\,(\text{Collector}) - 1.4964\,(\text{Feed Rate})^2 + 0.33405\,(\text{Air Holdup})^2 - 1.4143\,(\text{Collector})^2 + 0.28500\,(\text{Feed Rate})(\text{Air Holdup}) + 0.10000\,(\text{Feed Rate})(\text{Collector}) - 0.21857\,(\text{Air Holdup})(\text{Collector})$

where feed solids rate is reported in units of TPH, collector dosage in units of lb/ton, and air holdup is reported as a percentage. The trends observed in these plots are consistent with those predicted from the linear model. In general, energy recovery increased with increasing collector dosage and air holdup. A reverse trend was observed in the rejections of ash and pyritic sulfur. The effect of feed rate on energy recovery and ash rejection was somewhat more complicated. A higher feed rate could either increase or decrease recovery and/or rejection, depending on the specific combination of air holdup and collector dosage employed. However, the overall effect of feed rate was relatively small, which makes it difficult to draw definitive conclusions about the effects of this parameter on column performance. Feed rate had a slightly larger impact on pyritic sulfur rejection, although the magnitude of this effect was still much smaller than that obtained by changing the collector dosage or air holdup.

Based on the results of the Box-Behnken experiments, the operating conditions for the column flotation unit during the 24-hour demonstration run were selected. Table 4.30 presents these conditions.

Table 4.30
Illinois No. 6 Seam Coal,
Column Operating Conditions Established for the Demonstration Run

Plant Feed Rate (TPH)	Column Feed Rate (TPH)	Collector Dosage (lb/ton)	Air Hold-Up Rate (%)
2.6	2.0	1.0	21

24-Hour Demonstration Run

The POC module was configured based on the previously discussed unit operations optimization tests and readied for the 24-hour demonstration run. Ten complete 24-hour days of operation were attempted for the Illinois No. 6 coal. The sampling program was as described for the Pittsburgh No. 8 seam coal in section 4.5.1. Due to equipment failure, no samples were collected for one shift of operation and, therefore, 29 complete data sets were collected and submitted to the laboratory for analyses. Eight data sets were not considered for Bilmat evaluations because of data irregularities. Of the eight eliminated data sets, three were collected during shifts in which sampler problems were experienced, and in two of those shifts, the plant feed sampler was inoperable for a time. Three of the eliminated data sets were collected during shifts in which forced outages occurred, and the final two data sets were collected during shifts in which no problems could be identified from the plant records. The remaining results from the laboratory were input into the Bilmat Material Balance program in order to estimate a metallurgical balance around the plant and for the major cleaning circuits in the plant. Complete data for these 21 sample periods are provided in Appendix B.

The Bilmat computer program had to make relatively large adjustments to the ash data set (compared to the previous coals) in order to arrive at metallurgical balances. On average, the adjustments were greater than three percent of the measured values for five of the nine samples used for the plant balance. Table 4.31 presents the average measured and adjusted ash values for these nine samples. High clay content of the Illinois No. 6 coal was likely one factor contributing to the relatively large adjustments required. Interestingly, the average Btu adjustment was greater than three percent of the measured value for only two samples, the column-flotation reject and the refuse-thickener feed.

Figure 4.14 presents the average quality information and related performance data for both the overall plant and for the major plant circuits. Overall, the plant recovered 85.8 percent of the raw coal's energy content and rejected 79.4 percent of the pyritic sulfur. While this does not meet the performance goals, these results more closely approached the goals than those for the two previous coals.

Of the energy lost in the process, 32 percent was lost to the heavy-media cyclone reject, 15 percent was lost to the water-only cyclone reject, and 53 percent was lost to the column flotation tailings stream. Corresponding proportions of rejected pyritic sulfur in these streams were 70 percent, 13 percent and 17 percent. In order to achieve the goal for pyritic rejection, the advance froth flotation circuit would have to have removed nearly 19.2 percent of the raw coal's pyrite. On a unit

performance basis, the column would have had to remove 56 percent of the column flotation feed pyritic sulfur, in order to achieve this result.

Table 4.31
Illinois No. 6 Seam Coal,
Average Adjustments to Ash Values for Bilmat Material Balance

Sampled Stream	Ash %		Adjustment	
	Average Measured	Average Adjusted	Average Magnitude	% of Measured
Plant Feed	35.69	34.49	1.68	4.63
Deslime Screen Underflow	23.93	23.32	0.65	2.65
Heavy-Media Cyclone Refuse	77.10	78.00	1.48	1.93
Water-Only Cyclone Clean Coal	21.06	22.02	1.06	5.17
Water-Only Cyclone Refuse	52.74	54.15	1.76	7.41
Column Flotation Feed	22.37	22.02	0.66	2.97
Column Flotation Feed	7.20	7.20	<0.01	0.10
Column Flotation Tails	72.38	68.61	3.77	5.20
Refuse Thickener Feed	63.25	66.44	3.26	5.22

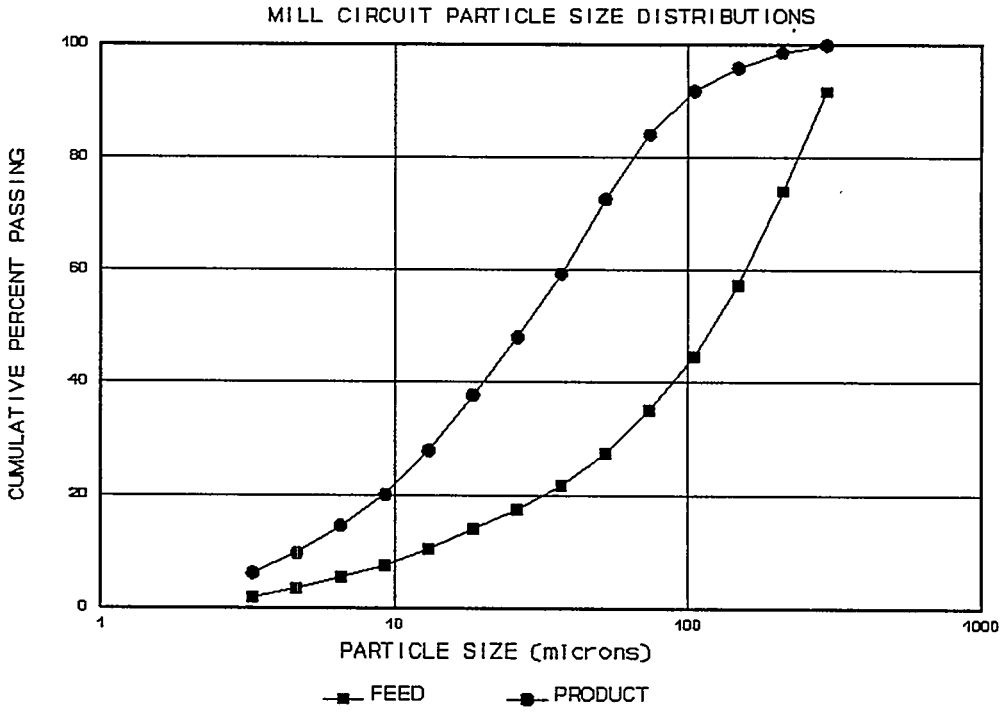

Figure 4.15 Illinois No. 6 Seam Coal, Average Mill Circuit Feed and Product Size

Figure 4.14
Illinois No. 6 Seam Coal
Average Performance
During 24-Hour Demonstration Run

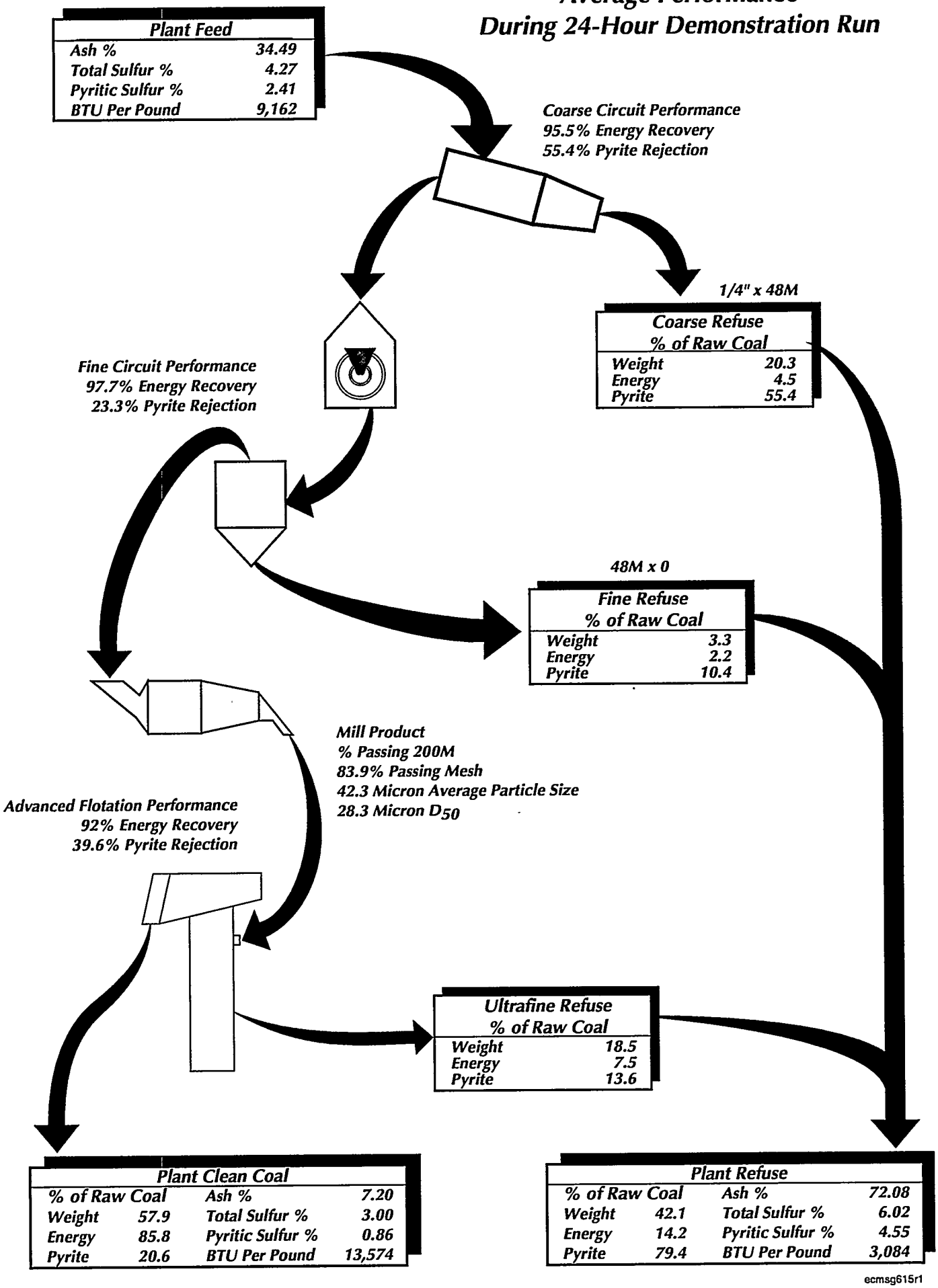

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Figure 4.15 presents the average particle size distributions of the mill-circuit feed and the column-flotation feed. Similar data for 21 test periods are presented in Appendix B. The mean particle size of the mill-circuit feed was 143 microns and the mean particle size of the column-flotation feed was 42 microns. Compared to a target of 95 percent passing 200 mesh, or 75 microns, the column-flotation feed was nearly 84 percent passing this size. Given the fact that, on a unit performance basis, the column removed 40 percent of the pyritic sulfur, and that it would have had to remove 56 percent to meet the overall goal (of 85 percent), it is possible that the goal may have been met if the mill circuit had ground the column feed to 95 percent passing 200 mesh.

4.6 Application of POC Results to the Preparation of the Final Conceptual Flowsheet

The engineering performance of the unit operations in the precleaning and advanced circuits were according to the initial design except for the grinding mill. A unit-operation-by-unit-operation discussion follows that describes the initial design criteria and whether or not the unit operation confirmed to the criteria or not and, then, what would be done in order to obtain the design criteria.

4.6.1 Raw Coal Storage

Although not part of the design consideration, the raw coal storage requires careful consideration for a commercial preparation plant. At the POC, an existing open storage system was utilized to receive the raw coal. This presented operational problems when processing the Pittsburgh No. 8 and the Illinois No. 6 coals. Both of these coals contained clay and/or shale that deteriorated when wet. Resultant handling problems from the reclaim feeders up to the raw coal screen were labor intensive. This could not be tolerated in a commercial preparation plant. For this reason it is recommended that each raw coal's handling characteristics be determined before selection of the raw-coal-storage system. In the case of the Pittsburgh No. 8 and Illinois No. 6 coals, closed storage would be considered.

4.6.2 Raw Coal Crushing

The POC included two (2) double-roll crushers. The first crusher reduced the raw coal top size from six (6) inch to two (2) inch. The second crusher reduced the raw coal from two (2) inch top size to one-quarter (¼) inch top size. There was a problem with the second crusher maintaining the gap between the crusher rolls to produce a one-quarter inch final product. Modifications were made to the rolls by adding a welded bead spaced every inch across the face of the roll. This improved the operation but still did not produce 90 percent minus one-quarter inch product. In addition, because of the clay-type material, the second crusher had a tendency to plug when wet material was being crushed. To overcome these problems in the Semi-Works preparation plant, it is recommended to increase the top size of the final crushed product to nominal one-half (½) inch. Although some liberation of material will be sacrificed, the continuous operation of the crusher would more than offset this problem. This loss of liberation will be offset by slightly

increased liberation performance in the 48 mesh by zero and 200 mesh by zero grinding circuits.

4.6.3 Oversize Protection and Initial Raw Coal Sizing

The oversize-protection screen unit operation worked as planned, and the design for the Semi-Works unit was based on criteria established by the Vibrating Screen Manufacturers Association[5]. The only problem with the unit in the POC facility was the inability to completely wet the raw coal before entering the screening area. This will be easily designed for in the Semi-Works preparation plant by adding raw coal pushwater ahead of the screen and improving the spray-water header design on the screen.

The deslime sieve bend design was based on Dutch State Mines (DSM) capacity charts. There were no surprises in the design and the sieve bend with 0.5 mm opening of the proper width was more than adequate for removing water and natural fines ahead of the deslime screen.

The deslime screen design was based on capacity calculations developed by the Dutch State Mines (DSM). The calculations are conservative and are adequate for determining the width of the deslime screen which determines capacity. The POC deslime screen was dressed with wedge wire panels with 0.3 mm openings and no problems were experienced in the operation.

4.6.4 Coarse Conventional Cleaning and Secondary Crushing

In the original POC design, a coarse water-only cyclone was proposed for primary precleaning. This unit operation was selected to reduce operating cost of the precleaning circuit. The final Semi-Works design will not use the coarse water-only cyclone. Instead, a heavy-media cyclone will be used to preclean the coarse raw coal. The magnetite loss was determined to be within commercial values and the high (1.75) specific gravity of separation was not an operational problem.

The heavy-media cyclone unit operation design was based on probable error calculations. The unit operation performed adequately in the POC and there is little doubt that the same will occur in the Semi-Works preparation plant.

The clean-coal and refuse-sieve-bend designs were based on the DSM capacity charts. Again, there were no surprises in the operation of these sieve bends with 0.5 mm opening. The proper width can be determined from the capacity charts and the units were adequate for removal of media ahead of the drain-and-rinse screens.

The clean-coal, middlings and refuse drain-and-rinse screen designs were based on capacity calculations developed by DSM. The calculations produced a conservative design and were adequate for determining the width of the drain-and-rinse screens. The POC drain-and-rinse screen was dressed with wedge-wire screen panels with 0.3 mm openings and experienced no problem in operation.

The fine crushing machine in the POC was a Gundlach cagepactor. This unit was partially refurbished after ten (10) years of storage. The machine was originally designed to produce minus 1/8 inch material. The POC

design required a size reduction to minus 48 mesh. In order to accomplish this, the existing machine was operated at 1000 rpm. Although this speed was not the upper limit of the manufacturer's recommended speed, the vibration generated at this speed caused several failures of the machine during the operation of the POC facility. The unit required the addition of vibration detectors to prevent catastrophic failure. In addition, structural support steel needed to be increased. With these changes and a more stringent maintenance program, the failure rate of the machine decreased to less than 1.0 percent of operating time.

In the Semi-Works size preparation plant, the unit would be properly sized for the application. The unit would include vibration detection and adequate structural support to minimize vibration. In the Semi-Works plant, this crusher is in closed circuit with the oversize protection sieve bend. The size distribution of the product was consistently 70 - 100 percent minus 48 mesh (297 microns) with a top size of 95 percent or greater minus 28 mesh (595 microns).

The oversize protection sieve bend design was based on the DSM capacity charts. Although this sieve bend was not included in the POC facility, it is anticipated that no design problems will be encountered for the Semi-Works plant.

4.6.5 Fine Conventional Coal Cleaning

The fine water-only cyclone unit operation design was based on probable error calculations. The unit performed as expected in the POC and there is little doubt that the same performance will occur in the Semi-Works preparation plant.

The above discussions conclude the precleaning circuit of the POC. The product (overflow) of the POC became the feed to the advanced circuit of the POC. The advanced circuit incorporated a reversed-closed circuit, ball-mill grinding circuit, column flotation, clean-coal and refuse thickener, and clean-coal and refuse dewatering.

4.6.6 Ultrafine Coal Grinding Circuit

The grinding circuit consisted of three unit operations, the classifying cyclones, the Varisieve, and the ball-mill. The classifying cyclones and the Varisieve were size-separating devices and the ball-mill was a size reduction device. The classifying cyclone separated into sizes based on particle size and particle specific gravity. The Varisieve separated based on size. The feed rate to the ball-mill of a given size and horsepower controlled the size reduction capability of the machine.

During the operation of the grinding circuit, while processing the Pittsburgh No. 8 seam coal, numerous combinations of feed, vortex finder, and apex diameters were tested to produce the best classification point for the cyclone. Two problems were discovered in the grinding circuit. First, the mill was not producing a fine grind and second, the quality of the feed to the mill circuit was higher in pyritic sulfur than the product from the mill circuit.

The problem with the ball-mill was the original design. The recirculating load to the mill was more than the design. Therefore, for the given ball-mill size the higher the feed rate the coarser the grind. In addition, the percent solids in the feed was lower than design and this also influenced the grind size. The lower the percent solids in the feed the coarser the grind. This problem will be remedied for the Semi-Works plant by providing the data required for the ball-mill manufacture to properly size the mill based on the manufacturer's calculated recirculating load. Then the mill will be of the proper size to handle the input and produce the 95 percent minus -200 mesh as required by the original design.

The ball-mill installed at the POC, though undersized, performed without any major problems. The only maintenance problems experience was the seal around the inlet to the mill. After one (1) year of daily operation it was a very reliable unit operation.

After considerable testing, the mill classifying cyclone orifice configuration and pressure drop were arrived at, which produced a size cut of d_{95} of approximately 120 mesh with a d_{50} of less than 325 mesh. The classifying cyclones operated without any problems. The classification point was for coal particles with a specific gravity of 1.40. As previously stated, a problem developed with respect to quality in the feed to the mill circuit being different than the product from the mill circuit. Basically, this quality problem was the pyrite difference. This was a direct result of the classification characteristics of the cyclone. The pyrite, having a specific gravity of around 5.0 was classifying at a finer size than the coal particles and hence was being recycled back to the ball-mill. The ball-mill circuit was concentrating the liberated pyrite.

Based on the above classification size differential, a Varisieve was incorporated into the mill-classification system. The Varisieve can handle a high volume flow rate per foot of width and was capable of making finer size separations than a static sieve. This unit received its feed from the classifying-cyclone underflow. The feed was diluted with a portion of the classifying-cyclone overflow. The over product of the Varisieve returned to the ball-mill. The sieve-effluent containing the fine pyrite was recombined with the classifying-cyclone overflow and became the feed to the advanced column flotation cell.

After the installation of the Varisieve the feed to the grinding circuit statistically matched the product of the grinding circuit. Based on the above information, the Semi-Works installation would incorporate a classifying cyclone with a Varisieve for fines removal from the cyclone underflow.

The grinding circuit, as described above, produced the fine grind with input and output quality being similar. The operation and maintenance of the circuit was minimal.

4.6.7 Advanced Column Flotation Circuit

The advanced column flotation devices had extensive experimentation conducted first by a factorial experimental design to determine major interacting variables and lastly by a Box-Behnken experimental design to

determine the exact rates for the major interactive variables. From these experiments the best conditions for operation are shown in Table 4.32. These conditions then become the basis for future design.

Table 4.32
Column Flotation Operating Conditions

Coal Seam	Feed Rate	Collector Rate	Air Holdup	Air Rate	Water Rate
Pittsburgh No. 8	2.0 tph	1.0 #/T	24%	140 cfm	100 gpm
Upper Freeport	2.0 tph	1.0 #/T	21%	150 cfm	100 gpm
Illinois No. 6	2.0 tph	1.0 #/T	21%	140 cfm	100 gpm

The design criteria that can be determined from the above data is presented in Table 4.33

Table 4.33
Column Design Criteria

FEED RATE = 0.0708 TPH/FT^2
WASH-WATER RATE = 0.4730 FT/MIN VELOCITY DOWN
AIR RATE = 4.95 cfm/FT^2 OF CELL AREA

These numbers agree closely with the scale-up values for larger commercial units.

4.6.8 Clarification and Dewatering

The product from the column flotation cell contains solids concentrations of around 10-15 percent by weight. The dewatering capacity of a filter can be increased by increasing the feed percent solids. This was accomplished at the POC by using a static thickener with standard flocculating reagents to increase the solids in the feed to the final dewatering device. An operational problem experienced with the clean-coal thickener was froth carryover in the clarified water. The problem was remedied by the addition of water spray nozzles mounted on the feed box and over the surface of the thickener.

In the Semi-Works installation the design criteria of 0.5-1.0 gpm/ft^2 of surface area is appropriate for design along with low-volume sprays to eliminate froth build up. The sprays are fed from the overflow pump of the clean-coal thickener and the remaining water is recycled for water use throughout the plant.

Tailings or refuse from the column flotation cell is very dilute with percent solids in the range of 0.1-3 percent solids by weight. It is necessary to increase the percent solids for final dewatering. This was accomplished in a conventional static thickener at the POC. There were no operating problems with the static thickener during the operation of the POC. The design criteria of 0.5-1.0 gpm/ft^2 of surface area is appropriate for scale-up to the Semi-Works size.

The final dewatering of the clean coal and the fine refuse in the POC were not successful. The unit operation selected for clean coal dewatering was the hyperbaric filter. The unit operation selected for fine-refuse dewatering was the belt press. Both of these machines experienced operating problems that required removal from the operating circuit.

The clean-coal hyperbaric filter installed at the POC was the first prototype developed for hyperbaric filtration by the equipment supplier. The unit was not specifically designed for continuous operation. The unit was capable of operating at 4 bars of pressure. However, at no time could the POC operation attain any greater than 1.2 bars of pressure. The problem was the direct result of the valve head design and the discharge system used to remove the clean coal from the pressure vessel to atmosphere.

Numerous modifications and attempts to operate the filter were unsuccessful. The primary problem was the discharge system employed on this small-scale device. The discharge system was a double knife gate arrangement. The knife gates experienced seal failures after only several hours of operation, and severe leakage sometimes after only five to ten minutes of operation.

The hyperbaric filter was operated several hours at a time producing a product that was low in moisture (25-28 percent) and very handleable. For this reason the Semi-Works installation would be equipped with the hyperbaric filter for final dewatering. The commercial-size filters are very successful and the problems experienced in the POC are not operating problems in commercial installations.

Because the hyperbaric filter was not operational no design data were acquired for this unit operation. However, literature supplied by two of the major manufacturers is available that provides design data that would be used in the final Semi-Works design.

The refuse belt press used to dewater the fine-refuse worked as designed. No operational problems occurred with the machine. The product generated from this machine was 30-32 percent moisture and very handleable. However, the belt press requires a large amount of flocculant to operate properly. This flocculant was recycled throughout the water system in the plant and interfered with the selectivity of the coal in the column flotation cell. For this reason the unit was removed from the circuit.

Because the belt press had only limited operation no design data were obtained. Instead a change in philosophy of fine-refuse dewatering resulted. The change in philosophy was to not close the water system with a mechanical device, but to close the water system by using a large refuse impoundment. The fine refuse would be thickened in a refuse thickener and pumped in a slurry to an impoundment built to current Federal, state, and local regulations for final dewatering. The clear water would be returned to the preparation plant for reuse.

4.6.9 Plant Process Control and Automation

The instrumentation in the POC was a mix of proven instruments and instruments that have not been previously incorporated into a coal

preparation plant. The proven instruments included speed controls, level detectors, specific gravity measurement devices, and flowmeters. The new instruments incorporated into the POC were an ash analyzer, a particle size analyzer, a novel automatic flocculant control system, and a thermal air flow meter.

The proven instrumentation in the POC worked as designed with no problem except with the nuclear density gauges measuring specific gravity at low-percent solids.

The problem was the short duration of exposure to the nuclear source through a small diameter pipe. To improve the length of exposure, a "z" section of pipe was installed into each of the small diameter pipes. It was then discovered that the nuclear source had to be replaced with a stronger source to maintain accuracy. After these changes were made, the specific gravity was measured properly.

A condition developed in the air flow measurement device that caused a failure in the unit. The condition was water in the thermal air flow measurement instrument. Even though air dryers were supplied in the compressed air lines, moisture developed in the air lines these instruments were to measure. The change made was to replace the thermal units with an orifice plate pressure drop flow meter. The orifice plate instruments performed properly after installation.

There were three instruments that had not been proven in a coal preparation plant environment. These three instruments were a slurry-ash analyzer, an on-line particle size analyzer, and an automated flocculant control system. All three of these instruments had been laboratory proven, prototype field proven, and in the case of the ash analyzer and particle size analyzer, commercially installed. However, except for the particle size analyzer the instruments had not demonstrated reliability. This was also the case with the POC installation.

The particle size analyzer was installed to measure the size distribution of the feed to the advanced column flotation cell. Any variations measured from a set point would be adjusted by modifying the feed pressure, to the mill-classifying cyclone. During the initial calibration process it was discovered that the sensing unit was very sensitive to alignment. After the alignment problem was corrected it was discovered that the size analyzes measured did not match sampled size measurements. The differences were random so no correction factor could be applied to make up a correlation. It is suspected that during the time of calibration, flocculation of the feed was occurring at different rates. The sample collected for calibration was subjected to dispersant that would break the flocculated particles and result in a finer size distribution. This would explain the problem of calibration.

During the operation of the mill-classifying circuit, it was discovered that for a given feed rate, cyclone orifice arrangement, and feed pressure the size distribution remained quite constant and did not require accurate control to maintain a size analysis. For this reason no further tests and/or calibrations were made for this instrument. The unit worked properly and with additional time and effort could have been made to

operate. The POC was installed not to demonstrate instruments but a circuit; therefore time and effort was not expended on this instrument.

The slurry-ash analyzer also experienced calibration problems and electronic failures. The unit was brought on line and an immediate electronic failure occurred in the radiation detector. When the unit did operate the calibration would drift causing poor readings. The electronic failure was corrected but the drift problem was never corrected.

This unit was to have an experimental pyritic sulfur detector based on readings from an iron peak and inferring the pyritic sulfur content in the sample streams. The laboratory experiments could not justify a full-scale sensor development and the ash analyzer company subsequently dropped development of a pyritic sulfur detector. Therefore, no test work was conducted in the POC installation.

The automatic flocculant control system was comprised of two systems. The first system was the settling rate control instrument and the second system was a water clarity control instrument. The settling rate control instrument was based on measuring density changes as the flocculated material settled in a standpipe. The water clarity control instrument measured the turbidity of the overflow water.

The settling rate instrument went through a series of debugging steps and calibration steps and in one case a complete redesign of the software was accomplished. However, the settling rate portion of the control system never functioned properly. The manufacturer attributed the problem to the low percent solids by weight in the feed to the thickeners. The settling rate system was not used to automatically control the anionic system but was used manually from time to time to determine settling rate and manually adjust the flocculant addition rate.

The water clarity control instrument worked as designed and was utilized to monitor and control the cationic flocculant addition to the water clarification circuits. This unit was not operated in automatic because of the failure of the settling rate instrument, but there is no reason why this instrument would not work when coupled with an operational settling rate instrument.

The conclusions that were drawn from the operation of the POC can be divided into three topics: the precleaning circuit, the advanced circuit, and the instrumentation. The precleaning equipment was composed of conventionally-designed coal preparation equipment and no problem to scale-up to the Semi-Works size plant. The advanced circuit had the only equipment design consideration and this concerned designing for increased recirculated load to the ball-mill. Otherwise this circuit had no problems in scale-up. The conventional instrumentations presented no problems and did scale-up to the Semi-Works plant. The advanced instruments would not be included in the Semi-Works plant because of operating problems and/or reliability with the instruments. The only instrument to be included would be the automatic flocculant control system. The modification made was that the settling rate instrument was changed to a Ramsey clarometer instead of the density measurement device.

The Semi-Works plant was easily scaled-up based on the experience gained in the POC operation. In fact, there were no major surprises. A philosophical adjustment developed in the disposal of the fine refuse in that an impoundment would be incorporated in the final design. Otherwise all other unit operations are scaleable to the Semi-Works size or greater.

4.6.10 Process Consumables

In addition to the engineering design data for the unit operations, several operational variables were also determined from the POC operation. These variables were the rates of reagent usage for flotation, rates of flocculant for dewatering, and the amount of magnetite used during operation. Table 4.34 presents the average usage rates for process consumables determined during POC testing. For the most part, these values are used to estimate the yearly costs of process consumables in the economics section of this report. The magnetite usage rates shown in the table, however, cannot be used. A systematic method for all three coals was developed to reach the actual usage of the consumables during the 24-hour demonstration runs. The data collected is discussed in the following paragraphs.

Magnetite consumption during operation is a function of the loss of magnetite on the refuse stream and the tailings of the magnetic separator. During the 24-hour demonstration runs, samples of the refuse streams for all three coals were analyzed for magnetite adhering to the material as it was discharged out of the media circuit. In addition, the feed to the refuse static thickener was also analyzed for magnetite. This stream would contain magnetite lost from the heavy-media cyclone clean coal and the tailings from the magnetic separator.

Magnetite loss is determined generally on a pounds-per-ton-of-coal feed to the media circuit. Losses are a direct measurement of the efficiency of rinsing the magnetite from the products and the efficiency of operation of the magnetic separator. The best efficiency of a magnetic separator is 99.8 percent magnetic recovery under the best operating conditions. This means for every one thousand pounds of magnetite processed in the magnetic separator, two pounds is lost to the tailings.

The normal feed rate of media to the magnetic separators during the 24-hour demonstration tests was 10,000-12,000 pounds-per-hour. Therefore, the loss of magnetite at peak efficiency would run 20-24 pounds-per-hour. If the efficiency of the magnetic separator would be less than this, magnetite loss would increase. An example would be if the efficiency dropped to 99.7 percent, the loss would be 30-36 pounds-per-hour. The purpose of this discussion is to explain the loss of magnetite when expressed in pounds per ton of feed appears to be totally out of control, when in fact, it is not. The POC circuit was processing 1.5-2.0 tph of feed, and the circuit was capable of processing 40-45 tph. If the same magnetite losses are assumed for both feed rates to the circuit, the pounds of magnetite loss per ton of feed changes from 9 pounds per ton to 0.45 pounds per ton.

Because of this problem, the POC results cannot be used to predict the magnetite usage of a heavy-media circuit properly sized for the tonnage capacity. Therefore, a value of 1.2 #/ton of feed , which is a more

realistic value, will be applied for magnetite losses in the Semi-Works plant design.

Table 4.34
Chemical and Magnetite Consumption Rates During 24-Hour Demonstration Runs

Process Consumable	Pittsburgh No. 8	Upper Freeport	Illinois No. 6
Clean Coal Thickener			
Anionic Flocculant (#/ton)	0.07	0.16	0.17
Refuse Thickener			
Anionic Flocculant (#/ton)	0.32	0.18	0.21
Cationic Flocculant (#/ton)	0.00	0.00	0.88
Sodium Hydroxide (#/ton)	0.0	10.1	0.0
Column Flotation Cell			
Frother (#/ton)	1.43	0.51	0.93
Collector (#/ton)	1.19	1.04	1.21
Magnetite (#/ton)	5.6	30.1	18.5

4.7 Summary of Kelsey Centrifugal Jig and Multi-Gravity Separator Testing

After completing the planned POC test program, investigators conducted short test programs on the Kelsey Centrifugal Jig and the Carpco Multi-Gravity Separator using column flotation concentrate as feed to each of the units. Detailed results of these tests are available under separate cover in Topical Report No. 6 related to the present project[6]. Pilot scale units were used in each case and a slip stream of column flotation concentrate was fed to the units while the POC was operated at the same conditioned employed during the 24-hour demonstration runs. Only the Pittsburgh No. 8 and the Illinois No. 6 coals were tested on these advanced gravity-based separation devices. Since pyritic sulfur is hydrophobic and can thus be recovered with the clean coal concentrate of froth flotation devices, investigators hoped to test whether significant improvements in pyrite rejection could be achieved with these units. Following is a description of these advanced coal-cleaning devices and a summary of the test-program results for each.

Kelsey Centrifugal Jig (JIG)

The Kelsey centrifugal jig engineering concept is a departure from the conventional jig configurations presently being used. The concept of the Kelsey centrifugal jig utilizes all the parameters of a conventional jig, as well as the additional feature of being able to vary the apparent gravitational field. This allows improved separation characteristics for fine- and ultra-fine particle applications. A cross-sectional drawing of the Kelsey centrifugal jig is shown in Figure 4.16.

In a conventional jig, the dynamics involve only specific induced movements. The centrifugal jig takes a conventional jig and spins it in a centrifuge. This is achieved by variable speed control of the spinning rotor. Inside the rotor a screen of parabolic shape is spun coaxially

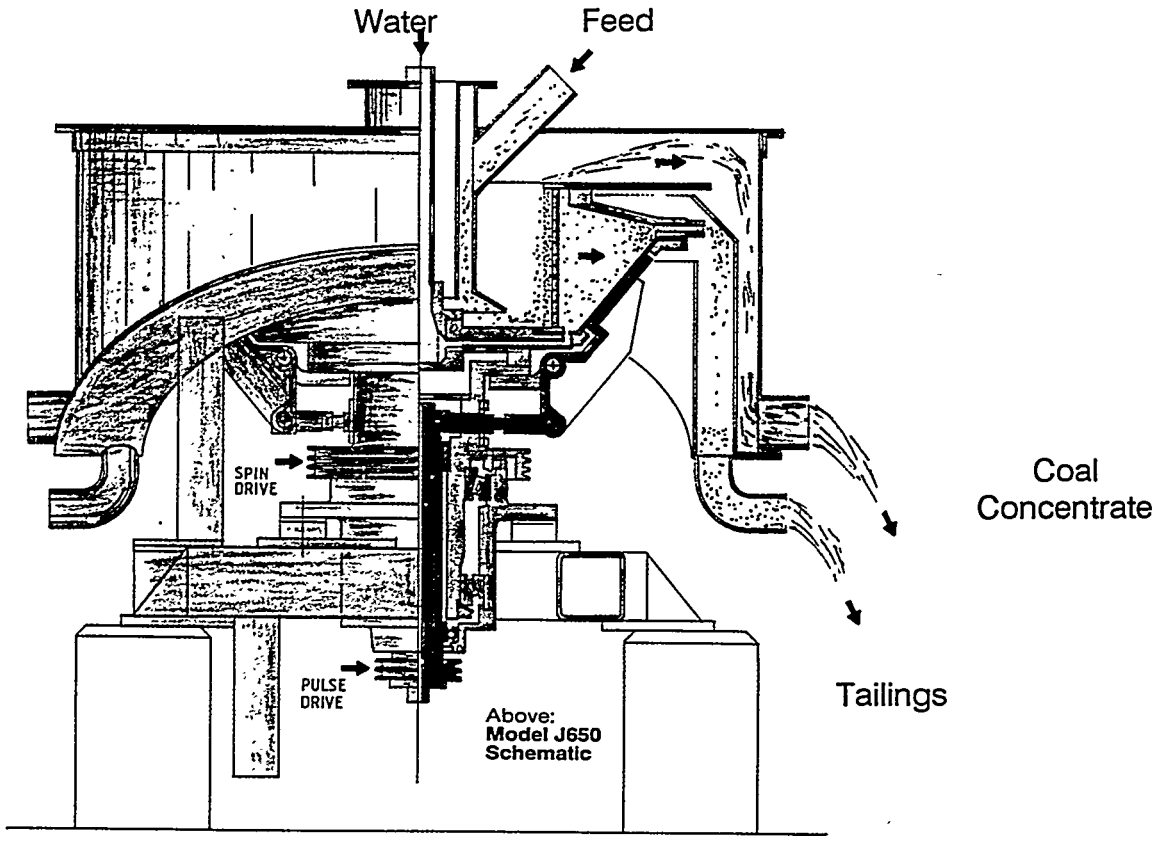


Figure 4.16 – Kelsey Centrifugal Jig

together with the rotor. The screen is lined inside with the ragging spread coaxially by centrifugal force evenly over the inside surface of the screen.

The feed pulp passes down the fixed center annular pipe and is distributed over the ragging. The feed flows upward over the ragging causing the coal concentrate to overflow the retention plate and then to the discharge orifice while the tailings pass through the ragging and screen and is discharged through the rotating spigots. Hutch makeup (the additional clean water required for the pulsing flow) is fed through the spinning center pipe.

The pulsator is driven to create a water pulse inwardly through the screen and ragging sequentially, while differentially accelerating the feed and ragging particles according to their specific gravity. The particles then settle under centrifugal force (or induced apparent gravitational force) causing the heavy mineral separation from the lighter fraction.

Table 4.35 presents select performance results of the JIG on the Pittsburgh No. 8 and the Illinois No. 6 coals. Seven tests were conducted on each of the coals and the results presented are the best-case results as determined by the separation efficiency. The definition of separation efficiency is also presented in Table 4.35.

Significant additional pyrite rejections resulted for each coal when the advanced column flotation concentrate was reprocessed in the JIG. Pyrite rejections ranged from 13.3 to 40.0 percent for the Pittsburgh No. 8 coal and from 18.9 to 29.0 percent for the Illinois No. 6 coal. Minimum energy recoveries were 93.2 percent for the Pittsburgh No. 8 coal and 90.1 percent for the Illinois No. 6 coal. These results indicate that, for each coal, significant amounts of liberated pyrite were recovered to clean coal in the advanced froth flotation cell. Importantly, these results also indicate that some combination of flotation-based and gravity-based separations on finely ground coals may improve the chances of achieving the 85/85 performance goals of the present work.

Table 4.35
Kelsey Centrifugal Jig, Best-Test Performance*

Coal	Energy Recovery (%)	Ash Rejection (%)	Pyritic Sulfur Rejection (%)
Pittsburgh No. 8	93.2	23.1	40.0
Illinois No. 6	93.6	15.0	27.8

* Best-Test Performance as Measured by Separation Efficiency:
Separation Efficiency = % Energy Recovery - (100 - % Pyritic Sulfur Rejection)

Carpco Multi-Gravity Separator (MGS)

The MGS was developed by Richard Mozley Limited, U.K., for the selective separation of fine particles based on differences in density. The MGS unit is distributed in North America by Carpco, Inc., of Jacksonville, Florida. A drawing of the pilot-scale version of this device is shown in Figure 4.17. The operating principle of the MGS is similar to that of a conventional concentrating table. However, by placing the carrying

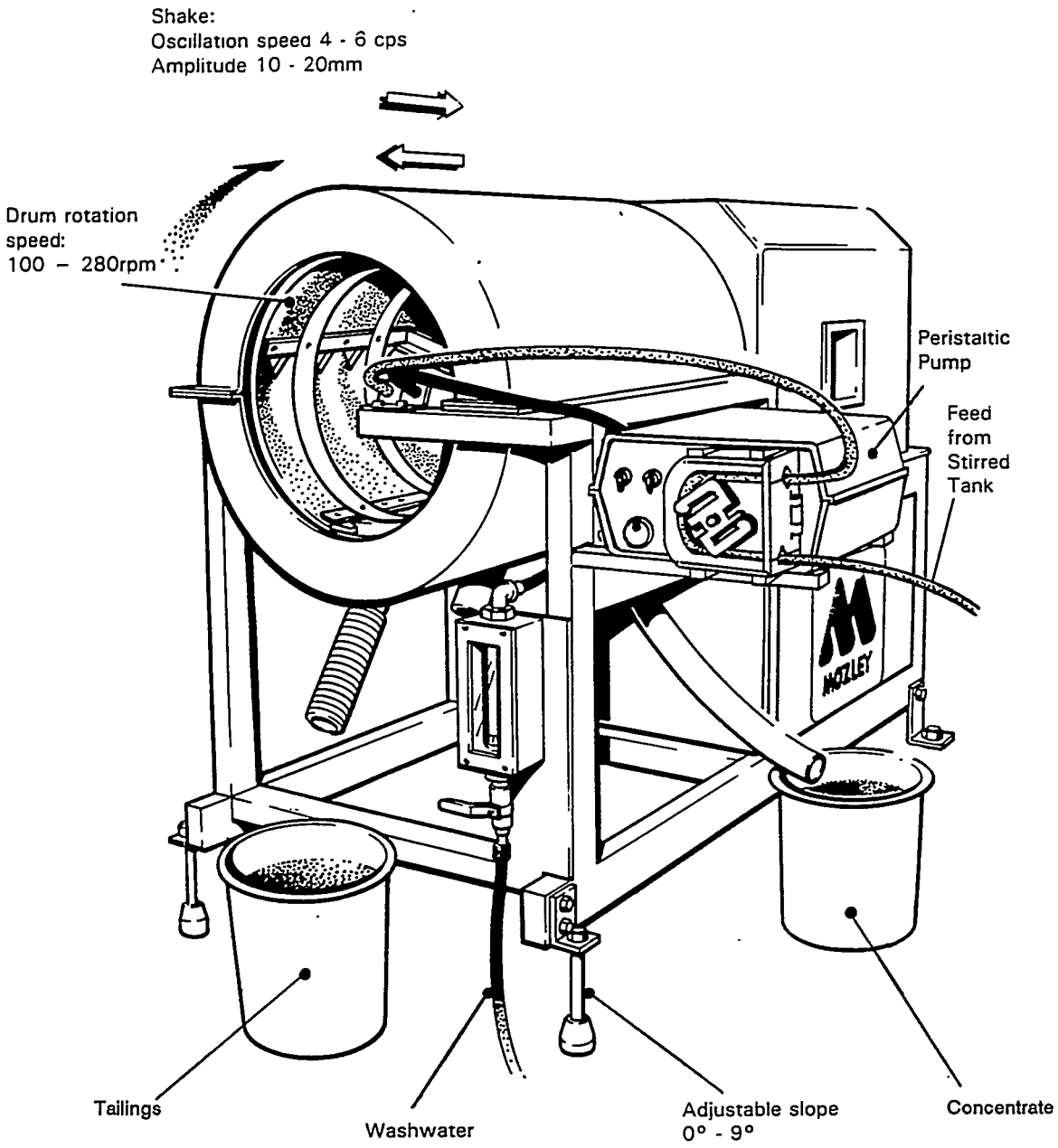


Figure 4.17 – Carpco Multi–Gravity Separator

surface inside a rotating drum, it is possible to achieve many times the normal gravitational pull on the particles as they move across this surface in a film of water flowing along the internal surface of the drum. The centrifugal field allows finer particles to be selectively separated compared to conventional flowing-film separators.

Successful applications of the MGS technology include the concentration of cassiterite, chromite, wolframite, graphite, mixed sulfides, and gold. For these application, MGS can treat particles in the range of 1-1000 μm with high separation efficiencies. On the other hand, shaking tables are generally effective over a particle size range of 200-1200 μm. The capacity of the MGS is also very high because of the centrifugal force. According to the manufacturer, a double drum MGS unit is equivalent to a dozen conventional shaking tables in terms of throughput.

Table 4.36 presents select performance results of the MGS on the Pittsburgh No. 8 and the Illinois No. 6 coals. Five tests were conducted on each of the coals, and the results presented are the best-case results as determined by the separation efficiency. This term was previously defined and presented in Table 4.35.

Pyrite rejections were poor for the MGS on both coals tested, and investigators believe that this was a result of low solids content in the feed to the MGS. Unfortunately, schedule and time constraints did not allow additional MGS testing at high feed-solids levels. Nonetheless, 4.3 percent pyrite rejection was achieved on the Pittsburgh No. 8 coal and 12.2 percent on the Illinois No. 6 coal, each at energy recoveries exceeding 99 percent.

Table 4.36
Carpco Multi-Gravity Separator, Best-Test Performance*

Coal	Energy Recovery (%)	Pyritic Sulfur Rejection (%)
Pittsburgh No. 8	99.8	4.3
Illinois No. 6	99.6	12.2

Summary

In summary, the short jig and MGS test programs conducted on the Pittsburgh No. 8 and Illinois No. 6 coals resulted in some findings that may be useful to future coal process-related research. Each unit rejected additional pyritic sulfur from advanced froth flotation concentrates that had been vigorously cleaned in the POC process of the present work. These promising results were accomplished without a thorough effort to maximize the jig and MGS operations. Integration of advanced froth flotation and gravity-based separation techniques on coals ground to 200 mesh or finer may be required to achieve the goals of high pyritic sulfur rejection and high energy recovery that were set for this project.

4.8 Summary of Trace Element Removal Study

Plant feed, plant clean coal and plant refuse samples collected during the 24-hour demonstration runs for each coal were analyzed for trace element content. This was done in order to evaluate the ability of the advanced

froth flotation process to remove trace elements prior to coal utilization. Detailed results and the evaluation of these results are presented under separate cover in Topical Report No. 5 - Trace Element Removal Study[7].

Coal cleaning is an effective strategy for reducing the amount of trace elements in coal. However, the degree of trace element removal is related to the amount of ash removed from the coal source. Results from Topical Report No. 5 show that advanced coal cleaning, in conjunction with conventional coal cleaning, can provide significant ash removal and trace element removal from a raw coal source.

For the Pittsburgh No. 8 seam coal, rejections in excess of 60 percent were observed for all trace elements analyzed. For some trace elements, such as arsenic, barium, cadmium, cobalt, chromium, copper, fluorine, lithium, manganese, nickel, lead, tin, thorium, thallium, uranium, vanadium and zinc, rejections of 80 percent and above were achieved. Due to the high ash content of the raw coal source, more than half of this rejection was achieved by conventional coal cleaning. After extensive additional grinding, advanced coal cleaning contributed an additional 20 percent to 30 percent rejection in most cases. Overall, nearly 83 percent of the total ash was rejected along with 91 percent of the total trace element weight.

For the Upper Freeport seam coal, the overall total rejections were not as significant. However, the ash content of the raw coal source in this case was significantly lower than the other two coal sources. As a result, the expectations for overall ash and trace element removal should be lower. In fact, about 61 percent of the ash was rejected in the POC demonstration runs along with 70 percent of the total trace element weight. In addition, significant rejections for all trace elements except for beryllium (24 percent) and vanadium (34 percent) occur. More than half of the total rejection for most elements was achieved by advanced coal cleaning. On the other hand, more than half of the total rejection for arsenic, mercury, lead, thallium, and uranium occurs by conventional coal cleaning. Perhaps this indicates a preferential association between certain elements and ash-forming mineral matter.

The results for the Illinois No. 6 seam coal were similar to the Pittsburgh No. 8 coal results. Nearly 80 percent of the total ash was rejected along with 88 percent of the total trace element weight. Significant rejections in excess of 60 percent were observed for all trace elements analyzed and rejections were above 80 percent for the following individual trace elements: arsenic, barium, cadmium, chromium, copper, fluorine, manganese, nickel, antimony, selenium, thallium and zinc. For most elements, conventional coal cleaning contributed a greater proportion of the total rejection than advanced coal cleaning.

For all three coal tests, a general linear relationship between ash rejection and trace element rejection has been shown. This observation is in general conclusion with other studies on the subject matter[8, 9, 10, 11]. In addition, the additive effect of conventional coal cleaning combined with advanced froth flotation has allowed for high trace element rejections to be achieved by physical coal cleaning processes. The

combined ability of these technologies to result in high trace element rejections is enhanced where the amount of ash in the parent coal is high.

5.0 FINAL SEMI-WORKS CONCEPTUAL DESIGN

This task involved the final revision of the conceptual flowsheet for a 20 TPH Semi-Works facility that incorporates advanced froth flotation technology. The design of this flowsheet incorporates important findings from both bench-scale and POC-level testing, and the final design represents a significant change from the original conceptual design. These design modifications and the reasons for the changes were addressed in Section 3.7 and 4.6 of this report. The performance of the final conceptual flowsheet is based on the raw coals procured for the POC operations and the process performance achieved during these operations.

5.1 Design Philosophy

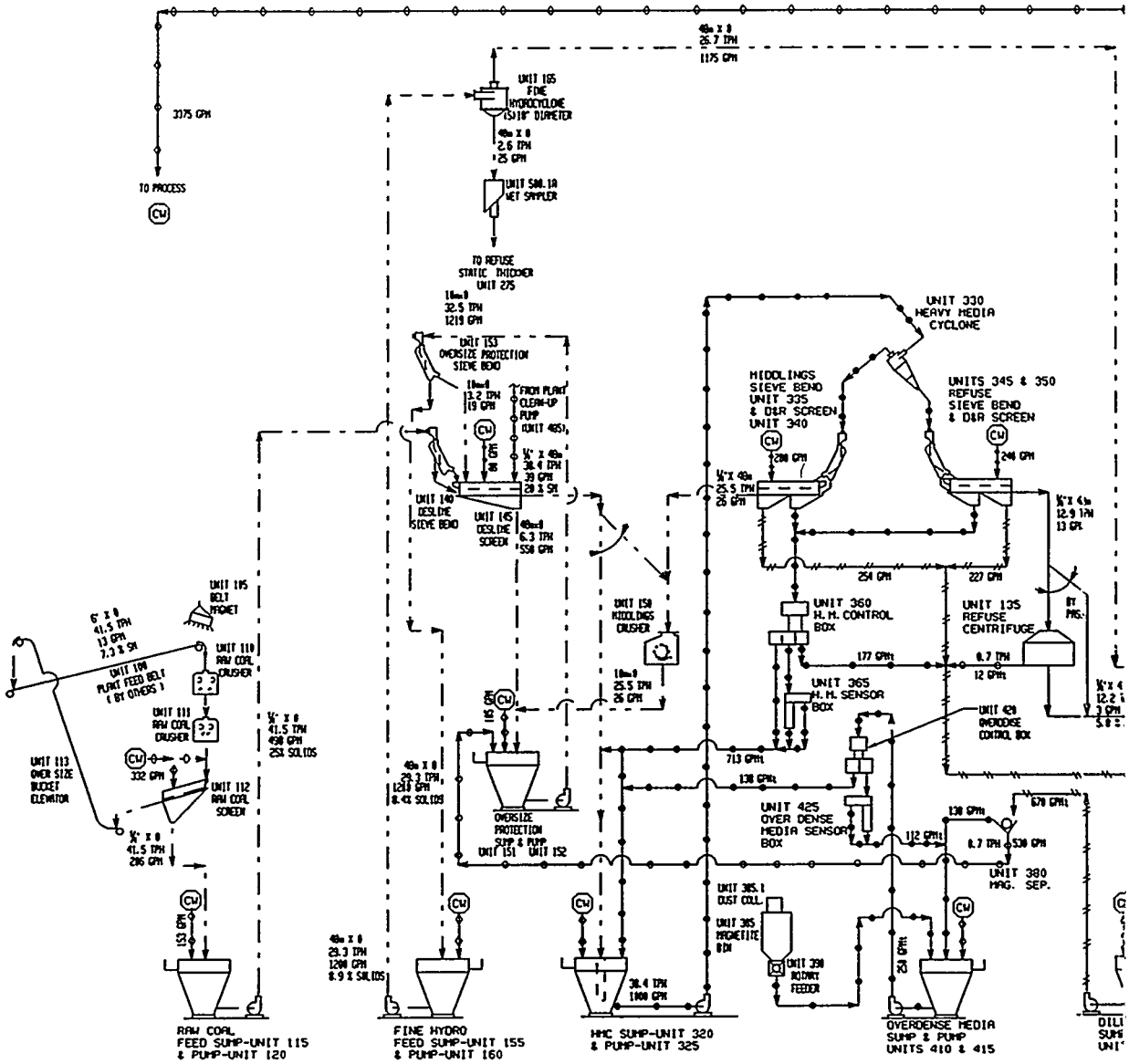
The design philosophy applied to achieving the goals of the project was to utilize conventional coal cleaning methods ahead of applications of fine coal grinding, advanced benefication, and product-recovery schemes. Conventional cleaning approaches can cost effectively remove fractions of the raw coal that contain high percentages of both ash and pyritic sulfur so as to eliminate the need for their comminution. While it is inevitable that some energy will be lost in the process, it was held to a minimum.

Utilizing this concept of conventional precleaning then, natural size fractions of the crushed ROM coals are separately processed, in the conceptual flowsheets, to reject high-ash streams before any further comminution efforts are completed on those fractions. The 1/4-inch by 48 mesh size fraction of the raw coal is cleaned in a heavy-media cyclone circuit at a high specific gravity of separation, in order to produce a reject stream that is low in energy content but high in both mineral matter and sulfur content. The precleaned product from this operation is crushed to 48 mesh by zero, combined with the like-sized fraction of the raw coal, and this combined stream is cleaned in water-only cyclones configured, again to make a high specific gravity of separation. From these two conventional cleaning stages, relatively easy-to-remove mineral matter and pyrites are excluded from the fine-grinding circuit, which next reduces the particle size of the water-only cyclone product from 48 mesh by zero to approximately 85 percent passing 200 mesh. This grinding stage liberates additional pyrite and mineral matter from the coal particles, and the advanced froth flotation process is used to exploit this in the final coal cleaning stage. Following is a description of the individual unit operations required in order to build an integrated and fully-automated advanced froth flotation plant.

5.2 Preparation of Conceptual Flowsheets and Material Balances

5.2.1 Revised Flowsheet Description

A final process flowsheet and a separate material balance schematic were developed for each of the three coals of the project. These are provided in Figures 5.01 through 5.06. The flowsheets describe the entire process and define the plant battery limits for which an equipment list, engineering drawings, and a capital cost estimate are later provided. The plant battery limits do not include any raw coal storage, reclaim system or plant feed belt. In addition they do not include any clean-coal-belt conveyors. Clean coal size reconstitution, clean-coal storage and clean-



MATERIAL BALANCE				
NAME	SIZE	TPH	GPM	SH
CLEAN COAL	28m x 0	20	27	25.2
TOTAL CLEAN COAL	28m x 0	20	27	25.2
REFUSE	¼" x 48m 48m x 0	12.2 9.3	3 160	5.8 —
TOTAL REFUSE	¼" x 0	21.5	163	—
TOTAL PRODUCTS FEED	¼" x 0 6" x 0	41.5 41.5	190 13	— 7.3
MAKE-UP	—	—	177	—

LEGEND

- RAW COAL
- CLEAN COAL
- REFUSE
- MIDDLINGS
- HEAVY MEDIA
- DILUTE MEDIA
- CLARIFIED WATER
- BLACK WATER
- TPH TONS PER HOUR
- GPM GALLONS PER MINUTE
- GPMt GALLONS PER MINUTE TOTAL
- (CW) CLARIFIED WATER
- (R) REAGENT
- [F] FLOCCULANT
- DENOTES MAX. TPH FOR DESIGN
- DENOTES AUTOMATIC SAMPLER
- SH SURFACE MOISTURE
- % SOLIDS BY WEIGHT

Figure 5.01 Pittsburgh No. 8 Seam Coal, 20 TPH Semi-Works Plant Flowsheet

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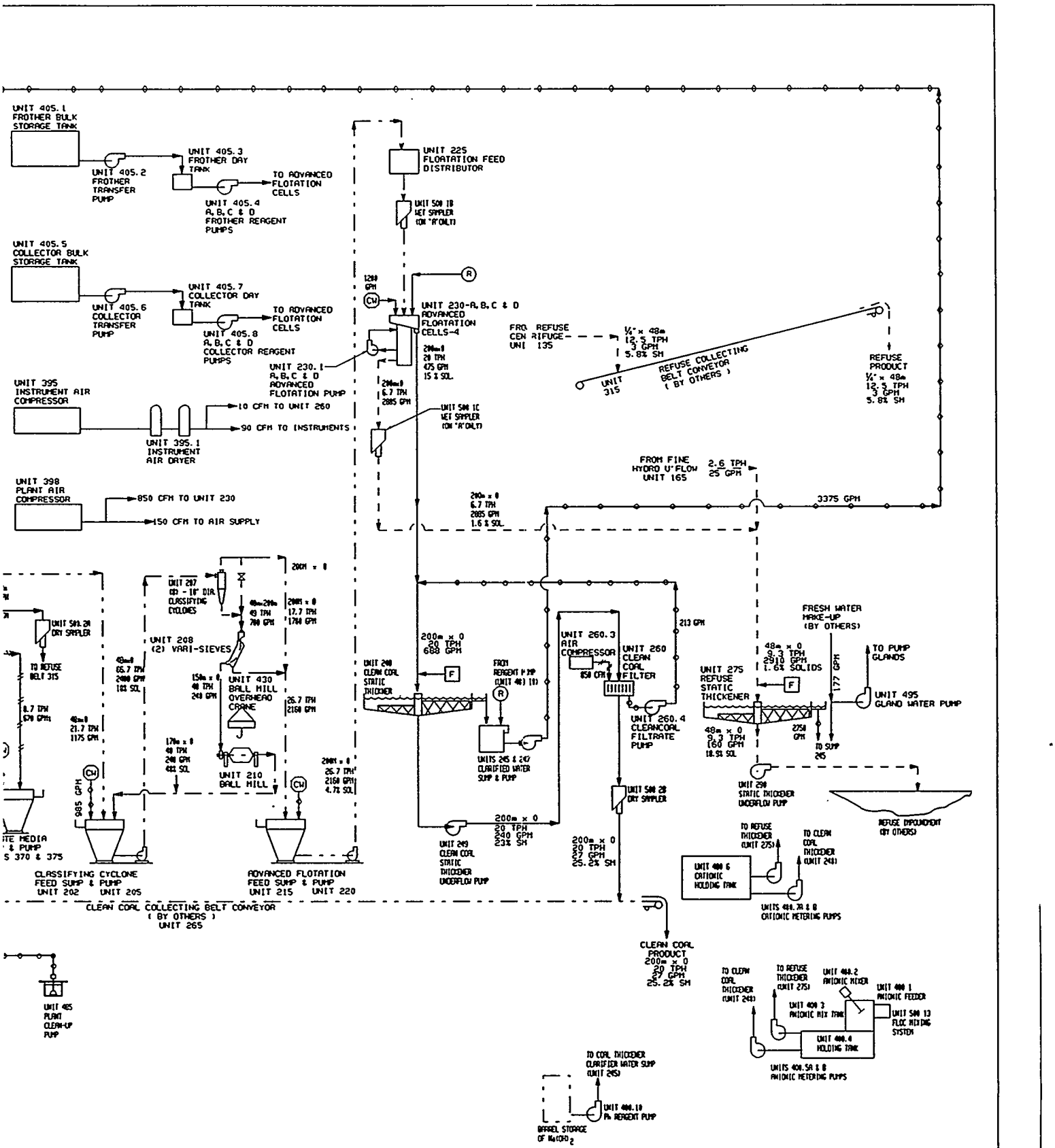

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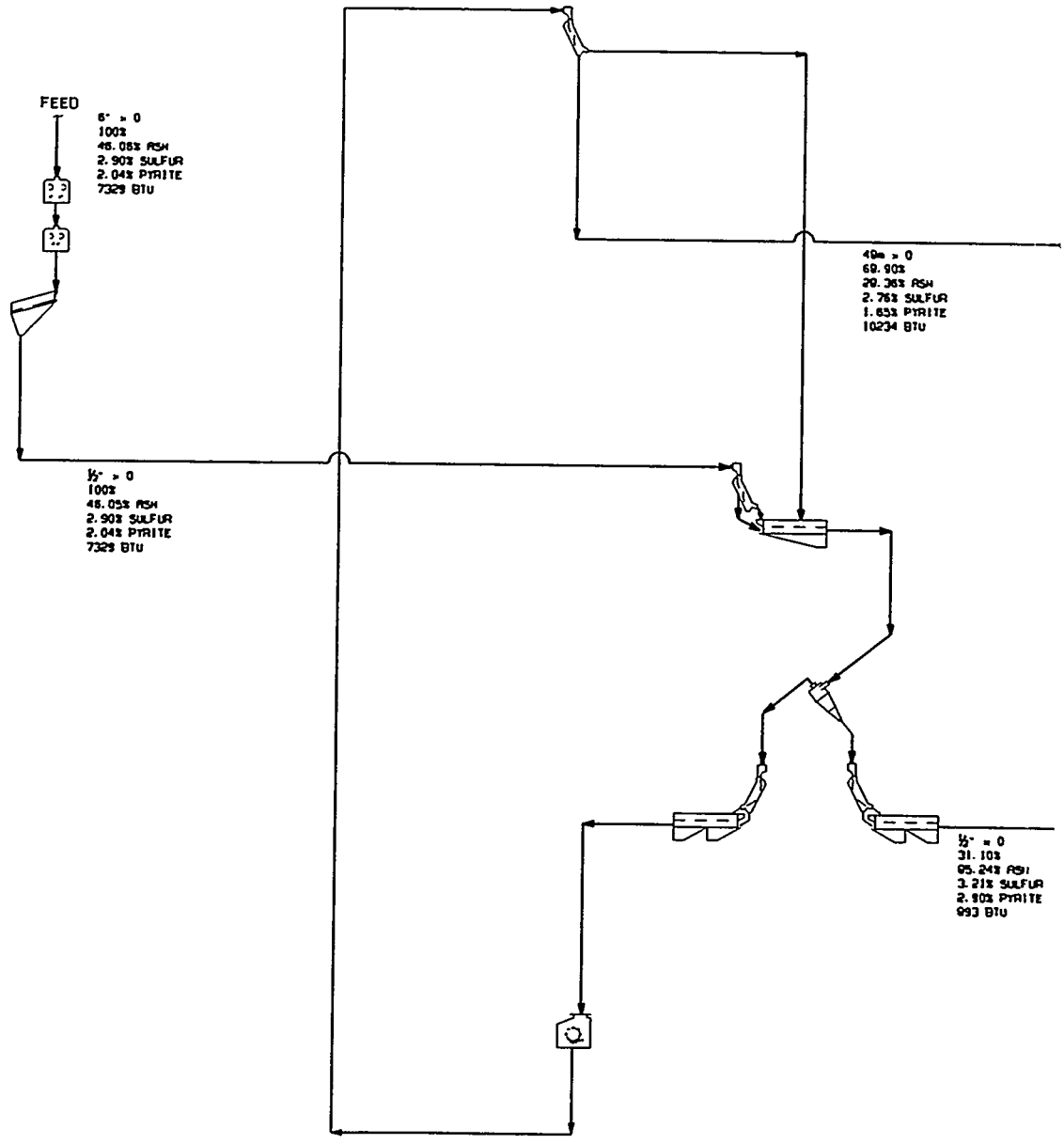

Figure 5.02 Pittsburgh No. 8 Seam Coal, Semi-Works Plant Material Balance

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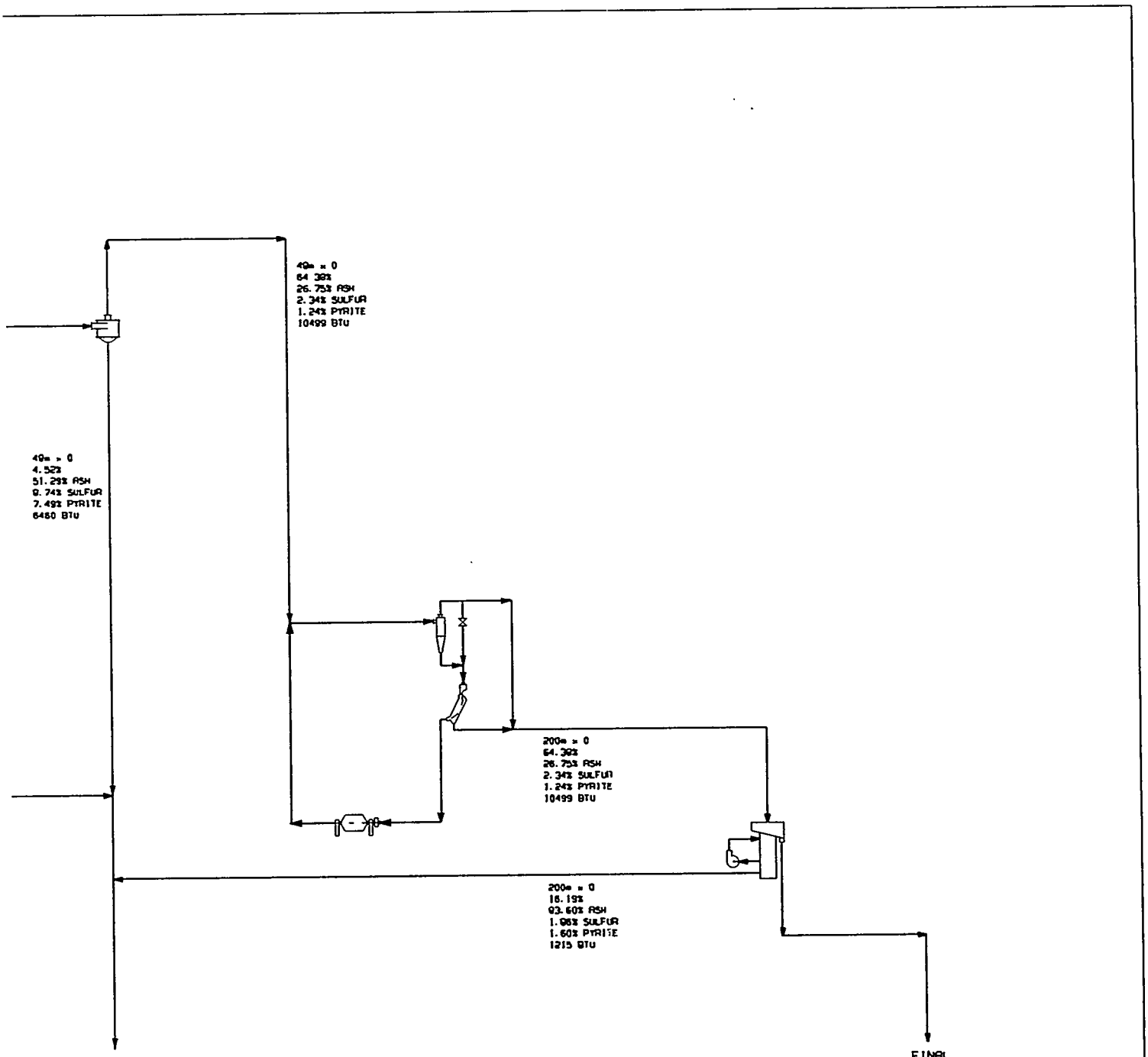

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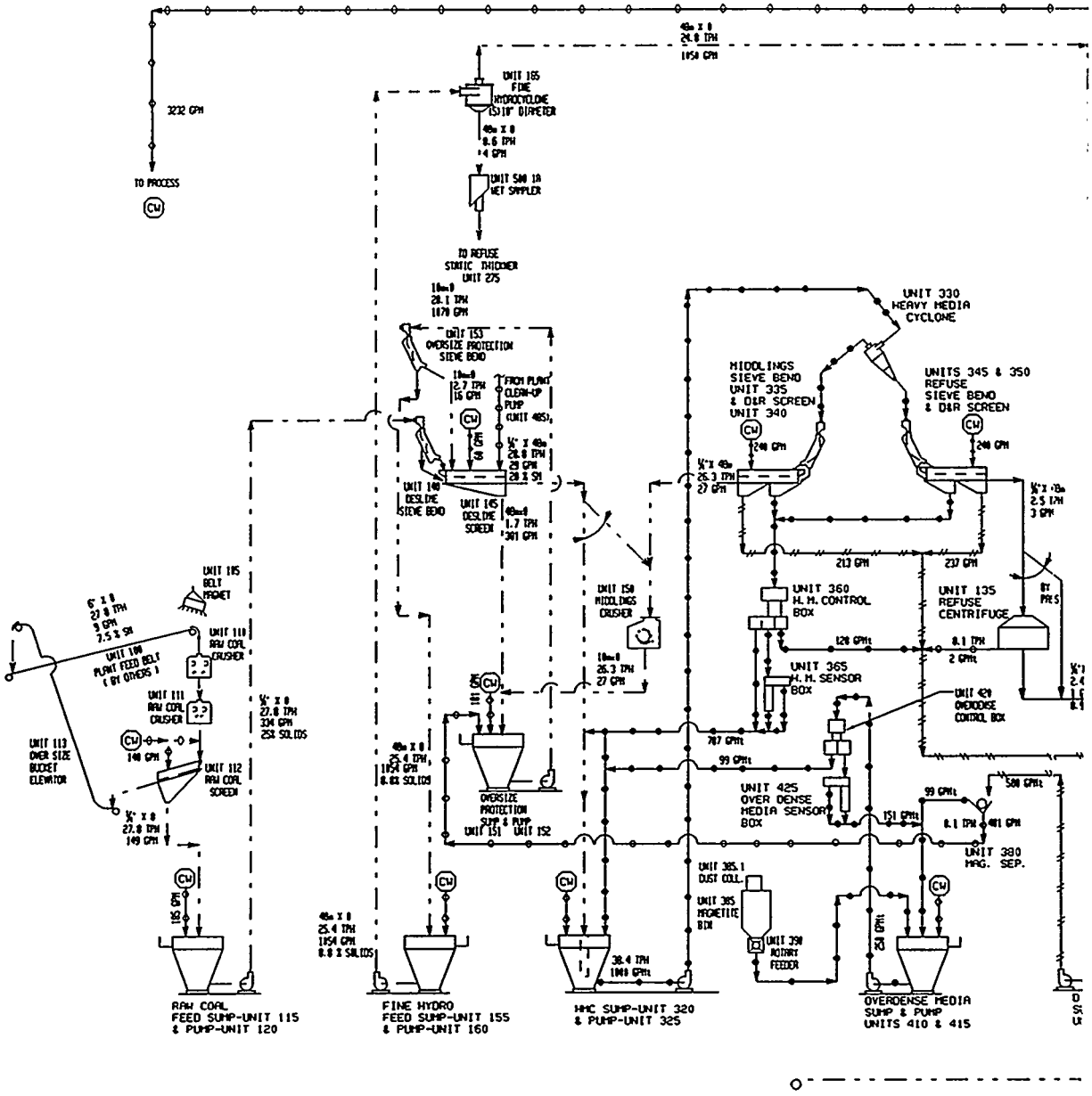

LEGEND

MATERIAL BALANCE				
NAME	SIZE	TPH	GPM	SH
CLEAN COAL	28m x 0	20	27	25.2
TOTAL CLEAN COAL	28 x 0	20	27	25.2
REFUSE	¼" x 48m 48m x 0	2.4 5.4	1 87	8.9 —
TOTAL REFUSE	¼" x 0	7.8	88	—
TOTAL PRODUCTS FEED	¼" x 0 6" x 0	27.8 27.8	115 9	— 7.5
MAKE-UP	—	—	116	—

RAW COAL
CLEAN COAL
REFUSE
MIDDLINGS
HEAVY MEDIA
DILUTE MEDIA
CLARIFIED WATER
BLACK WATER
TPH TONS PER HOUR
GPM GALLONS PER MINUTE
GPMt GALLONS PER MINUTE TOTAL
CW CLARIFIED WATER
R REAGENT

F FLOCCULANT
DENOTES MAX. TPH FOR DESIGN
DENOTES AUTOMATIC SAMPLER
SH SURFACE MOISTURE
% SOLIDS BY WEIGHT

TO DESLIME SCREEN (UNIT 145)

Figure 5.03 Upper Freeport Seam Coal, 20 TPH Semi-Works Plant Flowsheet

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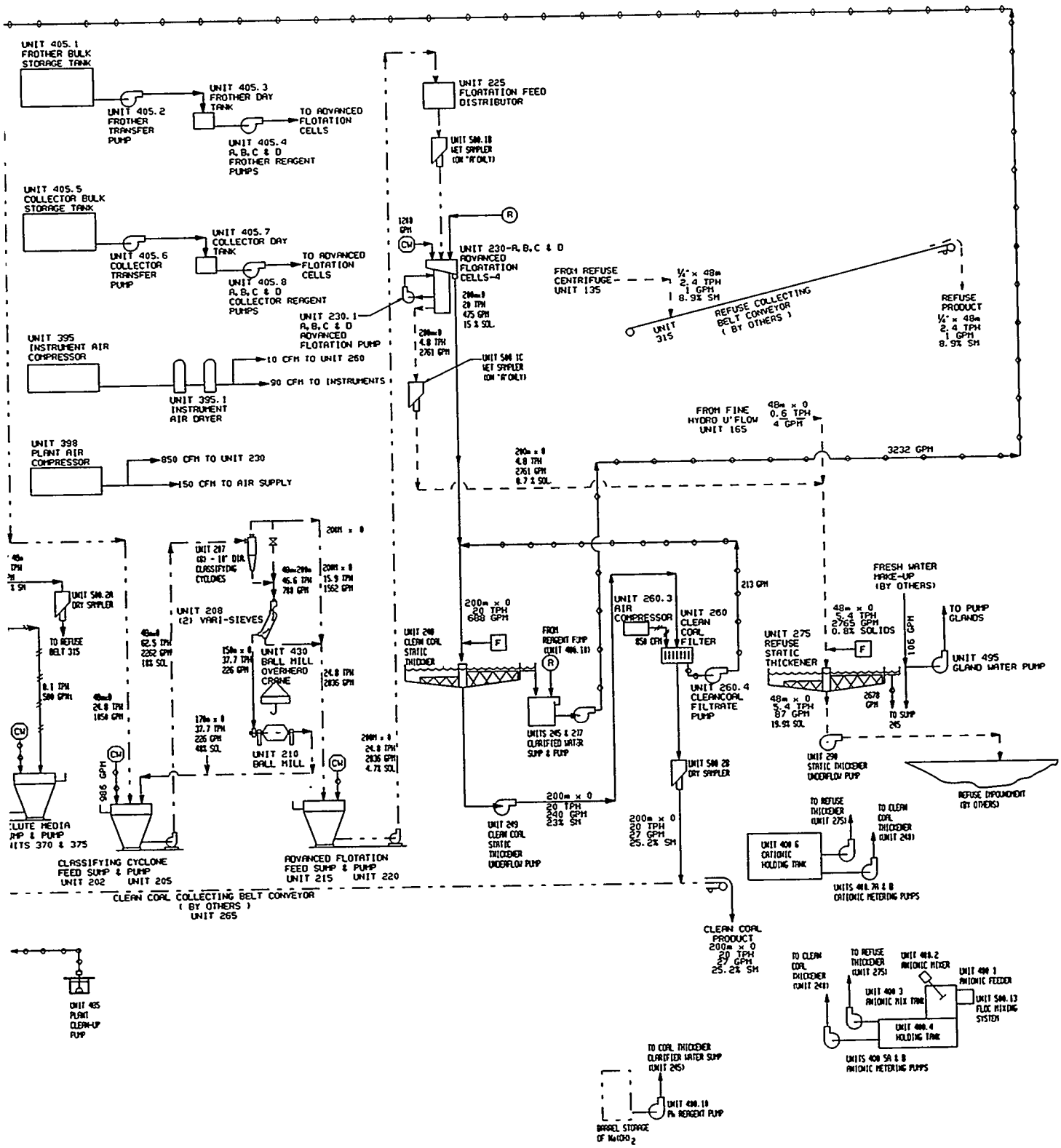

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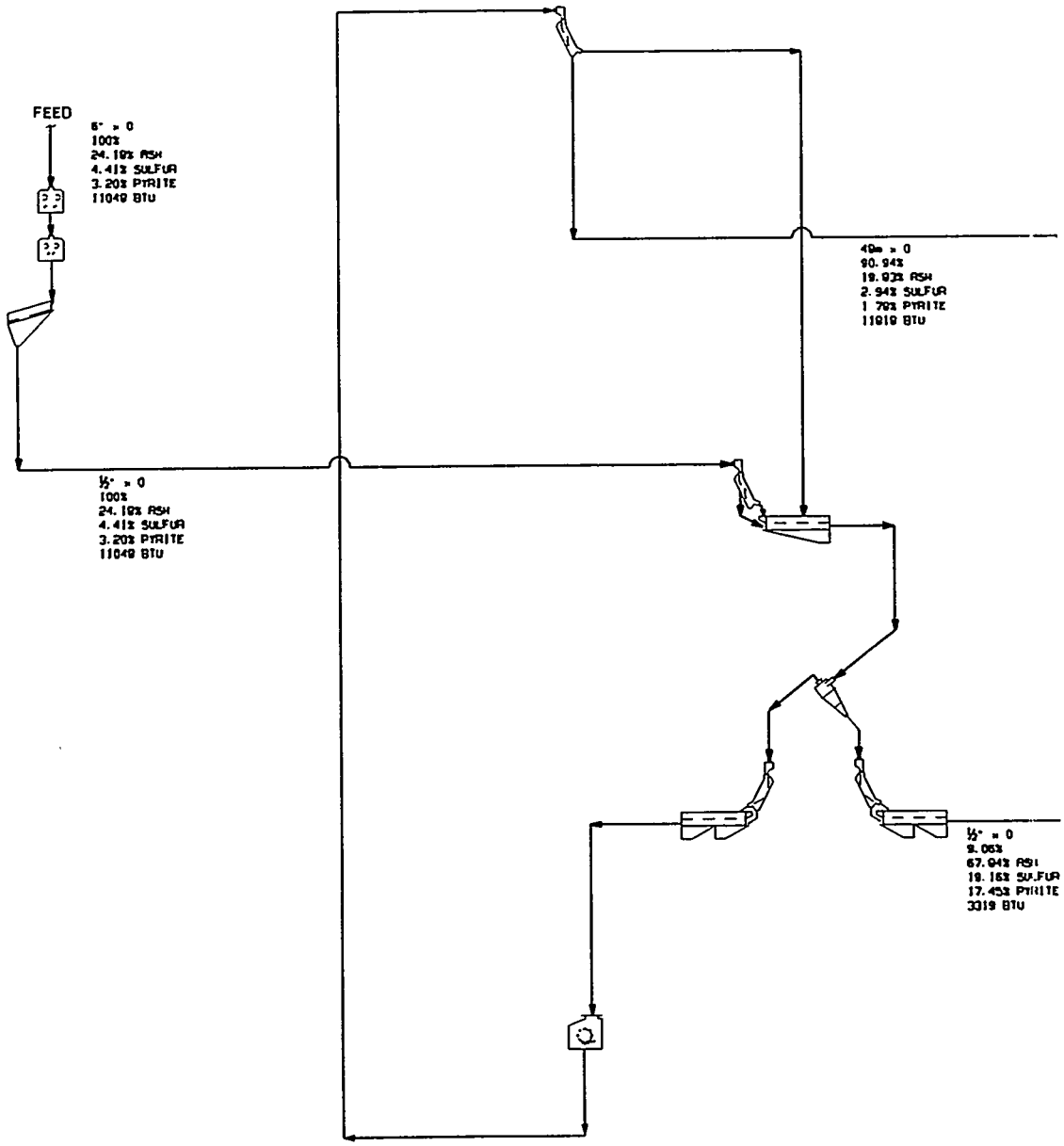

Figure 5.04 Upper Freeport Seam Coal, Semi-Works Plant Material Balance

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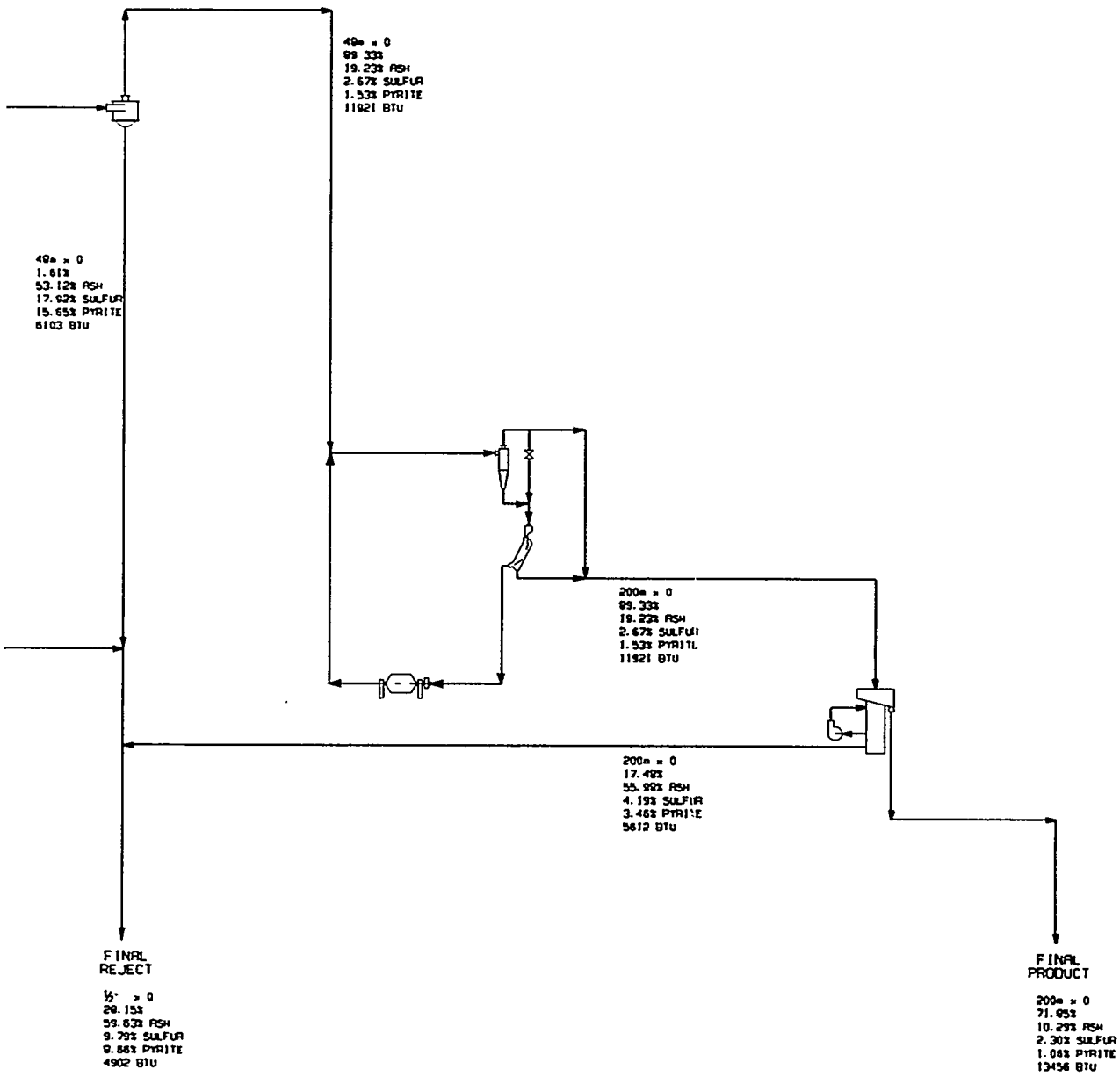

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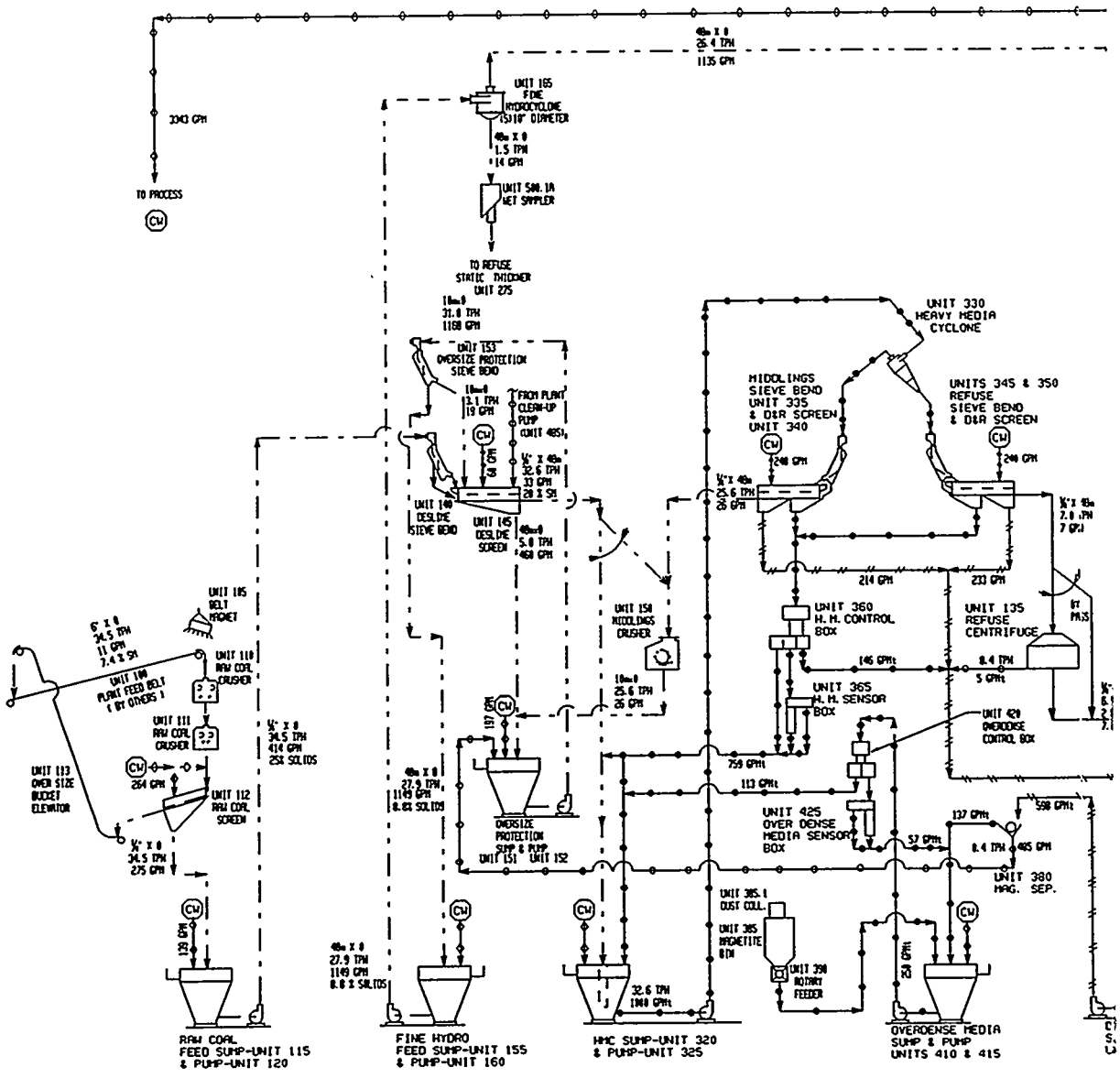

LEGEND

- RAW COAL
- CLEAN COAL
- REFUSE
- MIDDLINGS
- HEAVY MEDIA
- DILUTE MEDIA
- CLARIFIED WATER
- BLACK WATER
- TPH TONS PER HOUR
- GPM GALLONS PER MINUTE
- GPMt GALLONS PER MINUTE TOTAL
- (CW) CLARIFIED WATER
- (R) REAGENT
- [F] FLOCCULANT
- DENOTES MAX. TPH FOR DESIGN
- DENOTES AUTOMATIC SAMPLER
- SM SURFACE MOISTURE
- % SOLIDS BY WEIGHT

MATERIAL BALANCE

NAME	SIZE	TPH	GPM	SM
CLEAN COAL	28m X 0	20	27	25.2
TOTAL CLEAN COAL	28m X 0	20	27	25.2
REFUSE	½" X 48m 48m X 0	6.6 7.9	2 136	7.0 —
TOTAL REFUSE	½" X 0	14.5	138	—
TOTAL PRODUCTS FEED	½" X 0 6" X 0	34.5 34.5	165 11	— 7.4
MAKE-UP	—	—	154	—

Figure 5.05 Illinois No. 6 Seam Coal, 20 TPH Semi-Works Plant Flowsheet

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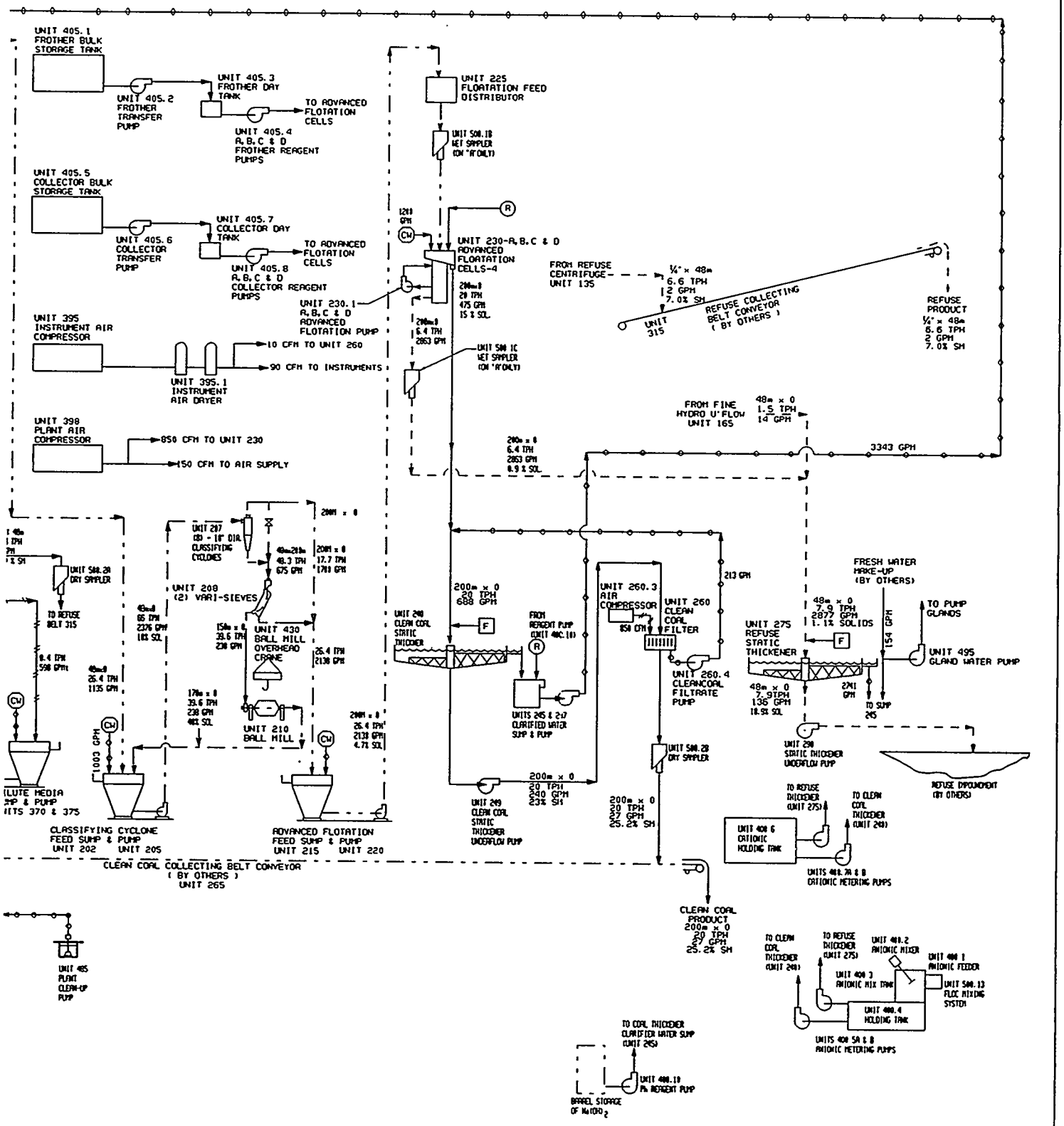

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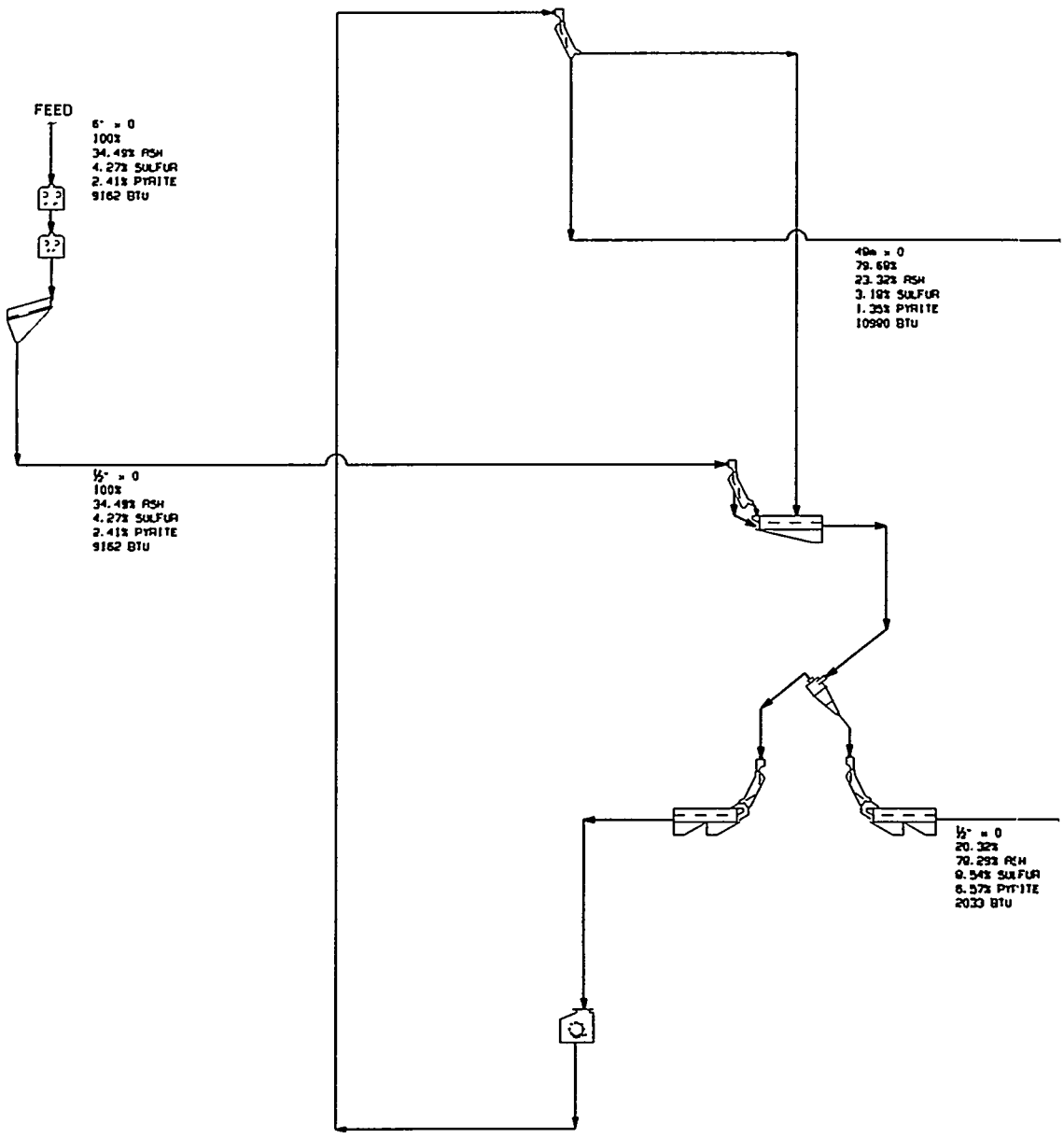

Figure 5.06 Illinois No. 6 Seam Coal, Semi-Works Plant Material Balance

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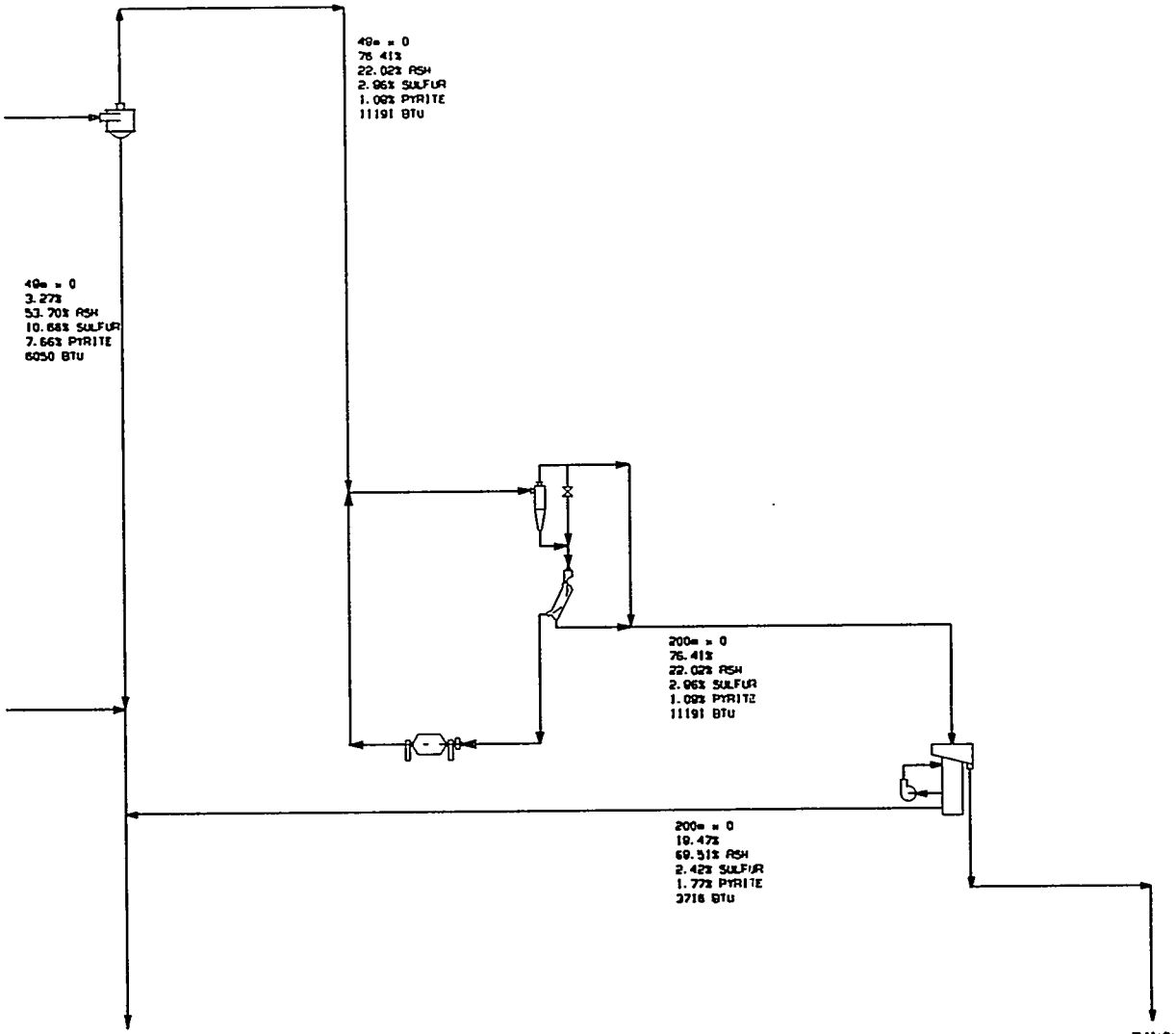

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coal shipment systems are also not included. Likewise, the plant battery limits do not include any refuse belt conveyors. Refuse storage and final refuse disposal systems are not included.

The utilities required by the preparation plant are fresh water, power of correct voltage (480 volt and 4160 volt, 3 phase, 60 cycle), magnetite, flotation reagents, and flocculants. These would have to be purchased from outside suppliers.

The Semi-Works plant receives run-of-mine coal from the plant feed belt, removing tramp iron by the tramp iron magnet and crushing the coal by the raw-coal crusher to minus 1/2 inch top size. The crusher product is pulped with water and wet screened on the oversize protection screen at 1/2 inch. Any material larger than 1/2 inch is recycled to the raw-coal crusher. The material that is smaller than 1/2 inch is pulped with additional water until the desired percent solids is obtained.

The pulped 1/2 inch x zero raw coal is pumped to a deslime sieve/screen combination fitted with panels to effect a nominal 48 mesh (300 microns) size separation. The coarse-screen discharge is pulped with magnetite-based media and flows to a heavy-media cyclone feed sump where additional recirculating and overdense media are added. This recirculating media is monitored by a nuclear density gauge for specific gravity and the overdense media is added if needed to maintain a specific gravity of 1.70 or 1.75, depending on the coal.

The sump contents are pumped to a heavy-media cyclone and the cyclone products are passed over drain-and-rinse sieve/screen combinations used for magnetite recovery. The refuse screen discharge is dewatered in a vertical basket centrifuge and is discharged to the refuse conveyor. The clean coal screen discharge is directed to an impact crusher to reduce the material to 48 mesh by zero. The crusher throughput is collected in a sump, pulped with water and pumped to an oversize protection sieve bend that effectively closes the coarse-grinding circuit. The sieve bend discharge is recycled to the deslime screen feed while the sieve effluent reports to the fine water-only cyclone feed sump.

The fine water-only cyclone is configured to produce a high specific gravity separation. The overflow is precleaned coal and the underflow is high-ash, high-sulfur, low-BTU refuse material. The refuse material is directed to the refuse-static thickener. The coal becomes the feed to the fine coal grinding circuit.

New grinding circuit feed and the ball-mill discharge are combined, sumped, and pumped to a thickening cyclone configured to make a size classification at 200 mesh. The minus 200 mesh will be sent to the advanced flotation circuit. The plus 200 mesh material will be processed in the ball-mill to produce a minus 200 mesh product. The ball-mill will be in reverse closed circuit with the cyclone.

The single-stage advanced froth flotation circuit produces a clean-coal and refuse stream. The clean coal reports to the clean-coal static thickener. This unit produces a concentrated solids underflow which is pumped to a hyperbaric disk filter for final dewatering and a low solid supernatant that is recycled to the plant process.

The refuse stream from the water-only cyclone and the advanced froth flotation units report to a refuse static thickener that produces a concentrated solids underflow and a low solid supernatant that is recycled to the plant process. The underflow is pumped to a refuse impoundment.

ICF KE developed the flowscheme presented above to comply with DOE requirements and ICF KE team member's design philosophy. Unit operations were evaluated and selected based upon economic and technological advantages.

5.2.2 Unit Operations Description

The following is a description of the individual unit operations:

- Primary Crushing

  In order to maximize pyrite reduction, it will be necessary to reduce the run-of-mine coal in size to liberate the pyrite. A minus 1/2" size was selected as a first stage, as this is a good feed size to conventional gravity separation equipment and provides some liberation of ash and pyrite to permit rejection of low Btu content material.

  Roll-type crushers are used for this application since they do not generate a lot of fines compared to ring- or hammer-type granulators. A large percentage of the roll-crusher product remains in the plus 48 mesh sizes.

  The primary roll crusher is in closed circuit with an oversize protection screen. Screen oversize discharges to a belt conveyor that recirculates + 1/2" material to the crusher feed. Screen underflow reports to the raw coal sump.

- Screening at 48 Mesh

  The next step in the flowsheet provides a size separation at 48 mesh (or 300 microns) in order to prepare a heavy-media cyclone feed. This size was selected instead of the more conventional size of 28 mesh in order to increase the tons going to the heavy-media cyclone. At 48 mesh, conventional coal and media recovery techniques can be applied and were successfully tested at the POC.

- Heavy-Media-Cyclone Circuit

  The heavy-media cyclone is presently the most efficient separating device for processing plus 48 mesh coal. The unit has been proven to efficiently separate coal down to 100 mesh. The heavy-media cyclone product is directed to a secondary crushing operation. Magnetite is removed on conventional drain-and-rinse screens and recovered in a conventional dilute media circuit.

- Secondary Crushing

  The heavy-media cyclone product will be directed to a crusher in closed circuit with a screening device for crushing and further

liberation at 48 mesh. The cagepactor crusher in closed circuit is used commercially to produce finely ground material while minimizing the generation of ultra-fines. This unit operation will produce the desired size product with the minimum amount of energy. Crusher discharge reports to the oversize protection sump.

- Fine Water-Only Cyclone

After the secondary crushing step, the material has been reduced to minus 48 mesh and there will be additional liberated pyrite and mineral matter. The water-only cyclone offers an economical solution to the removal of these unwashed impurities.

In order to remove the liberated pyrite and mineral matter the minus 48 mesh material will be processed in the fine water-only cyclone, again at a very high gravity in the 1.90 - 2.00 gravity range in order to maximize Btu recovery. The fine water-only cyclone underflow reject, which contains liberated pyrite, reports to the refuse static thickener. The water-only cyclone overflow reports to the mill classifying cyclone feed sump.

- Microgrinding/Classification

To maximize energy recovery and pyrite rejection, ultrafine grinding to liberate the majority of the mineral matter in the coal is required. POC results indicate that a significant percentage of the pyrite can be liberated by grinding to 85 percent passing 200 mesh although finer grinding would increase the changes of meeting the 85/85 performance goals of this project.

The ultrafine coal required for advanced flotation will be prepared using a tumbling-ball mill. The revised conceptual flowsheet incorporates a closed-classification circuit. This will prevent the generation of excess minus 5 micron ultrafines and provide a means of adjusting the final size consist of the feed to the advanced flotation circuit.

While the generation of fine and ultrafine coal particles is an intended and mostly beneficial result of coal grinding efforts, generation of excess submicron material can result in a number of operational problems. Poor thickener performance, higher filter-cake moisture, and impaired rejection of ultrafine refuse particles in the column flotation cell may each result from excess fines generation. For each coal, there is a unique level of fineness that will result in the best balance between the positive and negative aspects of ultrafines generation. Also, for any given coal, this relationship can vary with the current mining location. The closed grinding circuit provides a means for basic adjustments (screen apertures and cyclone configuration changes) in response to medium- to long-term changes in coal characteristics.

A classifying cyclone and Varisieve combination (in series) will adequately separate the precleaned coal streams at 200 mesh. The plus 200 mesh is returned to the ball-mill. The minus 200 mesh becomes the feed to advanced flotation.

- Advanced Flotation

  Column flotation was selected for the advanced flotation process because of the improved selectivity that column flotation cells exhibit in regard to minus 200 mesh particle separations (relative to conventional flotation cells). Column cells also improve coal recovery compared to conventional flotation operations, so that improved product quality is possible at higher energy recoveries. The essential features of column flotation are a countercurrent feeding arrangement, wash-water (sprinkling) additions, and generation and use of microbubbles.

  Due to the superior efficiency of column flotation, the final advanced circuitry configuration only requires a single stage. Task 5 and 6 results indicated limited performance improvement with additional stages.

- Final Dewatering

  The clean coal from the advanced flotation process is first thickened in a conventional static thickener with the addition of flocculant chemicals. The static thickener underflow is pumped to the hyperbaric filter. The clarified water is recycled back into the plant.

  The final dewatering of the clean coal is by a hyperbaric filter. This unit operation is incorporated into the final design because despite the fact that the hyperbaric filter tested at the POC was not operated during the extended-duration tests. A number of factors contributed to the decision to recommend the hyperbaric filter for the Semi-Works facility. The hyperbaric filter tested at the POC produced very handleable filter cakes, and filter coke samples that were extracted at the POC indicated likely compliance with the project goal of 30 percent surface moisture. Also, project investigators observed first-hand a competing hyperbaric filter test unit at a coal preparation plant in northern West Virginia. Using a variation of the double knife gate discharge system with critical improvements to the gate sealing approach, no evidence of seal leakage or subsequent pressure losses was found during four hours of observation. Both Andritz and KHD Humbolt Wedag claim to have sold successfully-operated commercial size units in Europe, albeit for coarser-coal applications (28 mesh and 100 mesh by zero). These commercial installations, reportedly, are not plagued by the problems associated with the unit that was utilized in the POC. The product of the filter, clean coal, is discharged to the clean coal conveyor and the filtrate is discharged to the static thickener for recycle.

  The POC underflow and the advanced flotation cell tailings are first thickened in a conventional static thickener with the addition of flocculant chemicals. The static thickener underflow is pumped to an impoundment. The impoundment is large enough to permit the solids to separate from the water. The solids are retained in the impoundment and the water is recycled back to the plant. The

clarified water from the static thickener is recycled into the plant.

5.2.3 Distributed Process Control System

- Control System Description

The Semi-Works coal preparation facility is organized and controlled on the basis of one control room containing a complete stand-alone control system. The control system shall include all the hardware and software required to provide regulatory control and sequential control of the process, motors, and monitoring.

The Programmable-Logic-Controller (PLC) based process-distributed control system is capable of performing data acquisition functions, supervisory setpoint control, operator control, and facilities for programming.

The major parts of the system includes:

Data Acquisition Computer System (DACS)

The DACS functions are:

- Real time relational database management
- Network communication with PLC's
- Generation and handling of process alarms
- Custom report generation
- Real time and historic trending
- Storage of operating system
- Storage of programs and displays
- Storage of process trend data
- Program loading

Operator Station

An operator station is provided with a 19-inch high resolution color graphic screen, custom membrane keyboard, and engineering keyboard. The main functions are:

- Configuration of database
- Generation of standard and custom displays
- Operator interaction for process control
- Graphical programming on-line and off-line program documentation.
- Reports to be user configurable to any desired format.
- User custom programming area, "C" language with full access to real time database.
- Loop tuning

- Instrumentation & Control

Process operational control can be summarized under the following physical parameters being measured.

A. Fluid Level (pressure)
B. Density
C. Flow
D. Moisture
E. Weight
F. Torque
G. Settling Rate
H. Turbidity (light transmittance)
I. pH

Nearly all unit operations throughout the entire flowsheet will have some combination of the above physical parameters measured and/or controlled.

There is an exception and special consideration for the heavy-media cyclone sump, since there are occasions when higher moisture on the incoming feed or excessive solids passing through the drain-and-rinse screen cause the sump level to increase instead of decrease.

The controller compares the transmitted level value with a preset high set point. When the transmitted value is higher than the preset value, the high level is annunciated and a bleed control valve is activated to bleed media out of the circuit and thus lower the sump level. This bleed valve is located at the level control box and the discharge reports to the dilute media system where the magnetite is recovered, concentrated, and returned to the overdense system.

A process instrumentation and control diagram for the Semi-Works plant is presented in Appendix C. Below is a functional description for the control of the various plant systems.

- Heavy-Media-Cyclone Density

  The heavy-media cyclone cleaning process is based on the difference in specific gravities of the desired product (coal) and the undesired product (refuse). A portion of the processing media (magnetite suspension) is diverted to the density measuring chamber where a slurry density determination is obtained with a nuclear density gauge.

  The nuclear density gauge transmits a reading back to the supervisory controller that compares this reading to a preset value. Adjustments are determined by the computer and output signals are transmitted to the appropriate control device. Specifically, the controller sends a signal to an air-motor-operated proportioning valve located in the overdense media distribution box. This valve either opens to raise the measured specific gravity or closes to maintain the current measurement.

  This system is basically designed to make-up for magnetite lost in the process and, in fact, anticipates that magnetite will be lost and measured density will decrease. The controller also retransmits this signal to a printer for periodic recording. A low-density condition is alarmed.

- Overdense Media Density

  A separate system is necessary to introduce magnetite into the heavy-media cyclone in order to make-up for what is being lost during processing. This system incorporates an overdense media sump and pump that recirculates a high-density-magnetite suspension to a media-distribution box. The heavy-media-cyclone circuit obtains make-up media from this distribution box as required.

  A nuclear density gauge on the pumped recirculation line makes a slurry density determination and transmits this value to the controller that, in turn, compares this value to a preset value. If the transmitted density value is lower than the preset point, an output signal is transmitted and will start a feeder. The feeder then introduces dry bulk magnetite into the overdense media sump. A low-density condition is alarmed.

- Fine Grinding/Classification

  Based on POC results, investigators believe that it would be very difficult to control the mill-circuit-product grind through online adjustments to operating conditions of the mill circuit. Thus, the online particle size analyzer, the mill classifying cyclone feed pressure gauge, and the variable cyclone feed pump motor have been removed from the Semi-Works plant design. Upon plant start-up, operators will fine-tune the mill circuit by making slight adjustments to the cyclone configuration and, potentially, ball-mill-feed dilution water. Measurements for product particle size will then be taken, and this process will be repeated until the proper mill circuit performance is achieved. A nuclear density gauge and a flowmeter will be installed on the cyclone feed pump in order to determine feed solids flowrate.

- Flotation Cells (Advanced)

  The advanced column flotation cell is equipped with a pressure measuring instrument to maintain a controlled level in the column. This pressure measuring instrument is located near the top of the column and transmits a level signal to the supervisory controller. The controller in turn compares this value with a preset value. When the transmitted value drops below the preset value, the controller sends a proportional signal to a pneumatically operated discharge valve on the column cell tailings line. The valve will gradually close in order to maintain the desired column level. By operating the column at the proper level, recovery and efficiency are maximized. A low level condition is alarmed.

  Another pressure cell located near the bottom of the column is used with the upper level-control transmitter to determine the gas hold-up. This measurement, along with the aeration rate, determines the amount of bubbles at any given time in the column. There is also a direct relationship to this value and the size of the bubbles. The gas hold-up in the column must be maintained at a critical value to guarantee high recovery.

The two pressure cells transmit signals to the supervisory controller which compares the differential between these two pressure values and divides it by the preset actual difference in fluid level height between the two pressure cells to yield the fractional gas hold-up. If this value decreases, there are insufficient microbubbles in the column. The controller then sends out a proportional signal to the frother reagent feed increasing its feedrate. This reduces the surface tension of the water and increase microbubble generation. Values outside the high and low preset ranges are alarmed.

- Clarification

Both clean-coal and refuse thickeners are provided with torque instrumentation to protect the mechanisms from damage. In either thickener, as solids build up in the bottom of the vessel, it becomes more difficult for the thickener rake-arms to travel through this sludge, thereby increasing torque. A motorized lift mechanism automatically raises the rake-arms once a preset torque is reached. Rakes must be lowered manually. Should torque continue to increase, a high-torque level is annunciated. If no remedial action is taken, the thickener drive will automatically be stopped. Additionally, the lift drive will be interlocked so that the lift drive will not operate unless the rake drive motor is running in automatic mode.

Automatic anionic flocculant control is being provided to improve thickener performance. The clarometer automatically obtains a sample of the thickener feed from the feedwell. The sample is taken into a device that photoelectrically obtains a settling-rate value. Based on the difference between the desired preset and actual settling time, the clarometer automatically adjusts the anionic chemical flocculant feedrates.

Automatic cationic flocculant control is also provided. It is very important to maintain the highest clarity to the recirculated process water. Water clarity is essential for effective wash-water application in the advance column cell.

A portion of the clarifier process water is taken into a turbidity measuring device. Upon reaching undesirable amounts of suspended solids a control signal will be transmitted to control the cationic flocculant feeder.

The flocculant preparation and dilution system is fully automated. The flocculant emulsions are pumped from delivery trucks into bulk storage tanks. When the low level in the batch-day tank is reached, a preset amount of chemical is withdrawn from the bulk tank and pumped into the day tank. Simultaneously, dilution water is added and mixed with the flocculant until the "HI" level in the day tank is reached. A low level in either the bulk tank or the day tank is annunciated.

- Belt Scales

  Electronic-type belt scales are mounted on the raw coal, clean-coal, and refuse belts. Each of these units transmits a signal to the controller and indicator, the printer, and a totalizer which cumulates tonnages on these belts. These belt scales are not included in the Semi-Works capital estimate.

- Quality Calculation Section Pyritic Sulfur Rejection/BTU Recovery

  Online determination of pyritic sulfur or energy content will not be attempted since there are no proven methods of determining the pyritic sulfur content of slurry or dry flow streams.

- pH Control

  A pH probe is installed on the thickener feed. Output from this probe is used to either add pH elevating or pH depressing chemicals such that the clarification/thickening process can be conducted under optimum pH conditions. When the resultant clarified water is recirculated it causes the advanced flotation process to be conducted under the best pH conditions.

- Automatic Sampling

  Automatic slurry samplers are located to obtain periodic samples of various flowstreams for analytical purposes. Sampling and weighing points are indicated on previously presented flowsheets. Cutter speeds and openings are mechanically preset. Cutter frequencies are controlled by preset values in the supervisory controller. The running number of cuts are totalized and stored within the controller's logic for access. Cutter operations are indicated on the panel. Slurry samples are as follows:

  1. Water-Only Cyclone Underflow
  2. Advanced Flotation Tails
  3. Advanced Flotation Product

  Automatic "dry type" samplers (primary cutter only) are located at the discharge of the refuse centrifuge and clean-coal filter. Cutter speeds and openings are mechanically preset. Cutter frequencies are controlled by preset values in the supervisory controller. The running number of cuts are totalized and stored within the controller's logic for access. Cutter operation are indicated on a panel.

  Plant process control and instrumentation functions are summarized in Table 5.01

- Discussion of Start-Up and Shutdown Procedures

  Automatic start or stop of the Semi-Works cleaning facility occurs in a predetermined order. That sequence is dependent upon operator selection, and is defined by a functional control specification, the flow diagram, and the interlocking diagram.

Table 5.01
Plant Control Summary

# AND ITEM	IND.	REC.	ALARM	ON-OFF	COMMENT
1. Sump Levels	Y			Y	Controls Make-up
2. H.M. Cyclone Sump Level	Y	-	Y	Y	Controls Make-up & Bleed
3. H.M. Cyclone Density	Y	Y	Y	-	Controls Recirculating Media
4. Overdense Media Density	Y	-	Y	Y	Controls Magnetite Feeder
5. Advanced Column Level	Y	-	Y	-	Controls Column Level
6. Advanced Column-Gas Hold-Up	Y	-	Y	-	Controls Frother Feeder
7. Advanced Feed-Flow Rate	Y	-	-	-	
8. Thickener Hi Torque	-	-	Y	Y	
9. Thickener Settling Rate	Y	-	-	-	Controls Anionic Floc.
10. Turbidity Meter	-	-	-	Y	Controls Cationic Floc.
11. Thickener Underflow Density	Y	-	-	-	Controls Speed of Underflow Pump
12. TPH - Plant Feed	Y	Y	-	-	
13. TPH - Product	Y	Y	-	-	
14. TPH - Refuse	Y	Y	-	-	
15. pH Thickener Feed	Y	-	-	Y	Controls Acid/Base Addition Feeders
16. Low Level in Anionic Floc Tank	-	-	Y	-	
17. Low level in Cationic Floc. Tank	-	-	Y	Y	
18. Slurry Samplers (3 total)	-	-	-	Y	
19. Dry Samplers (2 total)	-	-	-	Y	

The PLC contains the necessary process and safety interlocking functions. Interlocking prohibits a process or piece of equipment from running unless all conditions related to the proper and safe operation of that process or piece of equipment are met. Interlocking therefore ensures that operational values are within the operator defined ranges and that all devices are safe and the process is correctly configured.

If a failure occurs on a running piece of equipment the PLC initiates a shut down of that equipment and all pieces of equipment dependent upon that failed equipment in accordance with the interlock requirements.

Under normal shut down sequencing, the PLC takes a predefined adjustable time period for purging each of the major pieces of equipment.

Functional Criteria

Pilot devices will be furnished according to the following criteria:

- Alarm and shutdown circuits designed to be activated by devices such as pressure switches, relays, current switches, thermostats, PLC output cards, limit switches, pushbuttons, etc., are designed to fail safe; that is, the protective device will open under abnormal conditions to break continuity in the circuit.

- Stop functions are initiated by de-energizing the controlled device.

- Start pushbuttons has normally open contacts; that is, a contact closure will initiate the ON or START function.

- Jog pushbuttons has normally open contacts; that is, a contact closure will initiate the jog function.

- Stop pushbuttons have normally closed contacts; that is, a contact opening will initiate the OFF or STOP function.

- Selector switches have all normally open contacts and a contact closure will be indicative of the selected switch position.

- End of travel limit switches have normally closed contacts; that is at end of travel the electrical contact will be opened and closed at all other positions of travel.

Control Modes

The Semi-Works plant can be started in automatic or manual modes. In automatic mode, motors are started by the PLC in a preset sequence with all interlocks requirements in place. The operator has the capability of manual mode that allows him to start and stop any piece of equipment controlled by the system. The process interlocks are enforced unless the bypass mode has been invoked by the operator. Selecting between an automatic start sequence and manual mode of control does not stop or disrupt any equipment currently running.

Bypass Mode

In the normal bypass mode the operator can bypass the process interlocks required for the process pumps. These pumps are typically started in recirculation mode before most plant equipment in order to stabilize material consistency. In addition to the normal bypass mode, a special equipment bypass is available which allows the operator to select any piece of equipment to operate in the bypass mode. If a piece of equipment is selected in bypass mode, the interlocking required to operate it is no longer valid. The operator then has the capability to run that particular piece of equipment irrespective of the status of any other piece of equipment.

Whenever any start sequence is initiated by an operator, the status of the special bypass mode is checked. If any piece of equipment is in bypass, it is annunciated and the operator will be asked whether to take all the equipment out of bypass mode or to proceed with the requested start sequence.

Operator Interface

- The operator interacts with the PLC-based process control system via color video terminals with keyboards. These units are located in the operator control station (OCS).

- The OCS allows the operator to manipulate various process control variables and equipment operation by means of keyboard input. This includes but is not limited to adjustment of controller mode of operation (automatic, manual, cascade, etc.), setpoint value, control output value, alarm levels, timing constraints, remote start/stop of motors or other equipment and control system mode of operation (automatic, semi-automatic and manual).

- All system displays are accessible from any of the video terminals.

- Any real time process variable values displayed on any screen shall be updated at least every 2 seconds.

- The operator control station provides for the following control screens as a minimum:

  1) Overview Display

     All discrete analog or digital points displayed with indication of status (auto, manual, energized, de-energized, running, stopped, etc.), or alarm condition.

  2) Group Display

     A user configurable group of control or indication points including: the group identification, the individual point identification; process or control variables/parameters (i.e., setpoint, output, process variable, stations, etc.) and alarm conditions.

     The operator is able to select any point from the group and manipulate the appropriate control parameters (i.e., setpoint, controller mode, start/stop, etc.).

     The system allows for any individual point to be displayed in multiple group displays.

  3) Individual Point Display

     The individual loop display presents detailed information for any operator selected control or indication point. This information shall include the following as a minimum:

- Indication of all process variable or control parameter variables

- Point identification

- Tuning constants

- Alarm settings

  This system provides a security system to prevent unauthorized changes to control or indication parameters except for set-point adjustments, auto-manual selection, and output value under keylock operation.

4) Alarm Displays

The system has an alarm display system to alert the operator to any abnormal process or equipment condition.

When an alarm condition occurs, the operator is informed by audible horn and visual indication on the screen, regardless of which display screen the operator is viewing at the time.

The operator is able to acknowledge and silence an alarm through a simple keyboard entry.

The system has a chronological alarm summary display. The summary display shows all unacknowledged alarms and all active alarms which have been acknowledged, in a tabular format. This display includes the tag number of the alarm point, type of alarm (hi/lo process variable, deviation, etc.) and time the alarm condition occurred. When an individual point has been acknowledged and the condition has returned to within normal ranges, the alarm is automatically removed from the alarm summary.

The system provides a hard copy of all alarms by means of a printer. All alarms are logged with the alarm point tag number, type of alarm, time of alarm, time of acknowledgement, short description of alarm point and time the alarm condition returns to normal.

The operator control station is provided with the following graphic display screens:

1) Overview Display

An interactive color graphic display of the overall process operation with visual indication of equipment status (i.e. visual differentiation between running and non-running equipment) as well as dynamic display of selected process variable setpoints and controller outputs values as well as mode of operation.

2) Subsystem Displays

An interactive color graphic display of selected subsystem or equipment display screens with visual indication of equipment status as well as dynamic display of critical process variable values.

3) Auto Start Displays

A custom auto start screen, consisting of all text, provides the following:

- All major processing units arranged in start-up sequence.
- Each line showing equipment number, equipment description, current amp reading if available.
- Color of text changes to indicate status of equipment including, but not limited to, running, stopped, and failed.
- Indication of units being operated out of interlock.
- Indication of current operating status of levels, densities, and torques, if available.
- Indication of which equipment is in bypass mode and the ability to select interlocking mode or bypass mode.

5.3 Capital Cost Estimate

Based upon POC test results and all previous testing and evaluations, a final flowsheet, plant layout, and process and instrumentation diagram were developed for the Semi-Works facility. A process, sampling and laboratory equipment list, general arrangement drawings, and structural, electrical and piping drawings were also prepared. The process and instrumentation diagram, the equipment list and all engineering drawings may be found in Appendix C. These documents form the basis for defining the plant battery limits, upon which a detailed capital cost estimate was prepared.

The capital cost estimate for the Semi-Works facility is an ICF KE Type 3 preliminary estimate with an expected level of accuracy of ±10 percent. Besides the information described above, this type of estimate required the knowledge of product capacity and plant location. Craft wage rates and fringe benefits, payroll taxes and insurance, local sales and other taxes, design and construction work durations, and facility insurance requirements were estimated based on locating the facility in the area of Pittsburgh, Pennsylvania.

One capital cost estimate was prepared to cover all three of the test coals. A summary of the capital cost breakdown is presented in Table 5.02. The costs in this table are broken down into four areas: General contractor costs, construction contractor costs, engineering contractor costs and electrical contractor costs. It is assumed in this breakdown that the general contractor purchases all equipment and arranges the contracts for the three other subcontractors.

A detailed cost estimate for the Semi-Works facility appears in Appendix C. Information from this detailed estimate was grouped in order to prepare Table 5.02. The detailed estimate breaks all work down into the following elements:

200	Concrete and foundations
300	Structural steel
400	Architectural work
500	Equipment installation
600	Piping
675	Mechanical
700	Electrical and instrumentation
900	Indirect and distributable
901	Engineering
902	Project/construction management
903	Field office expenses
904	Insurance/taxes/permits

Costs in items 200 through 675 less the equipment costs in these areas were assigned to the construction contractor costs appearing in Table 5.02. Item 700 less equipment was the responsibility of the electrical contractor, and item 901 was set aside for the engineering contractor. All other costs including all equipment costs for all areas were contained in the costs presented for the general contractor.

The general contractor profit was calculated as five percent of the total costs for all the elements listed above. An additional five percent was added to these two costs for contingencies which are then spread between all contractors on a proportional basis.

Lump sums costs are provided in the detailed estimate for elements 901, 902 and 904. For each of the remaining work elements, required manhours were estimated. Costs were then estimated for labor, equipment usage, material, subcontracts, equipment, and element subcontractor overhead and profit for each work element.

Material quantities were developed based on the preliminary design drawings. Material pricing was based for the most part on vendor quotations with some complementary estimator judgement. Vendor quotations were received for all equipment. For the labor estimates, crew rates were established for each of the erection work elements assuming a crew of journeymen, a foreman and a general foreman. Crew rates included base wages, fringe benefits, payroll taxes and insurance, small tools, and overhead and profit.

Equipment usage was based on the blue book rental cost and includes fuel and maintenance. Finally, the construction and electrical contractors' overhead and profit is based on 10 percent each of equipment usage, material, and construction indirects.

Table 5.02
Total Estimated Capital Cost for Semi-Works Flowsheet

CONSTRUCTION CONTRACTOR		
Construction Contractor Cost		2,639,059
Contingency		138,778
Overhead and Profit		136,508
TOTAL CONSTRUCTION ESTIMATE		2,914,345
Basis for Estimate:	Cost	ICF KE Type 3, Preliminary Estimate
	Contingency	5% of (Construction Cost + Overhead and Profit)
	Overhead & Profit	10% of (Equipment Usage + Material + Construction Indirects)
GENERAL CONTRACTOR		
General Contractor Cost		5,600,892
Contingency		304,797
Overhead and Profit		495,027
TOTAL GENERAL CONTRACTOR ESTIMATE		6,400,716
Basis for Estimate:	Cost	ICF KE Type 3, Preliminary Estimate
	Contingency	5% of (Other Contractors' Total Costs Less Contingencies + General Contractor's Costs)
	Overhead & Profit	5% of (All Contractors' Costs Less Contingencies) - Other Contractors' Contingencies
ENGINEERING CONTRACTOR		
Engineering Contractor Cost		545,455
Contingency		30,000
Overhead and Profit		54,545
TOTAL ENGINEERING CONTRACTOR ESTIMATE		630,000
Basis for Estimate:	Cost	ICF KE Type 3, Preliminary Estimate
	Contingency	5% of (Engineering Cost + Overhead and Profit)
	Overhead & Profit	10% of Engineering Cost
ELECTRICAL CONTRACTOR		
Electrical Cost		896,813
Contingency		46,204
Overhead and Profit		27,274
TOTAL ELECTRICAL CONTRACTOR ESTIMATE		970,291
Basis for Estimate:	Cost	ICF KE Type 3, Preliminary Estimate
	Contingency	5% of (Electrical Cost + Overhead and Profit)
	Overhead & Profit	10% of (Equipment Usage + Material + Construction Indirects)
TOTAL PROJECT ESTIMATE		**$10,915,352**

6.0 ECONOMICS OF THE ADVANCED FROTH FLOTATION PROCESS

Using the Semi-Works plant design and capital cost estimate as a base, economics for the advanced froth flotation process were evaluated for a number of different scenarios, varying plant size, hours of operation, and expected rates of return. A standard set of economic assumptions and unit supply costs are presented in Table 6.01. These assumptions were used in the development of nine economic case studies for each coal.

Table 6.01
Standard Economic Assumptions

Capital Cost of Plant =	Capital Cost of 20 TPH Plant x (new plant size/20)$^{0.70}$		
Equipment Cost =	Equipment Cost of 20 TPH Plant x (new plant size/20)$^{0.70}$		
Plant Availability =	90 percent	Financing	100 percent equity
Plant Life =	20 years	Inflation Rate	4.0 percent
Royalties	None	Corporate Tax Rate	38.0 percent
Construction Period	2 years (50% investment each year)		
Standard Unit Supply Costs			
Land	$5,000 per acre	Kerosene	$0.09 per pound
Electric Power	$0.06 per kilowatt-hour	Grinding Media	$0.36 per pound
Flocculants	$2.00 per pound	Magnetite	$0.06 per pound
Frother Reagent	$0.55 per pound	Sodium Hydroxide	$0.07 per pound
Make-up Process Water	$0.05 per 1000 gallons		

The primary case for each coal involves a 200 tons-per-hour (product) commercial plant operating 7,560 hours per year. This plant operates 350 days per year and three shifts per day. An assumed 90 percent availability results in the total hours of operation. Economics were next calculated for similar 200 tons-per-hour plants with operating schedules of 5040 hours and 3456 hours per year. Each of these schedules included two operating and one maintenance shift each day. The former schedules, however, included seven days per week of operations while the latter includes only five. Sensitivity of the process economics to operating schedule is illustrated using these first three cases.

Economics were also evaluated for a 20 tons-per-hour Semi-Works plant and a 500 tons-per-hour commercial facility, each with an operating schedule of 7560 hours per year. While the Semi-Works size plant is not meant to be economically viable, these cases along with the primary 200 tons-per-hour case allow the evaluation of the sensitivity of process economics to plant capacity. Each of the five cases described above were evaluated based on an expected 10 percent, after-tax rate of return. For the primary case, additional economic evaluations are presented using 15 and 20 percent expected investment returns.

The last two economic evaluations for each coal break out the cost of the advanced froth flotation circuitry in order to evaluate the feasibility of adding this circuitry to existing commercial coal cleaning facilities. An advanced process equipment list is presented in Appendix D. This list is a subset of the process, sampling and laboratory equipment list that was

developed for work element 500 of the detailed, Semi-Works plant cost element. This subset includes coal communition equipment, advanced froth flotation equipment, and ancillary equipment required for the support of these operations.

In the detailed cost estimate, equipment costs appear in cost elements 675 (Mechanical) and 700 (Electrical and Instrumentation) in addition to element 500. The advanced equipment subset developed from cost element 500 was responsible for 77.4 percent of the cost and 73.3 percent of the horsepower requirements for all element 500 equipment. These percentages were used to assign a portion of element 675 and 700 costs to the advanced froth flotation addition. Thus, 77.4 percent of the mechanical equipment cost and 73.3 percent of the electrical and instrumentation equipment costs were required for the advanced process equipment. For the 200 TPH Semi-Works plant, then $3,592,174 or 76.8 percent of the total equipment cost of $4,675,561 was due to the advanced equipment. Total estimated capital cost of the 20 TPH plant addition is estimated, then as 76.8 percent of the 20 TPH Semi-Works plant. Economics of a 200 TPH plant addition was evaluated at an expected 10 percent after-tax rate of return and operating schedules of 7560 and 3456 hours per year.

In all, 27 case studies were evaluated covering all three base coals. The economics were analyzed for these cases using the Coal Preparation Plant Evaluation Model developed by Eos Technologies, Inc. under DOE Contract No. DE-AC22-87PC79338, Subcontract No. PTS-88-8244. For each case study, a coal cost, a direct processing cost, a working capital cost, and fixed and variable yearly operating and maintenance costs were input into the computer model. Input and output tonnages and qualities were required as well as the plant capacity factor: the estimated operating hours divided by the total hours available in a year (8760 hours). The cost for raw coal in every case was assumed to be $0.80 per million Btu.

6.1 Direct Processing Costs

Direct processing costs for each of the case studies included the capital cost of the plant, land purchase, preproduction costs, and costs for start-up modifications. The capital cost of the plant was calculated for the high capacity plants by extrapolating the cost of the 20 tons-per-hour Semi-Works plant or the 20 TPH plant addition using the formula in Table 6.01. The cost of land was based on the estimated requirements of 50, 500, and 1000 acres required for 20, 200, and 500 tons-per-hour plants, respectively. The cost of land for a 200 TPH plant addition was estimated as 76.8 percent of that for the entire 200 TPH plant. Preproduction costs included a month's supply of each of the following: power, process consumables, lubricants, manpower and maintenance supplies. Finally, a cost for start-up modifications was estimated for each case as 2 percent of the capital cost of the plant. Direct processing costs were unique for each base case evaluated.

6.2 Working Capital Requirement

Working capital requirements included a week's supply of flocculants, flotation reagents (frother and kerosene), grinding media, lubricants and magnetite. Also, two percent of the equipment cost, less electrical equipment, was added for a spare parts inventory.

6.3 Fixed Operating and Maintenance Costs

Fixed operating and maintenance costs included costs for operations and maintenance labor, administrative costs, yearly maintenance supply costs, and plant insurance and taxes. Operating and maintenance labor costs included plant supervision and classified workers. Table 6.02 presents these labor costs for the various operating schedules evaluated. For a 200 TPH plant addition, it was estimated that, on an incremental basis, the addition would require three men for a 7560 hour schedule and two men for a 3456 hour schedule. Administrative costs were calculated as 30 percent of the costs shown in Table 6.02 Yearly maintenance supply costs were estimated at 10 percent of the equipment cost. Finally, plant insurance and taxes were estimated as 3 percent of the capital cost of the plant in each case.

Table 6.02
Operating and Maintenance Labor Costs for Various Operating Philosophies

	7560 Hours/Year 20, 200 & 500 TPH	5040 Hours/Year 200 TPH	3456 Hours/Year 200 TPH
Superintendent	$89,114 (1)	$89,114 (1)	$89,114 (1)
Foreman	$249,522 (4)	187,141 (3)	124,760 (2)
Classified	$1,129,003 (21)	$752,699 (14)	672,036 (13)
Total	$1,467,639 (26)	1,028,924 (18)	$886,110 (16)

Note: Value in parentheses represents number of men required.

6.4 Variable Operating and Maintenance Costs

These costs included the yearly costs for flocculants, flotation reagents, grinding media, lubricants, magnetite, power, and process water. Costs for flocculants and flotation reagents are extrapolated based on the unit supply costs in Table 6.01, the usage rates, on a pound per ton of circuit feed, determined during POC testing, and the estimated circuit feed tonnage for each size plant.

Grinding media usage was estimated based on available mineral industry data. Magnetite usage was based on 1.2 pounds per ton of heavy-media-circuit feed. Equipment lubrication costs were estimated as $0.02 per clean coal ton.

6.5 Economic Evaluations

The costs described above were developed for 7 base cases for each of the three coals. For each of these cases, a ten percent rate-of-return was assumed. For the primary case of a 200 tons-per-hour plant operating 7560 hours per year, two additional cases were also run using 15 percent and 20 percent rates-of-return. This was completed for all three coals, making 27 total economic evaluations.

- 200 Tons-Per-Hour Advanced Froth Flotation Plant

The primary case study for each coal involved a plant that produces 200 tons-per-hour of clean coal product at the average quality produced during the 24-hour demonstration periods of POC testing. In these cases, the plant operation schedule is 350 days-per-year and 24 hours-per-day. Assuming 90 percent availability, these plants are operated for 7560 total hours-per-year.

These 200 tons-per-hour plants are estimated to cost $54,706,000 (capital cost). Including land, preproduction costs and expected start-up modifications, a total plant capital requirement of approximately $59,600,000 is expected. In addition $450,000 to $580,000 of working capital is required, depending on the coal, at plant start-up. Table 6.03 presents these capital requirements for the three base coals. Similar costs for the other base cases are presented in Appendix D.

Fixed annual operating and maintenance costs for these 200 TPH plants approach $5,900,000. Maintenance supplies represent the bulk of these costs at $2,340,000. Variable annual operating and maintenance costs range from $11,160,000 for the Upper Freeport coal to $12,610,000 for the Illinois No. 6 coal. Increased consumption of flocculants and flotation reagents account for the increased operating costs for the Illinois No. 6 coal. Table 6.04 provides a breakdown of the annual operating and maintenance costs for the three coals. Similar costs for the other base cases are presented in Appendix D.

Based on the costs presented in Tables 6.03 and 6.04, the raw coal cost, the assumptions presented in Table 6.01, and a ten percent expected after-tax rate-of-return, the Eos economics model calculates incremental coal cleaning costs and total coal product costs on annualized and levelized bases. In addition, the model calculates the present value for all costs, the investment payback period, and the annualized desulfurization costs.

Table 6.03
Capital Requirements for 200 TPH (Product) Plants
Operating 7560 Hours per Year

DIRECT PROCESSING COSTS ESTIMATION			
COST ITEM	ALL THREE COALS		
A - Capital Cost of Plant			54,706,371
B - Capital Cost of Equipment			23,433,315
C - Mechanical Equipment Cost			19,988,023
D - Land Purchase			2,500,000
E - Start-up Modifications			1,094,127
F - Preproduction Costs	Pittsburgh No. 8	Upper Freeport	Illinois No. 6
Power	720,166	720,166	720,166
Flocculants	55,138	76,572	151,339
Flotation Reagents	150,312	58,449	103,185
Water	3,345	2,003	2,911
Grinding Media	54,425	51,296	53,881
Lubricants	5,882	3,940	4,890
Magnetite	17,418	17,418	14,787
Manpower	122,303	122,303	122,303
Maintenance Supplies	195,278	195,278	195,278
DIRECT PROCESSING COSTS (A+D+E+F)	59,624,735	59,547,893	59,669,206

WORKING CAPITAL REQUIREMENT ESTIMATION			
COST ITEM	Pittsburgh No. 8	Upper Freeport	Illinois No. 6
Flocculants	13,233	18,377	36,321
Flotation Reagents	36,075	14,028	24,764
Grinding Media	13,062	12,311	12,931
Lubricants	1,412	946	1,174
Magnetite	4,180	4,180	3,549
Spare Parts = 2% of Mech. Equip.	399,760	399,760	399,760
TOTAL WORKING CAPITAL REQUIRED	467,723	449,603	478,500

Table 6.04
Annual Operating and Maintenance Costs for
200 TPH (Product) Plants Operating 7560 Hours per Year

YEARLY FIXED OPERATING AND MAINTENANCE COSTS			
Cost Item	Pittsburgh No. 8	Upper Freeport	Illinois No. 6
Plant Labor Costs	1,467,639	1,467,639	1,467,639
Administrative Labor and Costs	440,282	440,282	440,282
Maintenance Supplies	2,343,330	2,343,330	2,343,330
Insurance and Taxes	1,641,190	1,641,190	1,641,190
Yearly Fixed O&M Costs	5,892,451	5,892,451	5,892,451
YEARLY VARIABLE OPERATING AND MAINTENANCE COSTS			
Cost Item	Pittsburgh No. 8	Upper Freeport	Illinois No. 6
Flocculants	661,651	918,861	1,816,063
Flotation Reagents	1,803,749	701,393	1,238,219
Grinding Media	653,105	615,551	646,574
Lubricants	70,583	47,282	58,677
Magnetite	209,019	209,019	177,448
Power	8,641,987	8,641,987	8,641,987
Process Water	40,144	24,041	34,927
TOTAL YEARLY VARIABLE O&M COSTS	12,080,238	11,158,134	12,613,895

The incremental clean coal cost is the costs associated with the plant investment, operating and maintenance costs, and the cost of lost Btu. This cost is added to the raw coal cost and the subsequent total clean coal cost is the price of clean coal required to achieve the designated after-tax rate-of-return on investment. The annualized total clean coal cost may be interpreted as the real coal product selling price, in dollars relevant to the first year of operations, required during each operating year in order for the investment in the plant to realize the specified after-tax rate-of-return. Refer to the Eos Model User Guide and Technical Manual for additional information and the calculations completed for the annualized and levelized cost evaluations.

Table 6.05 presents the economic summary for each of the base case, 200 TPH preparation plants. Based on raw coal costs of $0.80 per million Btu, clean-coal prices of $40.27 to $41.96 per ton, on an annualized basis, are required for the three coals in order to earn a ten percent after-tax rate-of-return. Annualized desulfurization costs (dollars-per-ton of SO_2 equivalent) range from $304.60 for the Illinois No. 6 coal to $326.82 for the Pittsburgh No. 8 coal. Appendix D presents the results of economic evaluation for the different operating philosophies, plant sizes, and rates-of-return. Figure 6.01 presents the effect that expected rates of return have on the annualized desulfurization costs for the 200 TPH plants (7560 operating hours). For the Pittsburgh No. 8 coal, for instance, the

annualized desulfurization cost increases by $91.32 per ton to $418.14 when the expected rate of return increases from 10 to 20 percent. Similar increases of $85.75 and $79.38 are estimated for the Upper Freeport and the Illinois No. 6 coals.

Table 6.05
Advanced Froth Flotation Process Economics
200 TPH Commercial Plant Operating 7560 Hours per Year

Cost Item	Pittsburgh No. 8	Upper Freeport	Illinois No. 6
Annualized Costs			
Raw Coal $/MM Btu	0.80	0.80	0.80
$/ton	11.73	11.73	11.73
Clean Coal			
Incremental $/MM Btu	0.69	0.70	0.75
Total $/MM Btu	1.49	1.50	1.55
Total $/ton	40.65	40.27	41.96
Levelized Costs			
Raw Coal $/MM Btu	1.06	1.06	1.06
$/ton	15.48	15.48	15.48
Clean Coal			
Incremental $/MM Btu	0.91	0.92	0.98
Total $/MM Btu	1.97	1.98	2.04
Total $/ton	53.66	53.16	55.39
Other Costs			
Present Value of Costs	$180,642,000	$179,495,000	$193.879,000
Payback Period	7.9 Years	7.9 Years	7.9 Years
Annualized Desulfurization Costs	$326.82	$305.42	$304.60

- Economic Sensitivity to Plant Operating Hours

Economics of plant investment and the annualized desulfurization costs can be significantly affected by the plant operating schedule also. The previous examples presented the results for a plant operating virtually every day of the year (350 days) and three shifts every day. A two-shift operation scheduled the same number of days would have a significantly reduced plant capacity factor and, subsequently, the capital costs associated with the plant investment are then spread over significantly less tons of clean coal product. This assumes, of course, that the operating life of the plant remains unchanged. In order to illustrate this, the two-shift operating schedule and a third, five-day, two-shift schedule were evaluated. This third operating schedule is similar to that commonly employed in the coal industry. In this case, the plant is operated two shifts per day, five days-per-week. Due to a two-week summer shutdown period and scheduled holidays, 240 days per year are available. Maintenance is conducted on the third shift of every operating day. Based on 90 percent availability, the plant operates

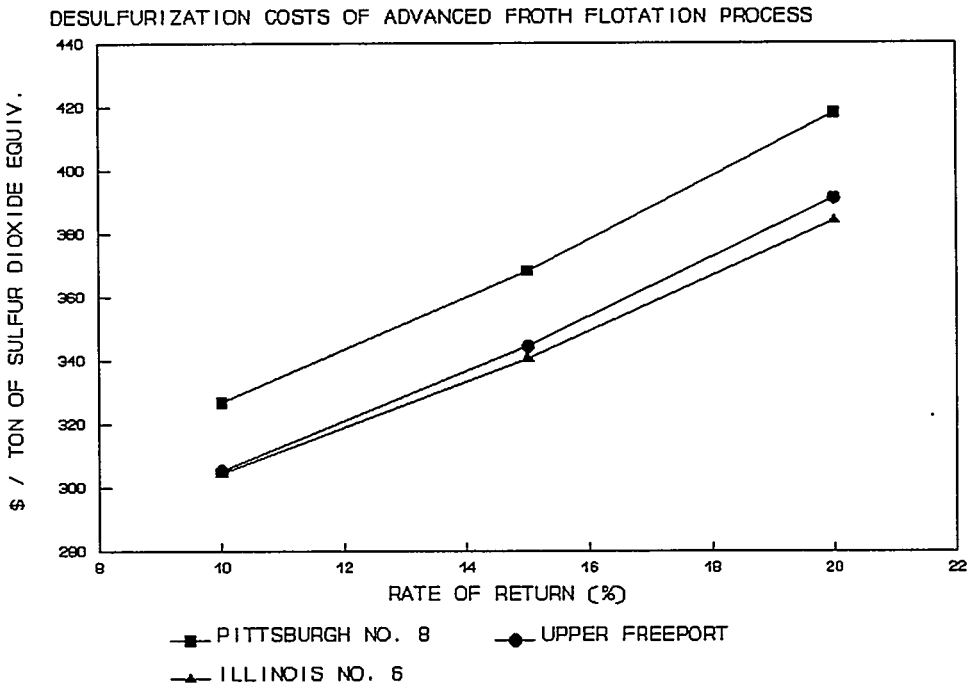

Figure 6.01 Sensitivity of Process Economics to Expected, After Tax Rate of Return

3456 hours per year. One less supervisor is required and one less classified worker is required to operate the plant, but the maintenance shift require six classified employees. Figure 6.02 presents the annualized desulfurization costs versus the plant operating hours for each of the three operating schedules. As expected, costs of desulfurization increase dramatically when the plant capital investment has to be spread over a smaller tonnage base.

- Economic Sensitivity to Plant Size

In addition to operating philosophy, plant size can significantly affect investment economics. To illustrate this point, the economic evaluations were also conducted on the 20 tons-per-hour Semi-Works plant and a 500 tons-per-hour commercial plant. In each case, the plant operating schedule was similar to the primary, 200 tons-per-hour case (i.e., 7560 operating hours per year). The capital cost estimate for the 20 tons-per-hour plant was presented in Section 5 of this report. The capital cost of the 500 tons-per-hour plant was extrapolated from the Semi-Works plant capital cost estimate using the formula in Table 6.01. Figure 6.03 presents the sensitivity of annualized desulfurization costs to plant size for the three plant sizes studied. The cost-per-ton-of-SO_2 removed drops dramatically between 20 and 200 tons-per-hour. For the Pittsburgh No. 8 coal, the 20 tons-per-hour plant investment scenario results in a desulfurization cost of $675.33 per ton, compared to $326.82 for the 200 tons-per-hour plant. Desulfurization costs decrease another 16

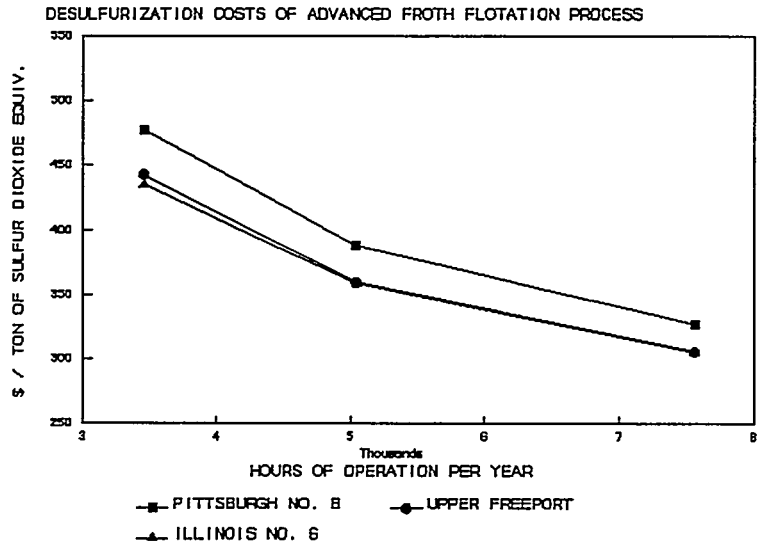

Figure 6.02 Sensitivity of Process Economics to Operations Schedule

percent to $275.27 by investing in a 500 tons-per-hour plant. The need to build a larger plant is obviously dependent on the demand of the coal product. If there are no long-term contracts in place to guarantee this demand, there is additional risk associated with the larger investment required for high-capacity plants.

- Economics of a 200 TPH Plant Addition

The process philosophy embraced for this project uses conventional coal cleaning techniques in order to remove the coarse and easy-to-

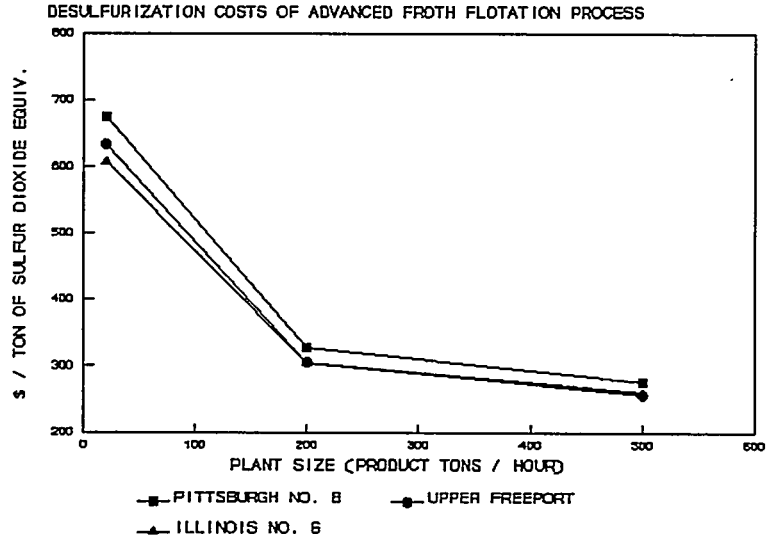

Figure 6.03 Sensitivity of Process Economics to Plant Capacity

remove sulfur and mineral matter prior to coal communition efforts. This reduces the capacity of the crushing and grinding equipment as

well as the advanced froth flotation equipment in two ways. The first of these is simply related to feed tonnage removed by the precleaning. Secondly, the high ash matter removed in precleaning would likely be comprised of harder, more-difficult-to-crush particles, which if not eliminated would increase recirculating loads in the coal communication circuits and thus reduce their capacity. The characterization of these intermediate streams as to their grindability was not studied as part of this project.

However, to gain an understanding of the incremental benefit of the advanced circuitry, a simplified economic evaluation was conducted. The capital, operating, and maintenance requirements for a 200 TPH advanced plant addition was developed as described in sections 6.1. through 6.4. Desulfurization costs were then estimated based on these costs applied to the sulfur removed by only the advanced forth flotation circuit. A portion of the sulfur removed in the water-only cyclone circuit is attributable to the advanced process equipment. The data obtained during POC testing does not allow the isolation of this portion, however, and thus was not included in the evaluation.

Table 6.06 presents the annualized desulfurization costs estimated for a plant addition based on two different operating schedules. The economics for the plant addition are much less favorable relative to the entire process due to the high capital cost of the advanced process equipment and the relatively small amount of sulfur removed in the advanced froth flotation cell. These factors will serve to restrict the application of the advanced froth flotation process primarily to new, greenfield, projects, or to cases where there are few or no alternatives to the physical removal of sulfur in the coal.

Table 6.06
Estimated Annual Desulfurization Costs Per Ton of SO_2 Equivalent
For 200 TPH (Product) Advanced Process Plant Addition

Operating Schedule	Pittsburgh No. 8	Upper Freeport	Illinois No. 6
7560 hours per year	$1148	$969	$1460
3456 hours per year	$1721	$1419	$2111

7.0 PROJECT CONCLUSIONS AND RECOMMENDATIONS

Important findings resulted from the conduct of bench-scale and 100 pounds-per-hour testing and the POC testing. From these results, a commercially-viable process incorporating conventional coal cleaning circuitry, the novel application of fine coal grinding, and an advanced froth flotation operation was developed in an attempt to meet process performance and product quality goals established by the U.S. Department of Energy. Finally a detailed capital cost estimate was determined for a 20 tons-per-hour Semi-Works advanced froth flotation plant. Economic evaluations were completed for this plant and 200 and 500 tons-per-hour commercial plants employing the proposed process. Following are the conclusions derived from testwork and evaluation as well as recommendations for future process development efforts.

7.1 Bench-Scale and 100 Pounds Per Hour Testing

- The Pittsburgh No. 8, Upper Freeport, and Illinois No. 6 coals all have the potential, when ground to the proper size, to be cleaned such that 85 percent of the pyritic sulfur is removed while 85 percent of the energy is recovered.

- Significant pyritic sulfur rejection can be achieved for these coals with conventional coal cleaning processes and with little energy loss. These operations should be employed prior to ultrafine grinding and advanced ultrafine coal cleaning processes. More effective application of the ultrafine grinding operation results since a large portion of unwanted impurities is already removed. Smaller grinding circuits are required due to lower tonnages and softer, easier-to-grind feedstock.

- Advanced column froth flotation can exploit the increased state of liberation imparted to the coal, mineral matter, and pyritic sulfur particles when reducing grinding size from 200 mesh by zero to 325 mesh by zero.

- Only slight metallurgical advantage is achieved with multiple stage column flotation, as compared with single stage, if wash-water is properly utilized.

7.2 Proof-Of-Concept Module Testing

- The proposed advanced froth flotation unit can be integrated with the proposed, commercial-ready unit operations to construct an overall commercially viable and continuous process.

- At the achieved final grind of about 85 percent passing 200 mesh, the proposed process can remove between 73 and 79 percent of the raw coals' pyritic sulfur while recovering 85 percent or more of the raw coals' energy content.

- The proposed process did not achieve 85 percent pyritic sulfur rejections at the goal of 85 percent energy recovery. Also, the target ash of 6 percent, on a dry basis, was not achieved. Grinding to a final product particle size finer than 85 percent passing 200

mesh is necessary to achieve the process performance goals and product quality targets.

- The high-g solid bowl centrifuge could not dewater the plant clean coal to the desired level of 30 percent surface moisture. The hyperbaric disk filter, commercially operated in Germany, likely can achieve the moisture target.

- Conventional thickening and dewatering techniques can be used to recover the advanced froth flotation products.

- The advanced froth flotation process can be adversely affected by high residual levels of flocculants in plant recirculating water.

7.3 Economics

- The capital cost of a 20 tons-per-hour Semi-Works plant incorporating the proposed advanced forth flotation process will approach $11,000,000 in 1994 dollars.

- Extrapolation of the costs for larger 200 and 500 tons-per-hour plants indicate the capital requirements will approach $60 million and $115 million respectively.

- Economic modelling indicates clean coal prices, F.O.B., the preparation plant, of $40 to $42 per ton (or $1.50 per MM Btu) will be required for investments in a 200 tons-per-hour (product) plant to earn a ten percent, after-tax rate of return.

- The larger, 500 tons-per-hour plant reduces required coal prices by $3 per ton or $0.12 per MM Btu.

- Desulfurization costs, on a dollar per ton of SO_2 equivalent, for the 500 tons-per-hour plant are $275.27 for the Pittsburgh No. 8 coal, $256.95 for the Upper Freeport coal, and $259.84 for the Illinois No. 6 coal.

7.4 Recommendations for Future Technology Development

- POC-scale or larger scale testing should be conducted on gravimetric treatment of the advanced froth flotation concentrate.

- POC-scale or larger-scale testing should be completed on the proposed advanced froth flotation process at grinds finer than that achieved during the present work. Grinds of 270 mesh or finer will likely be necessary in order to achieve 85 percent pyritic sulfur rejection and 85 percent energy recovery.

- Further development efforts on the cost-effective reconstitution of advanced froth flotation concentrate will be necessary in order to facilitate the commercialization of advanced coal cleaning technology.

- Additional testing of the hyperbaric disk filter is warranted based on the promising results achieved during the POC testing. Other

dewatering options such as the Larox pressure filter also hold potential for dewatering coal products sized at 85 percent passing 200 mesh to levels near 30 percent surface moisture.

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APPENDIX A

LABORATORY COLUMN FLOTATION DATA

LABORATORY COLUMN FLOTATION RESULTS
PARAMETRIC TEST MATRIX

Test No.	Coll. Dose #/ton	Froth. Dose #/ton	Air Rate ml/min	Feed Solids (%)	Feed Rate ml/min	Waswater Rate ml/min	Meas. Yield (%)	Ash (%)			Sulfur (%)			Btu per Pound			Pyritic Sulfur (%)			Adj. Yield (%)
								Feed	Conc.	Reject	Feed	Conc.	Reject	Feed	Conc.	Reject	Feed	Conc.	Reject	
1	1.5	2.5	1000	15	150	400	92.7	9.63	4.36	78.13	3.56	3.36	6.17	13205	14055	2147	1.28	0.92	5.82	92.9
2	0.5	2.5	1000	15	150	400	92.8	8.88	4.27	73.17	3.45	3.22	6.58	13265	14060	2170	1.23	0.88	6.18	93.3
3	1.5	0.5	1000	15	150	400	85.9	9.61	3.94	44.11	3.46	3.19	5.11	13205	14100	7760	1.23	0.81	3.89	85.9
4	1.5	2.5	1000	5	150	400	92.2	9.60	4.18	70.00	3.40	3.13	6.36	13240	13365	11847	1.22	0.80	5.85	91.8
5	0.5	0.5	1000	15	150	400	76.1	8.85	3.80	29.54	3.38	3.14	4.37	13265	14074	9948	1.17	0.83	2.83	80.4
6	1.5	0.5	1000	5	150	400	76.3	9.60	3.72	28.49	3.46	3.02	4.86	13240	14162	10280	1.25	0.64	3.15	76.3
7	0.5	2.5	1000	5	150	400	92.6	9.36	4.31	69.14	3.67	3.46	6.20	13130	13983	3037	1.32	0.95	5.62	92.2
8	0.5	0.5	1000	5	150	400	61.5	9.36	3.15	18.40	3.62	3.20	4.23	13130	14170	11614	1.30	0.70	2.19	59.3
9	1.0	2.5	1500	10	250	400	68.4	9.55	3.76	20.97	3.37	2.98	4.15	13175	14098	11355	1.21	0.66	2.30	66.4
10	1.0	0.5	1500	10	250	400	87.5	9.67	3.89	53.81	3.44	3.17	5.50	13158	13279	12233	1.24	0.80	4.50	88.4
11	1.0	2.5	500	10	250	400	29.4	9.54	3.16	11.98	3.38	2.95	3.54	13175	14223	12776	1.21	0.61	1.43	27.7
12	1.0	2.5	1500	10	50	400	100.0	9.68	7.12	87.66	3.49	3.38	6.82	13159	13590	12266	1.25	1.07	6.78	96.8
13	1.0	0.5	500	10	250	400	63.6	10.57	3.45	16.05	3.59	2.92	4.10	13056	14204	12173	1.24	0.41	2.08	43.5
14	1.0	2.5	500	10	50	400	89.6	9.66	3.52	61.29	3.33	3.04	5.78	13158	14085	5370	1.20	0.74	4.99	89.4
15	1.0	0.5	1500	10	50	400	98.2	10.52	6.10	79.63	3.67	3.15	11.80	13056	13775	5706	1.11	0.67	6.05	94.0
16	1.0	0.5	500	10	50	400	83.4	11.09	3.41	32.08	3.55	2.99	5.09	13056	14243	9810	1.27	0.48	3.40	73.2
17	1.0	1.5	1500	15	150	600	92.5	9.78	4.47	73.28	3.48	3.24	6.32	13202	14053	3026	1.25	0.86	5.89	92.3
18	1.0	1.5	500	15	150	600	84.9	9.77	3.68	43.23	3.64	3.32	5.37	13202	14140	8051	1.29	0.81	4.05	84.6
19	1.0	1.5	1500	5	150	600	93.5	9.28	5.63	63.69	3.80	3.61	6.69	13159	13754	4293	1.37	1.06	5.91	93.7
20	1.0	1.5	1500	15	150	200	97.5	9.77	7.07	86.74	3.59	3.51	5.93	13202	13592	2104	1.29	1.13	5.85	96.6
21	1.0	1.5	500	5	150	600	80.4	9.28	3.43	33.56	3.71	3.27	5.51	13159	14154	9033	1.33	0.72	3.88	80.6
22	1.0	1.5	1500	5	150	200	98.3	9.29	6.90	74.88	3.78	3.73	5.09	13159	13622	439	1.37	1.25	4.63	96.5
23	1.0	1.5	500	15	150	200	90.7	9.70	4.13	65.74	3.57	3.36	5.72	13202	13672	8475	1.31	0.91	4.95	91.0
24	1.0	1.5	500	5	150	200	90.6	9.29	3.59	49.06	3.71	3.37	6.05	13159	14103	6573	1.35	0.82	4.81	87.5
25	1.5	1.5	1000	15	250	400	93.5	9.62	3.98	69.83	3.38	3.14	5.96	13205	14144	3172	1.22	0.82	5.40	91.4
26	0.5	1.5	1000	15	250	400	89.7	8.88	4.05	53.27	3.42	3.16	5.82	13265	14088	5702	1.22	0.83	4.88	90.2
27	1.5	1.5	1000	5	250	400	90.5	9.63	3.80	55.17	3.48	3.12	6.24	13240	14206	5691	1.23	0.73	5.36	88.7

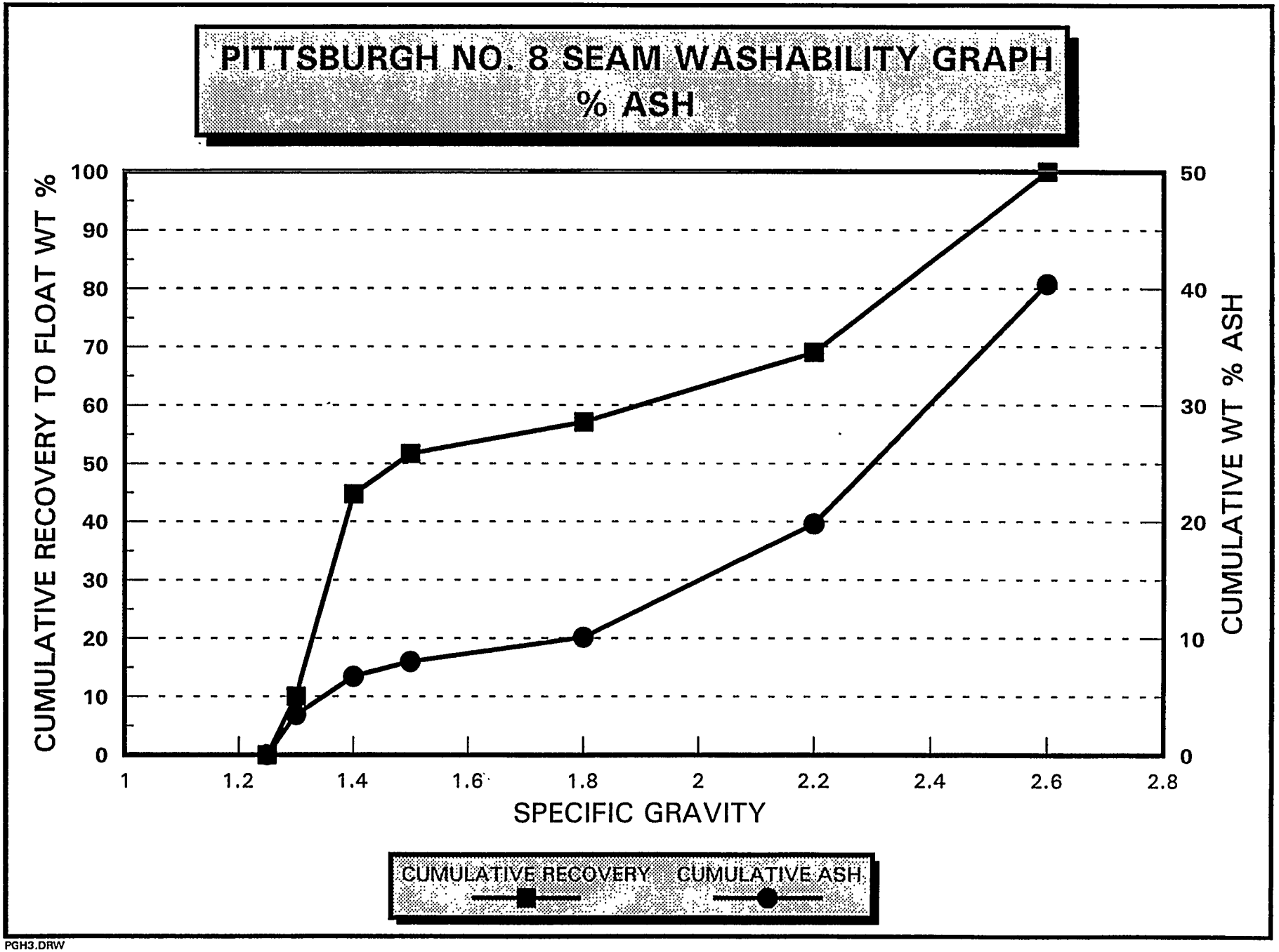
LABORATORY COLUMN FLOTATION RESULTS
PARAMETRIC TEST MATRIX

Test No.	Coll. Dose #/ton	Froth. Dose #/ton	Air Rate ml/min	Feed Solids (%)	Feed Rate ml/min	Waswater Rate ml/min	Meas. Yield (%)	Ash (%)			Sulfur (%)			Btu per Pound			Pyritic Sulfur (%)			Adj. Yield (%)
								Feed	Conc.	Reject	Feed	Conc.	Reject	Feed	Conc.	Reject	Feed	Conc.	Reject	
28	1.5	1.5	1000	15	50	400	91.9	9.68	4.55	57.13	3.73	3.50	5.90	13205	14060	5298	1.31	0.95	5.02	90.2
29	0.5	1.5	1000	5	250	400	86.0	9.36	3.60	41.38	3.59	3.18	5.84	13130	14099	7744	1.29	0.71	4.49	84.8
30	1.5	1.5	1000	5	50	400	93.7	9.60	4.23	68.31	3.50	3.09	8.00	13240	14302	1625				91.6
31	0.5	1.5	1000	15	50	400	91.9	8.85	3.89	57.75	3.35	3.06	6.18	13265	14161	4434	1.17	0.78	5.45	90.8
32	0.5	1.5	1000	5	50	400	90.6	9.38	4.45	58.68	3.68	3.30	7.43	13130	13945	4974	1.31	0.79	6.61	90.9
33	1.0	2.5	1000	10	250	600	50.6	9.55	3.46	15.09	3.40	2.92	3.83	13175	14173	12266	1.22	0.57	1.82	47.6
34	1.0	0.5	1000	10	250	600	80.0	10.52	3.79	33.92	3.47	3.03	4.99	13056	14138	9294	1.24	0.61	3.43	77.7
35	1.0	2.5	1000	10	50	600	92.6	9.70	4.01	56.94	3.37	3.17	5.03	13158	14056	5706	1.19	0.85	4.18	89.3
36	1.0	2.5	1000	10	250	200	55.3	9.55	3.71	15.96	3.31	2.98	3.68	13175	14145	12110	1.19	0.70	1.73	52.3
37	1.0	0.5	1000	10	50	600	87.9	10.55	3.87	42.84	3.34	2.92	5.34	13056	14140	7819	1.25	0.60	3.87	82.9
38	1.0	2.5	1000	10	50	200	95.4	9.64	4.93	79.86	3.41	3.29	5.26	13158	13853	2786	1.22	0.95	4.99	93.7
39	1.0	0.5	1000	10	250	200	91.2	10.53	4.14	54.97	3.39	3.06	5.70	13056	14063	6053	1.23	0.71	4.70	87.4
40	1.0	0.5	1000	10	50	200	93.7	10.53	3.89	64.59	3.36	3.03	6.03	13056	14091	4635	1.22	0.69	5.26	89.1
41	1.5	1.5	1500	10	150	600	91.5	9.75	4.42	68.90	3.51	3.24	6.52	13129	14005	3416	1.27	0.84	5.92	91.7
42	0.5	1.5	1500	10	150	600	90.8	9.73	4.33	59.96	3.27	2.94	6.29	13184	14048	5145	1.15	0.70	5.61	90.3
43	1.5	1.5	500	10	150	600	72.8	9.74	3.43	26.38	3.49	3.01	4.90	13129	14131	10172	1.24	0.59	3.23	74.7
44	1.5	1.5	1500	10	150	200	96.7	9.64	6.16	94.53	3.48	3.35	6.66	12129	13580	2118	1.27	1.02	6.77	96.1
45	0.5	1.5	500	10	150	600	72.1	9.70	3.41	27.57	3.30	2.80	4.70	13184	14238	10187	1.18	0.52	3.07	74.0
46	1.5	1.5	500	10	150	200	87.1	9.73	3.83	45.17	3.45	3.07	5.77	13129	14063	7517	1.25	0.69	4.51	85.7
47	0.5	1.5	1500	10	150	200	96.2	9.67	6.32	87.21	3.31	3.19	6.04	13184	13700	1207	1.19	0.98	5.98	95.9
48	0.5	1.5	500	10	150	200	85.4	9.69	3.72	42.56	3.27	2.89	5.37	13184	14172	7748	1.18	0.63	4.12	84.6
49	1.0	1.5	1000	10	150	400	90.1	9.72	3.92	59.66	3.47	3.10	6.65	12882	14100	2391	1.25	0.71	5.80	89.6
50	1.0	1.5	1000	10	150	400	92.3	9.60	3.86	71.06	3.42	3.15	6.21	12882	14072	141	1.26	0.80	5.54	91.5
51	1.0	1.5	1000	10	150	400	90.3	9.73	3.98	61.88	3.54	3.21	6.53	12882	14119	1669	1.27	0.77	5.75	90.1
52	1.0	1.5	1000	10	150	400	90.3	9.69	3.84	66.34	3.48	3.19	6.36	12882	13790	4089	1.27	0.79	5.65	90.6
53	1.0	1.5	1000	10	150	400	90.3	9.73	3.89	61.54	3.55	3.24	6.26	12882	14033	2675	1.37	0.91	5.45	89.9
54	1.0	1.5	1000	10	150	400	90.2	9.66	3.93	72.34	3.40	3.13	6.35	12882	13870	2070	1.24	0.79	5.79	91.6

APPENDIX B

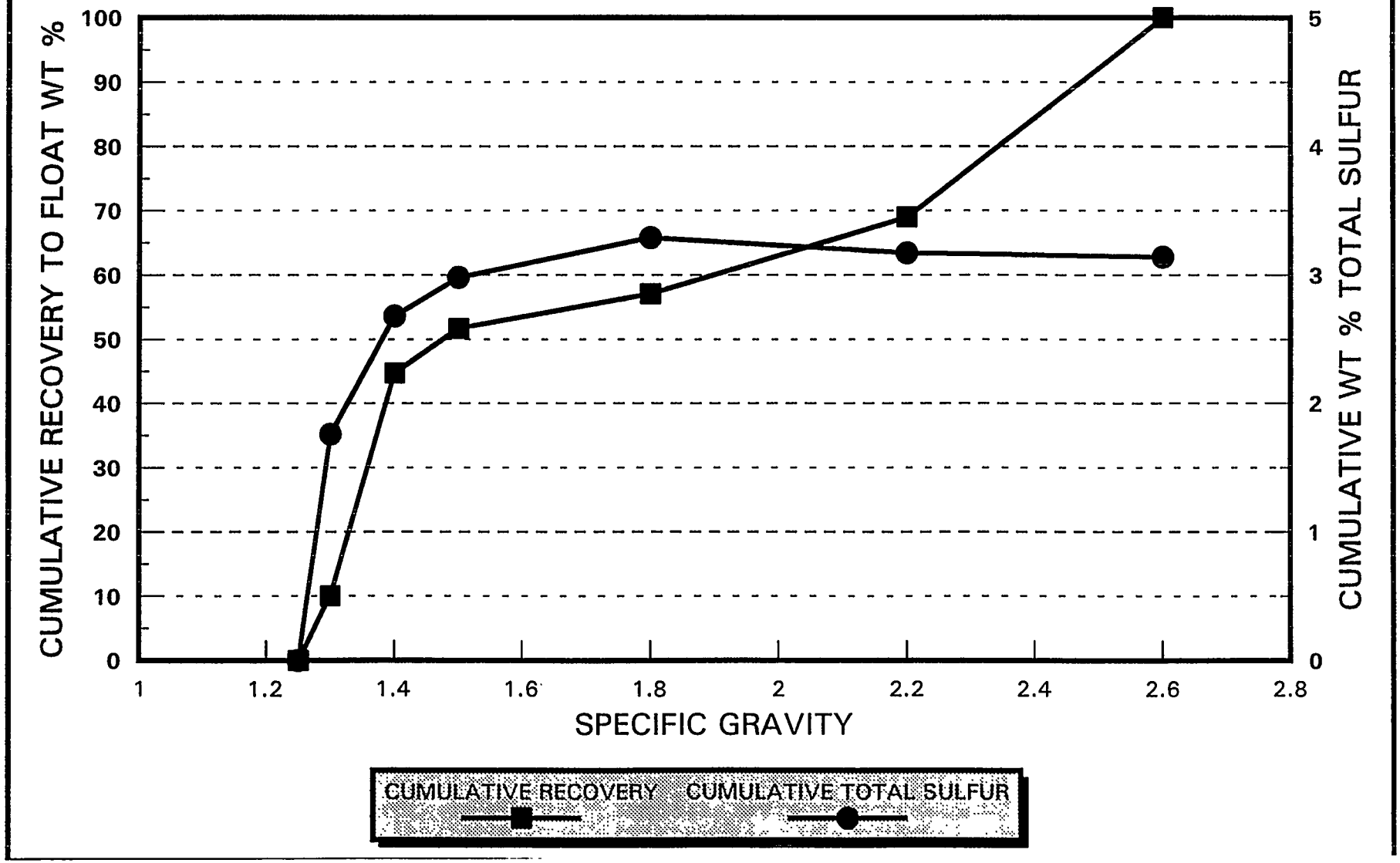
POC–SCALE DATA

PITTSBURGH NO. 8 SEAM WASHABILITY

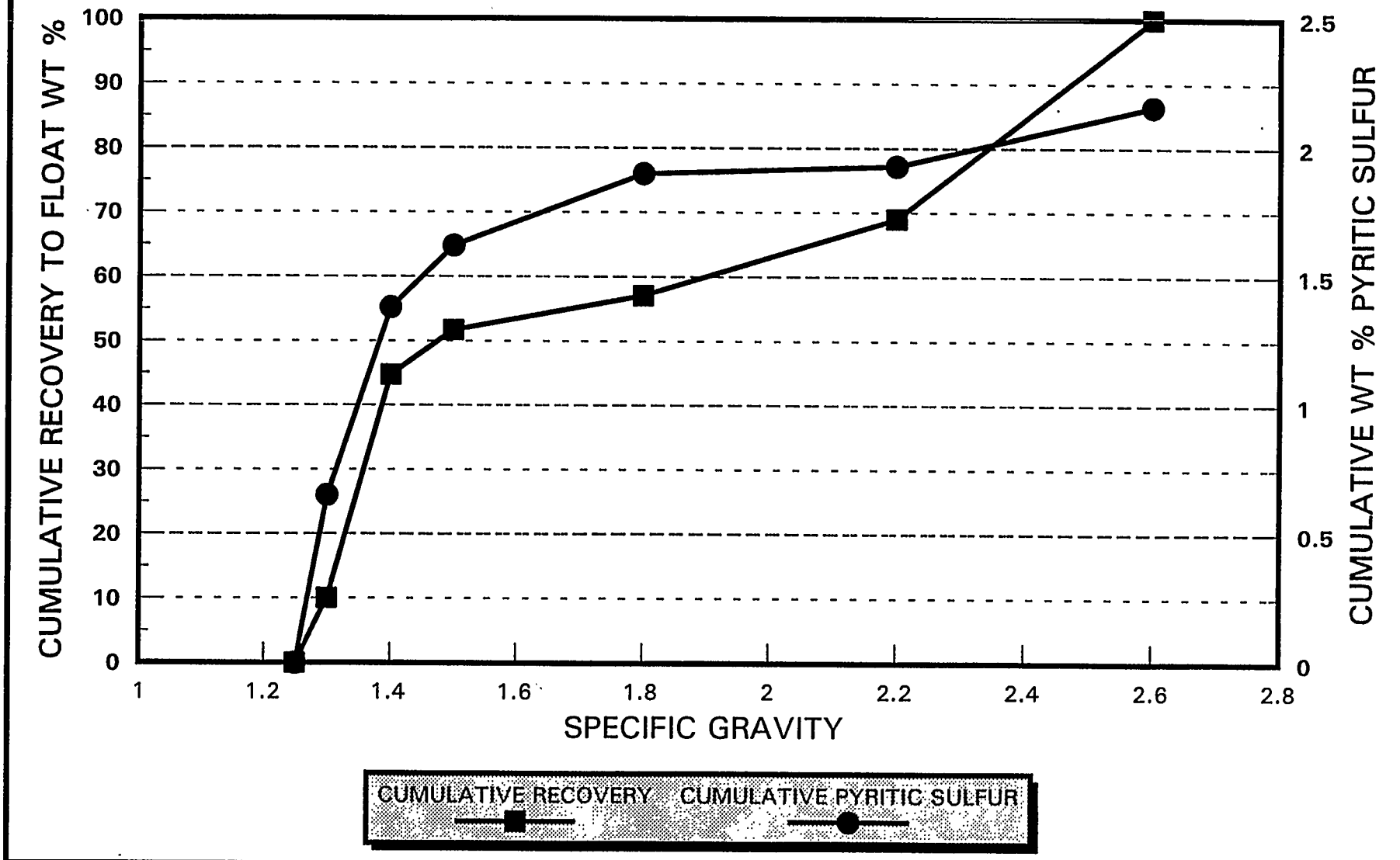

PITTSBURGH NO. 8 SEAM WASHABILITY GRAPH
% ASH
CUMULATIVE RECOVERY TO FLOAT WT %
CUMULATIVE WT % ASH
SPECIFIC GRAVITY
0
10
20
30
40
50
60
70
80
90
100
1
1.2
1.4
1.6
1.8
2
2.2
2.4
2.6
2.8
CUMULATIVE RECOVERY
CUMULATIVE ASH

PGH3.DRW

PITTSBURGH NO. 8 SEAM WASHABILITY GRAPH
% TOTAL SULFUR



PITTSBURGH NO. 8 SEAM WASHABILITY GRAPH
% PYRITIC SULFUR



PGH1.DRW

STANDARD LABORATORIES, INC.
147 Eleventh Avenue, South Charleston, WV 25303
Telephone: (304) 744-5472 • Fax# (304) 744-4319

FOR: ICF KAISER ENGINEERS
P.O. BOX 1488
BEVERLY, OHIO 45715

LAB NO. 31017901

SAMPLE ID: RUN NO: 93101501
COAL SEAM: PITTSBURGH SEAM
SAMPLE NAME: AS RECEIVED RAW COAL
OCTOBER 15, 1993

SAMPLED BY: ICF KAISER ENGINEERS

SIZE CONSIST

SIZE	ELEMENTARY % WEIGHT	CUMULATIVE % WEIGHT
+ 1/4" RD	51.37	51.37
1/4" RD X 48 MESH	33.48	84.85
48 MESH X 200 MESH	5.07	89.92
200 MESH X 0	10.08	100.00

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BEVERLY, OH 45715

CALCULATED COMPOSITE
Top x 0 = 100% OF TOTAL SAMPLE

SAMPLE ID:
RUN NO: 93101501
COAL SEAM: PITTSBURGH SEAM
SAMPLE NAME: AS RECEIVED RAW COAL
OCTOBER 15, 1993

LAB NO.: 31017901

SAMPLED BY: ICF-KE

SPECIFIC GRAVITY		ELEMENTARY DRY BASIS				CUMULATIVE RETAINED DRY BASIS				CUMULATIVE REJECT DRY BASIS			
SINK	FLOAT	% WT.	% ASH	% SUL.	BTU	% WT.	% ASH	% SUL.	BTU	% WT.	% ASH	% SUL.	BTU
	1.25	0.00				0.00							
1.25	1.30	10.05	3.42	1.76	14408	10.05	3.42	1.76	14408	100.00	40.38	3.14	8292
1.30	1.40	34.66	7.68	2.95	13658	44.71	6.72	2.68	13826	89.95	44.51	3.29	7608
1.40	1.50	6.96	16.14	4.91	12231	51.67	7.99	2.98	13611	55.29	67.59	3.50	3816
1.50	1.80	5.40	30.05	6.19	9992	57.07	10.08	3.29	13269	48.33	75.00	3.30	2605
1.80	2.20	11.91	66.42	2.62	4172	68.98	19.81	3.17	11698	42.93	80.66	2.94	1675
2.20		31.02	86.12	3.06	717	100.00	40.38	3.14	8292	31.02	86.12	3.06	717

		% PYRITE	% PYRITE	% PYRITE
	1.25	0.00	0.00	0.00
1.25	1.30	0.65	0.65	2.16
1.30	1.40	1.59	1.38	2.33
1.40	1.50	3.20	1.62	2.79
1.50	1.80	4.60	1.90	2.73
1.80	2.20	2.08	1.93	2.50
2.20		2.66	2.16	2.66

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FOR: ICF KAISER ENGINEERS
P.O. BOX 1488
BEVERLY, OH 45715

+1/4" RD = 51.37% OF TOTAL SAMPLE

LAB NO.: 31017901

SAMPLE ID:
RUN NO: 93101501
COAL SEAM: PITTSBURGH SEAM
SAMPLE NAME: AS RECEIVED RAW COAL
OCTOBER 15, 1993

SAMPLED BY: ICF-KE

SPECIFIC GRAVITY		ELEMENTARY DRY BASIS				CUMULATIVE RETAINED DRY BASIS				CUMULATIVE REJECT DRY BASIS			
SINK	FLOAT	% WT.	% ASH	% SUL.	BTU	% WT.	% ASH	% SUL.	BTU	% WT.	% ASH	% SUL.	BTU
	1.25	0.00				0.00				100.00	37.25	3.43	8753
1.25	1.30	6.49	4.00	1.71	14274	6.49	4.00	1.71	14274	93.51	39.56	3.55	8370
1.30	1.40	41.16	7.87	2.98	13636	47.65	7.34	2.81	13723	52.35	64.47	4.00	4229
1.40	1.50	8.67	16.27	5.12	12229	56.32	8.72	3.16	13493	43.68	74.04	3.77	2642
1.50	1.80	6.49	31.01	6.38	9887	62.81	11.02	3.50	13120	37.19	81.55	3.32	1377
1.80	2.20	5.66	57.42	4.38	5506	68.47	14.86	3.57	12491	31.53	85.88	3.13	636
2.20		31.53	85.88	3.13	636	100.00	37.25	3.43	8753				

SPECIFIC GRAVITY		% PYRITE	% PYRITE	% PYRITE
	1.25	0.00	0.00	0.00
1.25	1.30	0.72	0.72	2.41
1.30	1.40	1.64	1.51	2.52
1.40	1.50	3.34	1.80	3.22
1.50	1.80	4.95	2.12	3.19
1.80	2.20	3.66	2.25	2.89
2.20		2.75	2.41	2.75

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FOR: ICF KAISER ENGINEERS
P.O. BOX 1488
BEVERLY, OH 45715

1/4" RD X 48 MESH = 33.48% OF TOTAL SAMPLE

SAMPLE ID:
RUN NO: 93101501
COAL SEAM: PITTSBURGH SEAM
SAMPLE NAME: AS RECEIVED RAW COAL
OCTOBER 15, 1993

LAB NO.: 31017901

SAMPLED BY: ICF-KE

SPECIFIC GRAVITY		ELEMENTARY DRY BASIS				CUMULATIVE RETAINED DRY BASIS				CUMULATIVE REJECT DRY BASIS			
SINK	FLOAT	% WT.	% ASH	% SUL.	BTU	% WT.	% ASH	% SUL.	BTU	% WT.	% ASH	% SUL.	BTU
	1.25	0.00				0.00				100.00	34.95	3.16	9178
1.25	1.30	18.78	3.20	1.80	14469	18.78	3.20	1.80	14469	81.22	42.30	3.48	7955
1.30	1.40	35.21	7.64	3.01	13661	53.99	6.10	2.59	13942	46.01	68.82	3.83	3588
1.40	1.50	6.51	16.46	4.73	12156	60.50	7.21	2.82	13750	39.50	77.45	3.69	2176
1.50	1.80	4.98	29.36	6.27	10006	65.48	8.90	3.08	13465	34.52	84.39	3.31	1046
1.80	2.20	4.12	51.01	5.55	6338	69.60	11.39	3.23	13043	30.40	88.91	3.01	329
2.20		30.40	88.91	3.01	329	100.00	34.95	3.16	9178				

		% PYRITE	% PYRITE	% PYRITE
	1.25	0.00	0.00	0.00
1.25	1.30	0.64	0.64	2.06
1.30	1.40	1.57	1.25	2.38
1.40	1.50	3.10	1.45	3.01
1.50	1.80	4.29	1.66	2.99
1.80	2.20	4.07	1.80	2.80
2.20		2.63	2.06	2.63

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FOR: ICF KAISER ENGINEERS
P.O. BOX 1488
BEVERLY, OH 45715

48 MESH X 200 MESH = 5.07% OF TOTAL SAMPLE

SAMPLE ID:

LAB NO.: 31017901

RUN NO: 93101501
COAL SEAM: PITTSBURGH SEAM
SAMPLE NAME; AS RECEIVED RAW COAL
OCTOBER 15, 1993

SAMPLED BY: ICF-KE

SPECIFIC GRAVITY		ELEMENTARY DRY BASIS				CUMULATIVE RETAINED DRY BASIS				CUMULATIVE REJECT DRY BASIS			
SINK	FLOAT	% WT.	% ASH	% SUL.	BTU	% WT.	% ASH	% SUL.	BTU	% WT.	% ASH	% SUL.	BTU
	1.25	0.00				0.00				100.00	42.08	3.41	8011
1.25	1.30	8.43	2.13	1.60	14553	8.43	2.13	1.60	14553	91.57	45.76	3.58	7409
1.30	1.40	34.10	5.66	2.19	13898	42.53	4.96	2.07	14028	57.47	69.55	4.41	3558
1.40	1.50	6.45	12.26	3.26	12765	48.98	5.92	2.23	13862	51.02	76.79	4.55	2394
1.50	1.80	7.79	24.92	4.25	10815	56.77	8.53	2.51	13443	43.23	86.14	4.61	877
1.80	2.20	2.75	49.07	5.90	6807	59.52	10.40	2.66	13137	40.48	88.66	4.52	474
2.20		40.48	88.66	4.52	474	100.00	42.08	3.41	8011				

		% PYRITE	% PYRITE	% PYRITE
	1.25	0.00	0.00	0.00
1.25	1.30	0.31	0.31	2.41
1.30	1.40	1.03	0.89	2.60
1.40	1.50	1.99	1.03	3.53
1.50	1.80	2.98	1.30	3.73
1.80	2.20	4.08	1.43	3.86
2.20		3.85	2.41	3.85

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FOR: ICF KAISER ENGINEERS
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BEVERLY, OH 45715

200 MESH X 0 = 10.08% OF TOTAL SAMPLE

SAMPLE ID:
RUN NO: 93101501
COAL SEAM: PITTSBURGH SEAM
SAMPLE NAME: AS RECEIVED RAW COAL
OCTOBER 15, 1993

LAB NO.: 31017901

SAMPLED BY: ICF-KE

SPECIFIC GRAVITY		ELEMENTARY DRY BASIS				CUMULATIVE RETAINED DRY BASIS				CUMULATIVE REJECT DRY BASIS			
SINK	FLOAT	% WT.	% ASH	% SUL.	BTU	% WT.	% ASH	% SUL.	BTU	% WT.	% ASH	% SUL.	BTU
	1.25	0.00				0.00							
1.25	1.30	0.00				0.00							
1.30	1.40	0.00				0.00							
1.40	1.50	0.00				0.00							
1.50	1.80	0.00				0.00							
1.80	2.20	74.22	73.09	1.34	3205	74.22	73.09	1.34	3205	100.00	73.50	1.41	3135
2.20		25.78	74.69	1.61	2932	100.00	73.50	1.41	3135	25.78	74.69	1.61	2932

		% PYRITE	% PYRITE	% PYRITE
	1.25	0.00	0.00	0.00
1.25	1.30	0.00	0.00	0.00
1.30	1.40	0.00	0.00	0.00
1.40	1.50	0.00	0.00	0.00
1.50	1.80	0.00	0.00	0.00
1.80	2.20	1.06	1.06	1.12
2.20		1.29	1.12	1.29

PITTSBURGH NO. 8 SEAM GRINDING OPTIMIZATION TESTS

Mill Circuit Testing Pittsburgh No. 8

Note: Ball mill charge changed to finer media prior to run number – 93041901

TEST NUMBER		93040101	93040102	93040701	93040702	93040801	93040802	93040803	93041201	93041301	93041401	93041402	93041901	93041902	93041903	93042201
MILL SPEED – RPM		27.70	27.70	27.70	27.70	27.70	27.70	27.70	27.70	27.70	27.70	27.70	27.70	27.70	27.70	27.70
MILL FEED – TPH		4.42	2.08	1.25	2.79	3.01	2.76	2.48	9.30	5.84	4.45	2.72	2.61	6.52	1.99	3.80
MILL FEED – % SOLIDS		53.27	53.49	27.62	45.96	49.44	47.48	44.97	18.86	32.24	29.16	47.61	42.43	53.55	37.49	53.76
CYC FEED – TPH		8.35	4.29	2.28	4.74	5.64	4.92	4.23	11.56	8.11	6.47	4.96	5.07	13.46	3.28	7.06
CYC FEED – GPM		250.10	241.12	272.34	275.95	232.84	243.45	239.14	429.64	303.86	342.56	242.45	252.45	282.78	238.35	237.14
CYC FEED – % SOLIDS		12.92	6.99	3.32	6.76	9.47	7.93	6.96	10.48	10.39	7.41	8.03	7.87	18.18	5.42	11.56
NO. OF CYCLONES		2	2	2	2	2	2	2	3	2	3	2	2	2	2	2
VORTEX FINDER – DIA		1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.25	1.25	1.25	1.25	1.25	1.25
APEX – DIA		0.75	0.63	0.75	0.75	0.75	0.75	0.75	1.25	1.00	0.75	0.63	0.63	0.63	0.63	0.63
PRESSURE		27.40	22.20	34.10	34.10	20.00	37.80	15.50	22.20	39.30	31.00	36.00	35.50	35.00	35.00	34.00
COLUMN FEED																
MEAN SIZE – MICRONS		38.22	40.65	36.47	39.26	42.24	41.69	38.25	75.42	41.44	39.01	35.29	65.35	118.53	37.02	43.66
D 95 – MICRONS		126.58	113.83	100.95	109.21	122.12	123.00	109.96	230.53	119.62	115.08	112.60	205.03	285.73	112.54	107.45
MICROTRAC	+200	15.76	16.11	11.41	13.75	16.78	16.16	13.54	37.32	16.08	14.20	13.08	48.02	68.96	11.93	16.66
	200 x 325	15.13	19.99	18.61	19.85	20.47	19.52	18.88	17.64	19.48	18.21	15.81	24.79	18.39	16.33	25.23
	325 x 0	69.11	63.90	69.98	66.40	62.75	64.32	67.58	45.04	64.44	67.59	71.11	27.19	12.65	71.74	58.11
SCREEN	+200	–	–	8.62	9.19	8.79	10.10	12.90	22.00	11.84	14.11	12.12	6.22	31.79	9.34	14.57
ANALYSIS	200 x 325	–	–	17.07	15.72	11.57	14.62	19.86	17.08	17.60	15.84	17.63	19.75	15.60	15.66	18.18
	325 x 0	–	–	74.31	75.09	79.64	75.28	67.24	60.92	70.56	70.05	70.25	74.03	52.61	75.00	67.25
BALL MILL FEED																
MEAN SIZE – MICRONS		174.50	170.55	128.47	144.31	154.57	175.61	163.27	121.12	127.92	102.18	108.33	184.07	243.64	83.45	174.53
D 95 – MICRONS		402.34	387.12	307.09	335.74	342.61	413.16	396.46	278.26	305.21	222.63	228.00	430.83	494.96	181.74	389.61
MICROTRAC	+200	81.75	82.09	68.65	76.28	80.30	82.07	77.86	66.60	69.68	61.95	65.04	84.93	95.32	49.64	84.98
	200 x 325	9.70	10.86	18.68	16.25	12.86	12.22	14.82	18.92	19.21	23.73	23.28	11.67	3.83	27.57	11.01
	325 x 0	8.55	7.05	12.67	7.47	6.84	5.71	7.32	14.48	11.11	14.32	11.68	3.40	0.85	22.79	4.01
SCREEN	+200	–	–	67.29	69.40	76.05	71.96	70.56	58.17	57.11	58.82	73.85	62.93	84.28	75.55	74.79
ANALYSIS	200 x 325	–	–	18.17	16.34	12.19	14.07	14.73	20.07	21.68	21.77	11.99	21.01	5.58	8.11	10.97
	325 x 0	–	–	14.54	14.26	11.76	13.97	14.71	21.76	21.21	19.41	14.16	16.06	10.14	16.34	14.24
BALL MILL DISCHARGE																
MEAN SIZE – MICRONS		94.24	50.46	75.85	78.92	96.65	87.96	80.42	62.61	112.69	79.75	61.20	101.51	116.20	70.76	83.76
D 95 – MICRONS		240.15	156.46	208.72	209.47	237.51	231.13	212.03	207.17	264.12	179.54	163.72	206.49	242.00	163.16	169.42
MICROTRAC	+200	52.40	24.42	40.27	43.28	55.21	47.95	44.44	45.16	63.46	46.93	32.30	64.71	70.11	39.28	52.51
	200 x 325	18.37	17.26	21.10	21.24	18.52	19.69	19.27	23.68	19.72	27.04	22.54	22.29	18.53	28.28	29.26
	325 x 0	29.23	58.32	38.63	35.48	26.27	32.36	36.29	31.16	16.82	26.03	45.16	13.00	11.36	32.44	18.23
SCREEN	+200	–	–	25.95	30.98	35.95	30.83	27.92	45.09	47.01	32.47	24.61	18.48	44.69	31.22	35.87
ANALYSIS	200 x 325	–	–	21.56	22.57	21.68	21.18	21.06	18.44	22.96	28.49	26.46	32.89	14.02	21.16	18.19
	325 x 0	–	–	52.49	46.45	42.37	47.99	51.02	36.47	30.03	39.04	48.93	48.63	41.29	47.62	45.94
REDUCTION RATIO		1.85	3.38	1.69	1.83	1.60	2.00	2.03	1.93	1.14	1.28	1.77	1.81	2.10	1.18	2.08

PITTSBURGH NO. 8 SEAM
COLUMN FLOTATION
FACTORIAL TEST MATRIX RESULTS

The following pages contain the Factorial Matrix Test Results conducted on the Pittsburgh No. 8 coal seam. The tables below present the test conditions and sample stream identifications.

Pittsburgh No. 8 Factorial Matrix Test Conditions

Run Number	Feed Rate (tph)	Air Rate (SCFM)	Wash Water Rate (GPM)	Frother Name	Collector Type	Frother Dosage (ml/min)	Collector Dosage (ml/min)
609	2	84	127	CM-642	Kerosene	23	10
611	4	84	127	CM-642	Kerosene	23	19
612	4	139	42	CM-642	Kerosene	23	19
613	4	84	42	CM-642	Kerosene	46	38
614	2	84	42	CM-642	Kerosene	12	19
615	2	139	127	CM-642	Kerosene	12	19
616	2	139	42	CM-642	Kerosene	23	10
617	4	139	127	CM-642	Kerosene	46	38
618	4	139	127	CM-642	Kerosene	52	19
619	4	84	127	MIBC	Kerosene	26	38
620	4	139	42	MIBC	Kerosene	26	38
621	4	84	42	MIBC	Kerosene	52	19
622	2	84	42	MIBC	Kerosene	13	10
623	2	139	127	MIBC	Kerosene	13	10
624	2	84	127	MIBC	Kerosene	26	19
625	2	139	42	MIBC	Kerosene	26	19
626	4	84	42	MIBC	Kerosene	52	19
627	4	84	127	CM-642	Kerosene	23	19

Sample Stream Identification

Sample Identification No.	Sample Name
1	Plant Feed
8	Heavy-Media Cyclone Reject
11	Deslime Screen Underflow
13	Water-Only Cyclone Underflow
17	Water-Only Cyclone Overflow
19	Column Flotation Tailings
18	Column Flotation Concentrate
20	Refuse Thickener Feed

RUN NUMBER: 609

ASSAYS:

Stream	Weight (tph)		Ash (%)		Btu/lb	
	Exp	Calc	Exp	Calc	Exp	Calc
1	4.25	4.42	41.57	41.46	8204	8220
8	1.33	1.47	84.54	84.69	1157	1159
11	3.05	2.95	20.17	20.00	11621	11727
13	0.21	0.06	29.10	29.20	7821	7797
17	2.84	2.89	19.51	19.80	11902	11809
19	0.91	0.97	43.93	46.95	7782	7442
18	2.17	1.92	6.01	6.00	14063	14029
20	1.69	1.03	50.43	45.91	7167	7463

Stream	Weight (tph)		Total Sulfur (%)		Pyritic Sulfur (%)	
	Exp	Calc	Exp	Calc	Exp	Calc
1	4.25	4.42	2.93	2.85	2.03	1.90
8	1.33	1.47	3.01	3.04	2.65	2.72
11	3.05	2.95	3.08	2.75	1.84	1.49
13	0.21	0.06	8.76	8.68	6.84	6.85
17	2.84	2.89	2.66	2.63	1.47	1.38
19	0.91	0.97	3.37	3.21	2.32	2.41
18	2.17	1.92	2.19	2.33	0.79	0.86
20	1.69	1.03	3.21	3.53	2.44	2.67

RECOVERIES:

Stream	Weight %		Ash		Btu/lb	
	Exp	Calc	Exp	Calc	Exp	Calc
1	96.25	100.00	100.00	100.00	100.00	100.00
8	30.12	33.29	67.49	67.78	4.68	4.68
11	69.08	66.81	32.42	32.22	94.64	95.32
13	4.76	1.37	0.96	0.97	1.31	1.30
17	64.32	65.44	30.71	31.25	94.94	94.02
19	20.61	22.06	23.31	24.97	20.92	19.97
18	49.15	43.39	6.27	6.28	74.37	74.05
20	38.28	23.43	28.42	25.94	20.47	21.27

Stream	Weight %		Total Sulfur		Pyritic Sulfur	
	Exp	Calc	Exp	Calc	Exp	Calc
1	96.25	100.00	100.00	100.00	100.00	100.00
8	30.12	33.29	34.09	35.42	43.32	47.51
11	69.08	66.81	70.24	64.58	60.56	52.49
13	4.76	1.37	4.11	4.19	4.63	4.95
17	64.32	65.44	59.41	60.39	47.39	47.54
19	20.61	22.06	25.37	24.86	25.21	28.00
18	49.15	43.39	32.43	35.54	16.88	19.55
20	38.28	23.43	25.67	29.05	28.16	32.94

RUN NUMBER: 611

ASSAYS:

Stream	Weight (tph)		Ash (%)		Btu/lb	
	Exp	Calc	Exp	Calc	Exp	Calc
1	1.95	2.25	37.86	37.74	8786	8770
8	0.61	0.66	83.77	84.03	1335	1330
11	1.48	1.59	18.23	18.38	11916	11883
13	0.23	0.19	45.22	45.12	7638	7641
17	1.40	1.39	14.69	14.68	12426	12470
19	0.33	0.28	51.09	51.02	6455	6448
18	1.06	1.12	5.69	5.68	13967	13961
20	0.56	0.47	48.68	48.06	6941	6938

Stream	Weight (tph)		Total Sulfur (%)		Pyritic Sulfur (%)	
	Exp	Calc	Exp	Calc	Exp	Calc
1	1.95	2.25	2.76	2.82	1.89	1.86
8	0.61	0.66	2.75	2.73	2.32	2.33
11	1.48	1.59	2.94	2.85	1.72	1.66
13	0.23	0.19	4.55	4.56	3.09	3.11
17	1.40	1.39	2.60	2.61	1.48	1.46
19	0.33	0.28	4.94	4.95	3.94	4.00
18	1.06	1.12	2.03	2.04	0.82	0.84
20	0.56	0.47	4.78	4.79	3.59	3.63

RECOVERIES:

Stream	Weight %		Ash		Btu/lb	
	Exp	Calc	Exp	Calc	Exp	Calc
1	86.61	100.00	100.00	100.00	100.00	100.00
8	27.09	29.50	65.28	65.68	4.48	4.47
11	65.73	70.50	33.95	34.32	95.61	95.53
13	10.22	8.57	10.23	10.24	7.45	7.47
17	62.18	61.93	24.03	24.08	87.59	88.06
19	14.66	12.28	16.58	16.60	9.02	9.03
18	47.08	49.65	7.46	7.47	78.92	79.03
20	24.87	20.85	26.81	26.85	16.47	16.50

Stream	Weight %		Total Sulfur		Pyritic Sulfur	
	Exp	Calc	Exp	Calc	Exp	Calc
1	86.61	100.00	100.00	100.00	100.00	100.00
8	27.09	29.50	29.39	28.63	36.21	36.99
11	65.73	70.50	75.20	71.37	64.16	63.01
13	10.22	8.57	14.13	13.87	14.01	14.30
17	62.18	61.93	58.34	57.49	48.50	48.71
19	14.66	12.28	21.99	21.57	25.61	26.41
18	47.08	49.65	36.52	35.92	21.54	22.30
20	24.87	20.85	36.11	35.45	39.61	40.71

RUN NUMBER: 612

ASSAYS:

Stream	Weight (tph)		Ash (%)		Btu/lb	
	Exp	Calc	Exp	Calc	Exp	Calc
1	5.67	5.29	41.24	41.31	8020	8151
8	1.49	1.80	84.59	84.43	1159	1159
11	3.29	3.49	17.10	19.03	12184	11764
13	0.78	0.13	59.30	58.71	5805	5807
17	3.52	3.36	19.26	17.51	11816	11994
19	0.88	0.71	53.72	53.98	5586	5622
18	2.99	2.64	7.74	7.67	13737	13712
20	1.66	0.84	56.34	54.71	5689	5650

Stream	Weight (tph)		Total Sulfur (%)		Pyritic Sulfur (%)	
	Exp	Calc	Exp	Calc	Exp	Calc
1	5.67	5.29	2.83	2.58	1.91	1.68
8	1.49	1.80	2.75	2.83	2.32	2.44
11	3.29	3.49	2.78	2.45	1.60	1.29
13	0.78	0.13	3.57	3.60	2.34	2.36
17	3.52	3.36	2.24	2.40	1.21	1.25
19	0.88	0.71	3.25	3.34	2.36	2.45
18	2.99	2.64	2.05	2.15	0.85	0.92
20	1.66	0.84	3.40	3.38	2.35	2.43

RECOVERIES:

Stream	Weight %		Ash		Btu/lb	
	Exp	Calc	Exp	Calc	Exp	Calc
1	107.26	100.00	100.00	100.00	100.0	100.00
8	28.19	34.07	69.88	69.63	4.92	4.84
11	62.24	65.93	27.34	30.37	100.16	95.16
13	14.76	2.44	3.51	3.47	1.77	1.74
17	66.59	63.49	29.65	26.90	93.54	93.42
19	16.65	13.49	17.57	17.62	9.40	9.30
18	56.56	50.00	9.38	9.28	85.64	84.11
20	31.04	15.93	21.76	21.09	11.30	11.04

Stream	Weight %		Total Sulfur		Pyritic Sulfur	
	Exp	Calc	Exp	Calc	Exp	Calc
1	107.26	100.00	100.00	100.00	100.00	100.00
8	28.19	34.07	33.11	37.44	41.38	49.40
11	62.24	65.93	64.77	62.56	55.23	50.60
13	14.76	2.44	3.08	3.42	2.99	3.43
17	66.59	63.49	50.25	59.15	40.22	47.16
19	16.65	13.49	15.49	17.46	16.67	19.64
18	56.56	50.00	36.22	41.69	22.25	27.53
20	31.40	15.93	19.14	20.87	19.60	23.07

RUN NUMBER: 613

ASSAYS:

Stream	Weight (tph)		Ash (%)		Btu/lb	
	Exp	Calc	Exp	Calc	Exp	Calc
1	5.42	5.77	40.93	41.24	8062	8050
8	1.60	1.81	83.55	83.13	1086	1090
11	3.56	3.96	19.63	22.08	11471	11236
13	0.78	0.19	59.30	58.22	5805	5802
17	3.88	3.77	22.43	20.25	11309	11511
19	1.24	0.67	69.27	67.75	3530	3529
18	3.31	3.10	10.10	9.93	13250	13244
20	1.10	0.86	65.85	65.64	4031	4032

Stream	Weight (tph)		Total Sulfur (%)		Pyritic Sulfur (%)	
	Exp	Calc	Exp	Calc	Exp	Calc
1	5.42	5.77	2.69	2.64	1.01	1.27
8	1.60	1.81	2.64	2.65	2.43	1.95
11	3.56	3.96	2.87	2.63	0.91	0.97
13	0.78	0.19	3.57	3.60	2.34	2.31
17	3.88	3.77	2.60	2.59	0.88	0.90
19	1.24	0.67	3.10	3.18	2.62	2.45
18	3.31	3.10	2.31	2.46	0.65	0.56
20	1.10	0.86	3.30	3.27	2.59	2.42

RECOVERIES:

Stream	Weight %		Ash		Btu/lb	
	Exp	Calc	Exp	Calc	Exp	Calc
1	93.90	100.00	100.00	100.00	100.00	100.00
8	27.72	31.40	64.09	63.28	4.23	4.25
11	61.68	68.60	32.90	36.72	97.61	95.75
13	13.51	3.31	4.80	4.67	2.38	2.39
17	67.22	65.29	35.78	32.05	91.59	93.36
19	21.48	11.64	19.71	19.13	5.10	5.10
18	57.35	53.65	13.24	12.92	88.17	88.26
20	19.06	14.95	24.06	23.80	7.48	7.49

Stream	Weight %		Total Sulfur		Pyritic Sulfur	
	Exp	Calc	Exp	Calc	Exp	Calc
1	93.90	100.00	100.00	100.00	100.00	100.00
8	27.72	31.40	30.81	31.56	75.54	48.03
11	61.68	68.60	73.19	68.44	61.81	51.97
13	13.51	3.31	4.39	4.51	7.67	5.99
17	67.22	65.29	63.11	63.93	56.89	45.98
19	21.48	11.64	13.42	14.01	30.21	22.35
18	57.35	53.65	46.07	49.92	34.53	23.63
20	19.06	14.95	18.35	18.52	38.35	28.34

RUN NUMBER: 514

ASSAYS:

Stream	Weight (tph)		Ash (%)		Btu/lb	
	Exp	Calc	Exp	Calc	Exp	Calc
1	1.62	1.45	41.62	40.54	8464	8420
8	0.30	0.47	84.00	85.40	1343	1340
11	1.02	0.98	18.87	19.02	11730	11816
13	0.10	0.09	42.73	42.72	9056	9053
17	1.18	0.89	16.46	16.54	11982	12105
19	0.44	0.22	49.97	49.96	6779	6763
18	0.78	0.67	5.83	5.83	14037	13818
20	1.98	0.31	47.83	47.78	7452	7453

Stream	Weight (tph)		Total Sulfur (%)		Pyritic Sulfur (%)	
	Exp	Calc	Exp	Calc	Exp	Calc
1	1.62	1.45	2.76	2.66	1.06	1.38
8	0.30	0.47	2.49	2.52	2.20	1.75
11	1.02	0.98	2.74	2.74	1.12	1.20
13	0.10	0.09	5.30	5.31	3.85	3.69
17	1.18	0.89	2.51	2.47	0.83	0.94
19	0.44	0.22	3.78	3.81	3.31	2.61
18	0.78	0.67	1.99	2.04	0.47	0.40
20	1.98	0.31	4.23	4.26	3.47	2.93

RECOVERIES:

Stream	Weight %		Ash		Btu/lb	
	Exp	Calc	Exp	Calc	Exp	Calc
1	111.78	100.00	100.00	100.00	100.00	100.00
8	20.70	32.41	65.42	68.28	5.14	5.16
11	70.38	67.59	30.64	31.72	93.67	94.84
13	6.90	6.41	6.58	6.75	6.86	6.89
17	81.42	61.18	24.20	24.96	86.61	87.95
19	30.36	14.85	17.83	18.30	11.89	11.93
18	53.82	46.33	6.49	6.66	76.83	76.02
20	136.62	21.26	24.43	25.06	18.72	18.82

Stream	Weight %		Total Sulfur		Pyritic Sulfur	
	Exp	Calc	Exp	Calc	Exp	Calc
1	111.78	100.00	100.00	100.00	100.00	100.00
8	20.70	32.41	29.24	30.60	67.27	41.20
11	70.38	67.59	67.10	69.40	71.41	58.80
13	6.90	6.41	12.31	12.77	23.27	17.13
17	81.42	61.18	55.64	56.64	47.90	41.67
19	30.36	14.85	20.34	21.28	46.37	28.09
18	53.82	46.33	33.40	35.33	20.54	13.58
20	136.62	21.26	32.58	34.02	69.59	45.22

RUN NUMBER: 615

ASSAYS:

Stream	Weight (tph)		Ash (%)		Btu/lb	
	Exp	Calc	Exp	Calc	Exp	Calc
1	2.07	2.64	42.97	42.33	8028	7994
8	0.70	0.86	84.61	85.44	1300	1300
11	1.48	1.78	19.44	21.54	11798	11222
13	0.55	0.09	52.29	17.64	6270	6297
17	1.45	1.69	24.48	21.77	10875	11502
19	0.60	0.45	57.33	59.36	5756	5823
18	1.84	1.24	8.03	8.00	13716	13581
20	1.15	0.55	54.92	52.05	6002	5906

Stream	Weight (tph)		Total Sulfur (%)		Pyritic Sulfur (%)	
	Exp	Calc	Exp	Calc	Exp	Calc
1	2.07	2.64	2.70	2.51	1.10	1.33
8	0.70	0.86	2.43	2.48	2.27	1.95
11	1.48	1.78	2.64	2.52	0.90	1.03
13	0.55	0.09	4.11	4.19	3.28	3.22
17	1.45	1.69	2.44	2.42	0.85	0.90
19	0.60	0.45	2.83	3.02	2.40	2.14
18	1.84	1.24	2.09	2.20	0.52	0.45
20	1.15	0.55	3.44	3.23	2.82	2.33

RECOVERIES:

Stream	Weight %		Ash		Btu/lb	
	Exp	Calc	Exp	Calc	Exp	Calc
1	78.30	100.00	100.00	100.00	100.00	100.00
8	26.48	32.53	64.06	65.66	5.27	5.29
11	55.98	67.47	30.52	34.34	99.15	94.71
13	20.80	3.64	4.42	1.52	2.84	2.86
17	54.85	63.83	36.36	32.82	86.47	91.84
19	22.70	17.11	22.82	23.99	12.27	12.46
18	69.60	46.72	8.73	8.83	79.83	79.38
20	43.50	20.74	26.51	25.50	15.51	15.33

Stream	Weight %		Total Sulfur		Pyritic Sulfur	
	Exp	Calc	Exp	Calc	Exp	Calc
1	78.30	100.00	100.00	100.00	100.00	100.00
8	26.48	32.53	29.28	32.19	67.14	47.82
11	55.98	67.47	65.97	67.81	54.59	52.18
13	20.80	3.64	5.53	6.08	10.84	8.82
17	54.85	63.83	57.69	61.73	49.32	43.36
19	22.70	17.11	17.93	20.64	37.32	27.56
18	69.60	46.72	36.17	41.09	22.09	15.80
20	43.50	20.74	26.43	26.72	53.18	36.38

RUN NUMBER: 516

ASSAYS:

Stream	Weight (tph)		Ash (%)		Btu/lb	
	Exp	Calc	Exp	Calc	Exp	Calc
1	2.46	3.15	41.44	40.70	8169	7808
8	0.69	0.90	84.18	85.02	1041	1041
11	1.53	2.25	20.92	22.96	11484	10516
13	0.53	0.24	60.62	36.59	1779	1757
17	1.68	2.01	22.87	21.36	10465	11545
19	0.44	0.40	74.97	77.63	2927	2811
18	1.26	1.62	7.66	7.61	13598	13680
20	0.97	0.63	67.13	62.27	2300	2417

Stream	Weight (tph)		Total Sulfur (%)		Pyritic Sulfur (%)	
	Exp	Calc	Exp	Calc	Exp	Calc
1	2.46	3.15	2.63	2.52	2.07	1.85
8	0.69	0.90	2.55	2.58	2.44	2.53
11	1.53	2.25	2.57	2.50	1.63	1.58
13	0.53	0.24	3.14	3.14	2.49	2.50
17	1.68	2.01	2.34	2.42	1.46	1.47
19	0.44	0.40	3.52	3.49	3.04	3.04
18	1.26	1.62	2.15	2.16	1.05	1.09
20	0.97	0.63	3.31	3.36	2.74	2.84

RECOVERIES:

Stream	Weight %		Ash		Btu/lb	
	Exp	Calc	Exp	Calc	Exp	Calc
1	78.17	100.00	100.00	100.00	100.00	100.00
8	21.92	28.58	58.06	59.71	3.64	3.81
11	48.62	71.42	36.05	40.29	100.40	96.19
13	16.84	7.51	10.98	6.75	1.63	1.69
17	53.38	63.91	35.27	33.55	81.87	94.50
19	13.98	12.55	22.71	23.94	4.50	4.52
18	40.04	51.36	9.49	9.60	85.49	89.98
20	30.82	20.06	32.5	30.69	5.65	6.21

Stream	Weight %		Total Sulfur		Pyritic Sulfur	
	Exp	Calc	Exp	Calc	Exp	Calc
1	78.17	100.00	100.00	100.00	100.00	100.00
8	21.92	28.58	27.71	29.21	33.69	39.03
11	48.62	71.42	69.79	70.79	56.24	60.97
13	16.84	7.51	8.96	9.36	9.03	10.12
17	53.38	63.91	56.86	61.43	45.08	50.85
19	13.98	12.55	16.8	17.38	18.44	20.64
18	40.04	51.36	41.98	44.05	26.05	30.21
20	30.82	20.06	25.25	26.73	26.55	30.77

RUN NUMBER: 517

ASSAYS:

Stream	Weight (tph)		Ash (%)		Btu/lb	
	Exp	Calc	Exp	Calc	Exp	Calc
1	5.95	6.66	39.85	39.75	8417	8135
8	1.83	1.85	84.31	84.36	1205	1201
11	4.03	4.81	22.58	22.58	11183	10804
13	0.66	0.73	62.48	62.35	4360	4383
17	4.67	4.08	15.38	15.52	10945	11944
19	1.26	0.33	77.25	76.95	2257	2259
18	3.72	3.75	10.13	10.06	13362	12807
20	1.50	1.06	66.95	66.95	3724	3713

Stream	Weight (tph)		Total Sulfur (%)		Pyritic Sulfur (%)	
	Exp	Calc	Exp	Calc	Exp	Calc
1	5.95	6.66	3.07	2.51	2.20	1.78
8	1.83	1.85	2.54	2.65	2.37	2.51
11	4.03	4.81	2.23	2.46	1.37	1.50
13	0.66	0.73	3.16	3.16	2.98	2.98
17	4.67	4.08	2.40	2.34	1.54	1.23
19	1.26	0.33	3.15	3.16	1.86	1.90
18	3.72	3.75	2.23	2.26	1.05	1.18
20	1.50	1.06	3.16	3.16	2.64	2.64

RECOVERIES:

Stream	Weight %		Ash		Btu/lb	
	Exp	Calc	Exp	Calc	Exp	Calc
1	89.32	100.00	100.00	100.00	100.00	100.00
8	27.47	27.79	58.80	58.98	3.98	4.10
11	60.49	72.21	40.91	41.02	95.94	95.90
13	9.91	10.89	17.07	17.08	5.64	5.87
17	70.10	61.32	23.67	23.94	79.74	90.03
19	18.91	5.01	9.72	9.70	1.34	1.39
18	55.84	56.31	14.31	14.24	89.39	88.64
20	22.52	15.90	26.71	26.78	7.03	7.26

Stream	Weight %		Total Sulfur		Pyritic Sulfur	
	Exp	Calc	Exp	Calc	Exp	Calc
1	89.32	100.00	100.00	100.00	100.00	100.00
8	27.47	27.79	22.99	29.27	29.94	39.18
11	60.49	72.21	52.45	70.73	44.97	60.82
13	9.91	10.89	11.21	13.68	14.75	18.23
17	70.01	61.32	47.94	57.05	42.92	42.59
19	18.91	5.01	5.14	6.30	4.24	5.35
18	55.84	56.31	40.90	50.75	26.87	37.25
20	22.52	15.90	16.37	19.98	19.08	23.58

RUN NUMBER: 518

ASSAYS:

Stream	Weight (tph)		Ash (%)		Btu/lb	
	Exp	Calc	Exp	Calc	Exp	Calc
1	6.17	6.12	39.66	39.53	8313	8505
8	1.64	2.00	84.89	84.90	1081	1078
11	3.19	4.12	16.13	17.55	12368	12103
13	0.70	0.30	40.66	39.55	10230	11396
17	4.05	3.82	17.40	15.84	12377	12157
19	0.69	0.59	69.77	66.98	1135	1159
18	3.44	3.24	6.55	6.55	13908	14156
20	1.39	0.89	55.11	57.77	5715	4597

Stream	Weight (tph)		Total Sulfur (%)		Pyritic Sulfur (%)	
	Exp	Calc	Exp	Calc	Exp	Calc
1	6.17	6.12	2.84	2.64	2.20	1.91
8	1.64	2.00	2.53	2.58	2.45	2.57
11	3.19	4.12	2.77	2.66	1.62	1.59
13	0.70	0.30	4.42	4.46	3.06	3.07
17	4.05	3.82	2.47	2.52	1.49	1.47
19	0.69	0.59	4.10	4.15	3.52	3.55
18	3.44	3.24	2.15	2.23	1.04	1.09
20	1.39	0.89	4.26	4.26	3.29	3.39

RECOVERIES:

Stream	Weight %		Ash		Btu/lb	
	Exp	Calc	Exp	Calc	Exp	Calc
1	100.86	100.00	100.00	100.00	100.00	100.00
8	26.81	32.63	69.85	70.09	4.24	4.14
11	52.15	67.37	27.40	29.91	100.23	95.86
13	11.44	4.86	4.98	4.86	5.98	6.51
17	66.21	62.51	27.42	25.05	93.06	89.35
19	11.28	9.61	16.91	16.29	1.31	1.31
18	56.23	52.90	8.74	8.77	88.5	88.04
20	22.72	14.47	20.11	21.15	9.95	7.82

Stream	Weight %		Total Sulfur		Pyritic Sulfur	
	Exp	Calc	Exp	Calc	Exp	Calc
1	100.86	100.00	100.00	100.00	100.00	100.00
8	26.81	32.63	29.07	31.96	36.34	43.95
11	52.15	67.37	65.71	68.04	49.61	56.05
13	11.44	4.86	7.56	8.23	6.76	7.82
17	66.21	62.51	54.36	59.81	42.33	48.23
19	11.28	9.61	13.88	15.14	15.38	17.91
18	56.23	52.90	40.04	44.68	25.01	30.32
20	22.72	14.47	21.71	23.36	21.64	25.73

RUN NUMBER: 619

ASSAYS:

Stream	Weight (tph)		Ash (%)		Btu/lb	
	Exp	Calc	Exp	Calc	Exp	Calc
1	6.37	6.44	34.45	34.45	9257	9293
8	1.66	1.77	83.44	83.49	1204	1199
11	4.07	4.67	15.36	15.86	12413	12361
13	0.35	0.30	35.13	34.87	10426	10494
17	4.19	4.37	14.98	14.56	12538	12488
19	0.73	0.76	55.09	54.7	5261	5322
18	4.87	3.61	6.10	6.10	13986	13999
20	1.08	1.06	48.62	49.12	6935	6779

Stream	Weight (tph)		Total Sulfur (%)		Pyritic Sulfur (%)	
	Exp	Calc	Exp	Calc	Exp	Calc
1	6.37	6.44	2.81	2.76	2.08	1.82
8	1.66	1.77	2.68	2.69	2.42	2.52
11	4.07	4.67	3.02	2.79	1.81	1.56
13	0.35	0.30	5.65	5.72	4.47	4.60
17	4.19	4.37	2.58	2.59	1.33	1.35
19	0.73	0.76	3.61	3.68	2.77	2.88
18	4.87	3.61	2.25	2.36	0.95	1.03
20	1.08	1.06	4.27	4.25	3.32	3.37

RECOVERIES:

Stream	Weight %		Ash		Btu/lb	
	Exp	Calc	Exp	Calc	Exp	Calc
1	98.97	100.00	100.00	100.00	100.00	100.00
8	25.79	27.48	66.56	66.61	3.57	3.55
11	63.24	72.52	32.33	33.39	97.24	96.45
13	5.44	4.63	4.73	4.69	5.22	5.23
17	65.10	67.88	29.52	28.70	91.94	91.22
19	11.34	11.82	18.90	18.77	6.72	6.77
18	75.67	56.07	9.93	9.94	84.71	84.45
20	16.78	16.45	23.22	23.46	12.32	12.00

Stream	Weight %		Total Sulfur		Pyritic Sulfur	
	Exp	Calc	Exp	Calc	Exp	Calc
1	98.97	100.00	100.00	100.00	100.00	100.00
8	25.79	27.48	26.21	26.78	31.98	37.98
11	63.24	72.52	77.94	73.22	63.10	62.02
13	5.44	4.63	9.32	9.59	9.96	11.71
17	65.10	67.88	62.33	63.63	43.41	50.31
19	11.34	11.82	15.18	15.73	15.74	18.71
18	75.67	56.07	44.89	47.90	25.61	31.60
20	16.78	16.45	25.00	25.33	26.26	30.42

RUN NUMBER: 520

ASSAYS:

Stream	Weight (tph)		Ash (%)		Btu/lb	
	Exp	Calc	Exp	Calc	Exp	Calc
1	6.64	6.53	38.06	38.08	8569	8790
8	1.89	1.96	84.37	84.42	1227	1228
11	3.17	4.56	18.11	18.17	12017	12040
13	0.35	0.35	26.77	26.80	10339	10302
17	4.45	4.22	17.40	17.45	12131	12184
19	0.74	0.59	72.61	72.43	3315	3309
18	5.61	3.63	8.59	8.57	14070	13619
20	1.34	0.94	55.49	55.41	5938	5918

Stream	Weight (tph)		Total Sulfur (%)		Pyritic Sulfur (%)	
	Exp	Calc	Exp	Calc	Exp	Calc
1	6.64	6.53	2.95	2.83	2.24	1.92
8	1.89	1.96	2.60	2.63	2.48	2.60
11	3.17	4.56	3.32	2.91	1.99	1.64
13	0.35	0.35	4.10	4.14	2.40	2.44
17	4.45	4.22	2.74	2.81	1.52	1.57
19	0.74	0.59	3.86	3.90	3.20	3.29
18	5.61	3.63	2.46	2.64	1.17	1.29
20	1.34	0.94	3.95	3.99	2.90	2.97

RECOVERIES:

Stream	Weight %		Ash		Btu/lb	
	Exp	Calc	Exp	Calc	Exp	Calc
1	101.75	100.00	100.00	100.00	100.00	100.00
8	28.96	30.06	66.63	66.63	4.30	4.20
11	48.58	69.94	33.28	33.37	98.09	95.80
13	5.36	5.35	3.76	3.76	6.46	6.27
17	68.19	64.59	29.53	29.60	91.44	89.53
19	11.34	8.99	17.15	17.10	3.48	3.38
18	85.96	55.60	12.55	12.51	91.3	86.14
20	20.53	14.34	20.91	20.86	9.94	9.65

Stream	Weight %		Total Sulfur		Pyritic Sulfur	
	Exp	Calc	Exp	Calc	Exp	Calc
1	101.75	100.00	100.00	100.00	100.00	100.00
8	28.96	30.06	26.49	27.94	33.28	40.56
11	48.58	69.94	78.71	72.06	62.14	59.44
13	5.36	5.35	7.44	7.84	5.73	6.78
17	68.19	64.59	59.99	64.22	43.83	52.66
19	11.34	8.99	11.76	12.41	12.84	15.37
18	85.96	55.60	46.37	51.81	29.04	37.29
20	20.53	14.34	19.20	20.25	18.56	22.15

RUN NUMBER: 521

ASSAYS:

Stream	Weight (tph)		Ash (%)		Btu/lb	
	Exp	Calc	Exp	Calc	Exp	Calc
1	5.89	6.45	38.53	38.38	8712	8757
8	1.82	1.98	82.32	82.47	1578	1579
11	3.97	4.47	19.36	18.82	11791	11941
13	0.35	0.40	26.77	26.91	10339	10296
17	4.07	4.07	17.52	18.04	12268	12100
19	0.74	0.66	72.61	72.47	3315	3311
18	5.02	3.42	7.57	7.56	13835	13793
20	5.89	1.05	55.49	55.39	5938	5930

Stream	Weight (tph)		Total Sulfur (%)		Pyritic Sulfur (%)	
	Exp	Calc	Exp	Calc	Exp	Calc
1	5.89	6.45	2.83	2.68	2.12	1.83
8	1.82	1.98	2.64	2.68	2.57	2.70
11	3.97	4.47	3.44	2.68	2.10	1.45
13	0.35	0.40	4.10	4.18	2.40	2.45
17	4.07	4.07	2.50	2.53	1.47	1.35
19	0.74	0.66	3.86	3.96	3.20	3.45
18	5.02	3.42	2.03	2.26	0.82	0.95
20	5.89	1.05	3.95	4.04	2.90	3.07

RECOVERIES:

Stream	Weight %		Ash		Btu/lb	
	Exp	Calc	Exp	Calc	Exp	Calc
1	91.34	100.00	100.00	100.00	100.00	100.00
8	28.22	30.73	65.65	66.03	5.57	5.54
11	61.56	69.27	34.81	33.97	93.75	94.46
13	5.43	6.12	4.25	4.29	7.26	7.19
17	63.11	63.16	28.72	29.68	88.93	87.27
19	11.48	10.20	19.22	19.26	3.88	3.86
18	77.84	52.96	10.40	10.43	84.10	83.41
20	20.78	16.31	23.49	23.54	11.12	11.05

Stream	Weight %		Total Sulfur		Pyritic Sulfur	
	Exp	Calc	Exp	Calc	Exp	Calc
1	91.34	100.00	100.00	100.00	100.00	100.00
8	28.22	30.73	28.67	30.75	37.25	45.24
11	61.56	69.27	84.20	69.25	68.62	54.76
13	5.43	6.12	8.86	9.54	6.92	8.18
17	63.11	63.16	55.79	59.71	43.79	46.58
19	11.48	10.20	13.91	15.09	15.39	19.17
18	77.84	52.96	37.99	44.62	20.48	27.41
20	20.78	16.31	22.77	24.62	22.31	27.35

RUN NUMBER: 622

ASSAYS:

Stream	Weight (tph)		Ash (%)		Btu/lb	
	Exp	Calc	Exp	Calc	Exp	Calc
1	2.42	2.64	38.01	37.50	8761	8765
8	0.57	0.76	83.66	84.39	1111	1109
11	1.54	1.89	18.63	18.68	11765	11837
13	0.02	0.03	26.77	26.80	10339	10286
17	1.67	1.85	18.43	18.52	11906	11867
19	0.67	0.43	54.95	54.85	5850	5803
18	3.00	1.42	7.67	7.66	13661	13681
20	0.69	0.46	52.78	52.73	6093	6142

Stream	Weight (tph)		Total Sulfur (%)		Pyritic Sulfur (%)	
	Exp	Calc	Exp	Calc	Exp	Calc
1	2.42	2.64	3.15	3.29	2.32	2.43
8	0.57	0.76	2.92	2.89	2.89	2.84
11	1.54	1.89	3.39	3.45	2.16	2.27
13	0.02	0.03	4.10	4.09	2.40	2.39
17	1.67	1.85	3.54	3.44	2.45	2.27
19	0.67	0.43	6.45	6.09	5.51	5.14
18	3.00	1.42	2.68	2.64	1.42	1.41
20	0.69	0.46	5.69	5.94	4.69	4.93

RECOVERIES:

Stream	Weight %		Ash		Btu/lb	
	Exp	Calc	Exp	Calc	Exp	Calc
1	91.56	100.00	100.00	100.00	100.00	100.00
8	21.57	28.64	63.04	64.46	3.63	3.63
11	58.27	71.36	34.98	35.54	95.83	96.37
13	0.76	1.32	0.93	0.94	1.56	1.55
17	63.18	70.04	33.96	34.60	95.18	94.83
19	25.35	16.13	23.32	23.59	10.77	10.68
18	113.50	53.91	10.88	11.01	84.06	84.15
20	26.11	17.45	24.23	24.53	12.14	12.23

Stream	Weight %		Total Sulfur		Pyritic Sulfur	
	Exp	Calc	Exp	Calc	Exp	Calc
1	91.56	100.00	100.00	100.00	100.00	100.00
8	21.57	28.64	26.55	25.14	35.68	33.44
11	58.27	71.36	76.79	74.86	66.44	66.56
13	0.76	1.32	1.72	1.64	1.36	1.30
17	63.18	70.04	78.71	73.22	73.96	65.27
19	25.35	16.13	33.03	29.88	38.31	34.09
18	113.50	53.91	45.87	43.34	33.00	31.18
20	26.11	17.45	31.52	31.52	35.27	35.38

RUN NUMBER: 623

ASSAYS:

Stream	Weight (tph)		Ash (%)		Btu/lb	
	Exp	Calc	Exp	Calc	Exp	Calc
1	3.10	2.80	39.62	39.54	8550	8501
8	0.88	0.95	77.63	77.67	2314	2311
11	2.12	1.85	19.40	20.06	11678	11664
13	0.40	0.06	49.84	49.65	7262	7296
17	1.25	1.80	19.84	19.16	11887	11798
19	0.47	0.50	51.06	50.85	5892	6114
18	3.04	1.30	6.96	6.96	13839	13986
20	0.87	0.56	50.50	50.73	6522	6231

Stream	Weight (tph)		Total Sulfur (%)		Pyritic Sulfur (%)	
	Exp	Calc	Exp	Calc	Exp	Calc
1	3.10	2.80	3.25	3.03	2.38	2.22
8	0.88	0.95	2.91	2.97	2.74	2.81
11	2.12	1.85	3.28	3.06	2.10	1.92
13	0.40	0.06	5.35	5.42	3.88	3.92
17	1.25	1.80	2.82	2.99	1.71	1.85
19	0.47	0.50	3.96	4.20	3.34	3.45
18	3.04	1.30	2.48	2.53	1.23	1.24
20	0.87	0.56	4.60	4.32	3.59	3.49

RECOVERIES:

Stream	Weight %		Ash		Btu/lb	
	Exp	Calc	Exp	Calc	Exp	Calc
1	110.61	100.00	100.00	100.00	100.00	100.00
8	31.40	33.82	66.26	66.42	9.15	9.19
11	75.64	66.18	32.41	33.58	90.40	90.81
13	14.27	1.97	2.47	2.47	1.67	1.69
17	44.60	64.22	32.16	31.11	89.28	89.12
19	16.77	17.85	23.00	22.95	12.30	12.84
18	108.47	46.37	8.15	8.16	75.05	76.28
20	31.04	19.82	25.26	25.42	15.12	14.52

Stream	Weight %		Total Sulfur		Pyritic Sulfur	
	Exp	Calc	Exp	Calc	Exp	Calc
1	110.61	100.00	100.00	100.00	100.00	100.00
8	31.40	33.82	30.28	33.11	38.93	42.87
11	75.64	66.18	66.80	66.89	58.40	57.13
13	14.27	1.97	3.24	3.51	3.21	3.47
17	44.60	64.22	55.72	63.38	46.14	53.66
19	16.77	17.85	21.75	24.70	25.05	27.73
18	108.47	46.37	35.38	38.67	23.96	25.93
20	31.04	19.82	28.05	28.22	29.89	31.20

RUN NUMBER: 624

ASSAYS:

Stream	Weight (tph)		Ash (%)		Btu/lb	
	Exp	Calc	Exp	Calc	Exp	Calc
1	1.83	2.36	38.50	38.03	8677	8775
8	0.52	0.64	83.01	83.59	1286	1289
11	1.34	1.72	20.40	21.06	11649	11564
13	0.33	0.21	34.94	34.68	9582	9619
17	1.75	1.51	19.45	19.14	11938	1183
19	0.44	0.30	71.97	71.67	3093	3096
18	3.00	1.21	6.34	6.33	13968	13970
20	0.77	0.51	56.10	56.19	5874	5826

Stream	Weight (tph)		Total Sulfur (%)		Pyritic Sulfur (%)	
	Exp	Calc	Exp	Calc	Exp	Calc
1	1.83	2.36	3.15	3.10	2.31	2.33
8	0.52	0.64	2.86	2.87	3.03	3.02
11	1.34	1.72	3.28	3.18	2.17	2.07
13	0.33	0.21	4.54	4.55	3.36	3.36
17	1.75	1.51	3.09	2.99	2.04	1.89
19	0.44	0.30	4.77	4.84	4.53	4.67
18	3.00	1.21	2.43	2.54	1.16	1.22
20	0.77	0.51	4.67	4.72	4.03	4.12

RECOVERIES:

Stream	Weight %		Ash		Btu/lb	
	Exp	Calc	Exp	Calc	Exp	Calc
1	77.41	100.00	100.00	100.00	100.00	100.00
8	22.00	27.14	58.52	59.65	4.02	3.99
11	56.68	72.86	38.61	40.35	97.81	96.01
13	13.96	9.01	8.18	8.22	9.95	9.88
17	74.03	63.85	32.26	32.13	87.84	86.13
19	18.61	12.52	23.40	23.58	4.46	4.42
18	126.90	51.33	8.45	8.55	82.63	81.72
20	32.57	21.53	31.37	31.80	14.57	14.29

Stream	Weight %		Total Sulfur		Pyritic Sulfur	
	Exp	Calc	Exp	Calc	Exp	Calc
1	77.41	100.00	100.00	100.00	100.00	100.00
8	22.00	27.14	24.64	25.17	35.60	35.18
11	56.68	72.86	75.86	74.83	68.44	64.82
13	13.96	9.01	12.99	13.25	13.11	12.98
17	74.03	63.85	62.63	61.58	56.38	51.84
19	18.61	12.52	18.95	0.95	24.54	25.07
18	126.90	51.33	39.60	42.03	25.78	26.77
20	32.57	21.53	31.91	32.80	37.55	38.06

RUN NUMBER: 525

ASSAYS:

Stream	Weight (tph)		Ash (%)		Btu/lb	
	Exp	Calc	Exp	Calc	Exp	Calc
1	1.83	1.88	38.52	38.18	8732	8496
8	0.44	0.53	82.37	82.81	747	747
11	1.12	1.35	20.03	20.51	11586	11564
13	0.18	0.13	41.48	41.29	8545	8601
17	1.17	1.21	18.53	18.23	11481	11890
19	0.25	0.19	76.48	76.19	2441	2444
18	1.03	1.02	7.29	7.28	13769	13674
20	0.43	0.32	61.83	61.91	4996	4962

Stream	Weight (tph)		Total Sulfur (%)		Pyritic Sulfur (%)	
	Exp	Calc	Exp	Calc	Exp	Calc
1	1.83	1.88	3.25	3.33	2.33	2.45
8	0.44	0.53	3.25	3.23	2.93	2.88
11	1.12	1.35	3.31	3.37	2.21	2.28
13	0.18	0.13	5.48	5.46	4.47	4.42
17	1.17	1.21	3.16	3.14	2.14	2.04
19	0.25	0.19	5.91	5.88	5.31	5.30
18	1.03	1.02	2.68	2.63	1.44	1.43
20	0.43	0.32	5.73	5.71	4.96	4.94

RECOVERIES:

Stream	Weight %		Ash		Btu/lb	
	Exp	Calc	Exp	Calc	Exp	Calc
1	97.42	100.00	100.00	100.00	100.00	100.00
8	23.42	28.36	60.65	61.51	2.43	2.50
11	59.62	71.64	37.25	38.49	95.05	97.50
13	9.58	7.10	7.64	7.68	6.95	7.19
17	62.29	64.54	31.05	30.81	84.86	90.32
19	13.31	10.26	20.36	20.46	2.87	2.95
18	54.83	54.29	10.27	10.35	85.60	87.37
20	22.89	17.35	27.86	28.14	9.93	10.14

Stream	Weight %		Total Sulfur		Pyritic Sulfur	
	Exp	Calc	Exp	Calc	Exp	Calc
1	97.42	100.00	100.00	100.00	100.00	100.00
8	23.42	28.36	28.36	27.47	35.66	33.32
11	59.62	71.64	72.96	72.53	67.95	66.68
13	9.58	7.10	11.97	11.62	13.62	12.81
17	62.29	64.54	62.75	60.91	59.28	53.88
19	13.31	10.26	18.65	18.09	23.37	22.19
18	54.83	54.29	44.76	42.82	33.55	31.69
20	22.89	17.35	30.60	29.72	36.94	34.99

RUN NUMBER: 526

ASSAYS:

Stream	Weight (tph)		Ash (%)		Btu/lb	
	Exp	Calc	Exp	Calc	Exp	Calc
1	4.39	4.83	38.13	37.93	8922	8970
8	1.20	1.33	82.85	83.02	1542	1539
11	3.03	3.50	19.81	20.72	11856	11806
13	0.33	0.32	51.63	51.72	9064	8939
17	3.16	3.17	17.55	17.58	12209	12097
19	0.59	0.52	71.93	72.06	2710	2693
18	3.76	2.66	6.95	6.94	13839	13932
20	0.92	0.84	64.65	64.27	4989	5085

Stream	Weight (tph)		Total Sulfur (%)		Pyritic Sulfur (%)	
	Exp	Calc	Exp	Calc	Exp	Calc
1	4.39	4.83	2.98	2.89	2.38	2.20
8	1.20	1.33	2.94	2.97	2.92	2.99
11	3.03	3.50	3.05	2.86	2.07	1.90
13	0.33	0.32	5.59	5.62	5.05	5.12
17	3.16	3.17	2.55	2.58	1.62	1.57
19	0.59	0.52	3.47	3.48	3.24	3.32
18	3.76	2.66	2.30	2.40	1.15	1.23
20	0.92	0.84	4.23	4.30	3.89	4.01

RECOVERIES:

Stream	Weight %		Ash		Btu/lb	
	Exp	Calc	Exp	Calc	Exp	Calc
1	90.87	100.00	100.00	100.00	100.00	100.00
8	24.84	27.63	60.03	60.47	4.77	4.74
11	62.72	72.37	37.60	39.53	96.17	95.26
13	6.83	6.66	9.02	9.08	6.76	6.64
17	65.41	65.71	30.25	30.45	89.92	88.62
19	12.21	10.73	20.24	20.39	3.26	3.22
18	77.83	54.98	10.02	10.06	85.29	85.40
20	19.04	17.39	29.48	29.47	9.72	9.86

Stream	Weight %		Total Sulfur		Pyritic Sulfur	
	Exp	Calc	Exp	Calc	Exp	Calc
1	90.87	100.00	100.00	100.00	100.00	100.00
8	24.84	27.63	27.26	28.39	33.90	37.57
11	62.72	72.37	74.07	71.61	62.95	62.43
13	6.83	6.66	12.49	12.98	14.13	15.49
17	65.41	65.71	56.23	58.64	44.73	46.95
19	12.21	10.73	12.49	12.95	14.61	16.17
18	77.83	54.98	42.44	45.68	26.57	30.78
20	19.04	17.39	24.68	25.93	28.42	31.65

RUN NUMBER: 527

ASSAYS:

Stream	Weight (tph)		Ash (%)		Btu/lb	
	Exp	Calc	Exp	Calc	Exp	Calc
1	5.40	6.05	40.82	40.31	8493	8473
8	1.57	2.06	83.62	84.29	1375	1370
11	3.53	3.99	16.50	17.65	12309	12134
13	0.56	0.09	53.56	36.04	6707	6726
17	3.78	3.90	18.44	17.22	12115	12260
19	0.86	0.74	55.89	56.40	5944	6040
18	4.05	3.17	8.11	8.09	13748	13710
20	1.42	0.83	54.97	54.17	6245	6115

Stream	Weight (tph)		Total Sulfur (%)		Pyritic Sulfur (%)	
	Exp	Calc	Exp	Calc	Exp	Calc
1	5.40	6.05	3.35	2.95	2.65	2.34
8	1.57	2.06	2.89	2.99	3.14	3.29
11	3.53	3.99	3.06	2.92	2.04	1.85
13	0.56	0.09	3.98	3.99	3.33	3.33
17	3.78	3.90	2.80	2.90	1.86	1.82
19	0.86	0.74	4.18	4.20	3.63	3.70
18	4.05	3.17	2.47	2.59	1.27	1.38
20	1.42	0.83	4.10	4.17	3.51	3.66

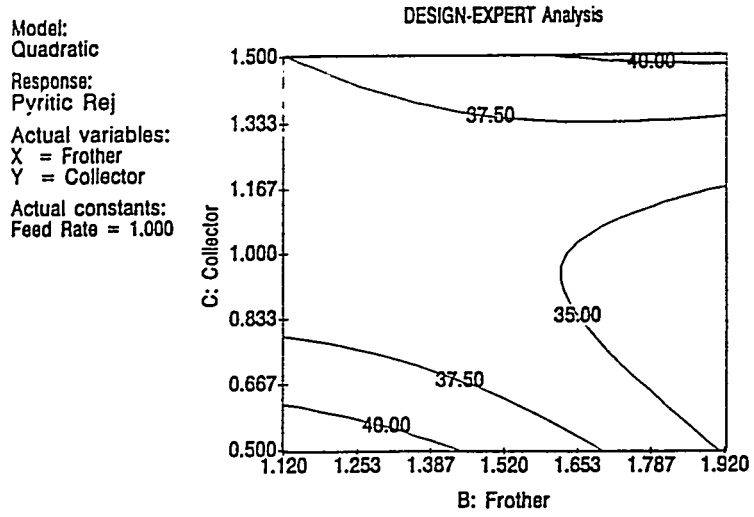
RECOVERIES:

Stream	Weight %		Ash		Btu/lb	
	Exp	Calc	Exp	Calc	Exp	Calc
1	89.22	100.00	100.00	100.00	100.00	100.00
8	25.94	34.01	69.67	71.11	5.51	5.50
11	58.32	65.99	26.67	28.89	95.64	94.50
13	9.25	1.49	1.96	1.34	1.18	1.19
17	62.45	64.50	29.14	27.55	92.00	93.31
19	14.21	12.20	16.70	17.06	8.54	8.69
18	66.91	52.30	10.39	10.49	84.66	84.62
20	23.46	13.69	18.44	18.40	10.07	9.88

Stream	Weight %		Total Sulfur		Pyritic Sulfur	
	Exp	Calc	Exp	Calc	Exp	Calc
1	89.22	100.00	100.00	100.00	100.00	100.00
8	25.94	34.01	29.34	34.54	40.30	47.76
11	58.32	65.99	60.28	65.46	50.80	52.24
13	9.25	1.49	1.78	2.02	1.88	2.13
17	62.45	64.50	53.91	63.43	45.27	50.11
19	14.21	12.20	15.22	17.37	16.71	19.27
18	66.91	52.30	38.56	46.06	25.07	30.84
20	23.46	13.69	16.76	19.39	18.13	21.40

PITTSBURGH NO. 8 SEAM
COLUMN FLOTATION
BOX-BEHNKEN TEST MATRIX RESULTS

a)



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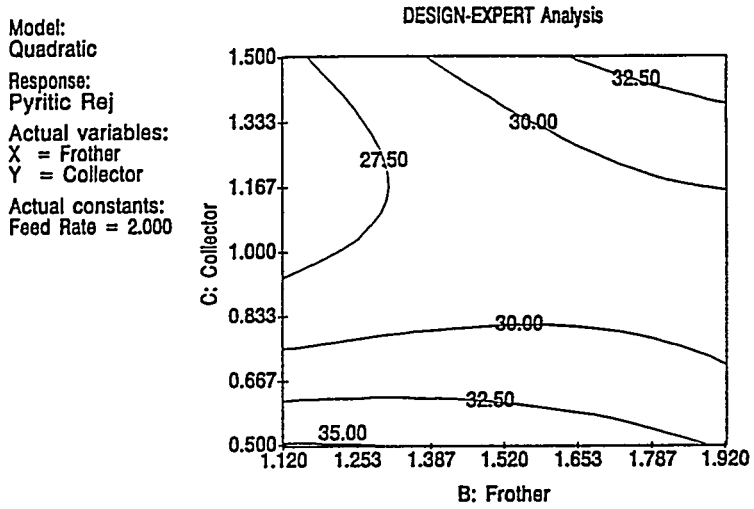


c)

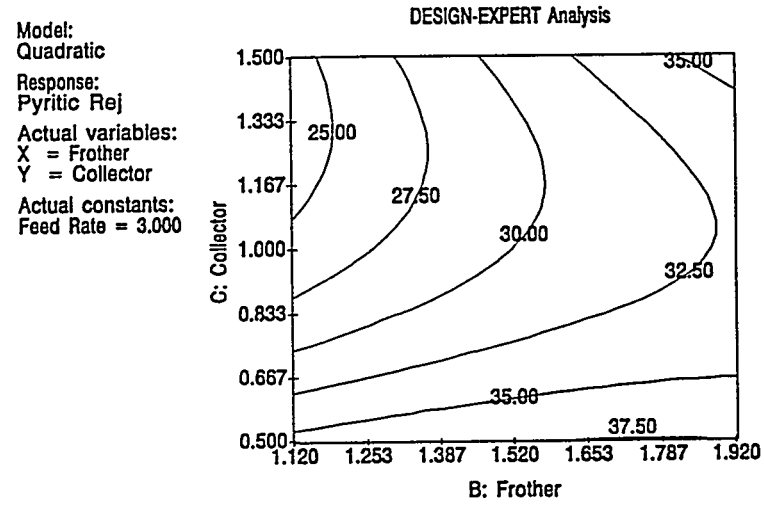
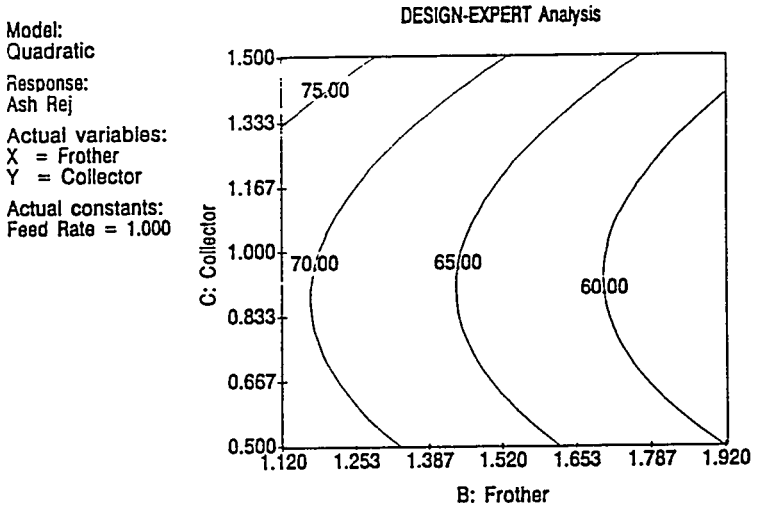


Figure 2.25

Effects of Collector Dosage and Frother Dosage on Pyritic Sulfur Rejection for the Pittsburgh No. 8 Coal at Feed Rates of (a) 1.0, (b) 2.0, and (c) 3.0 tph

a)



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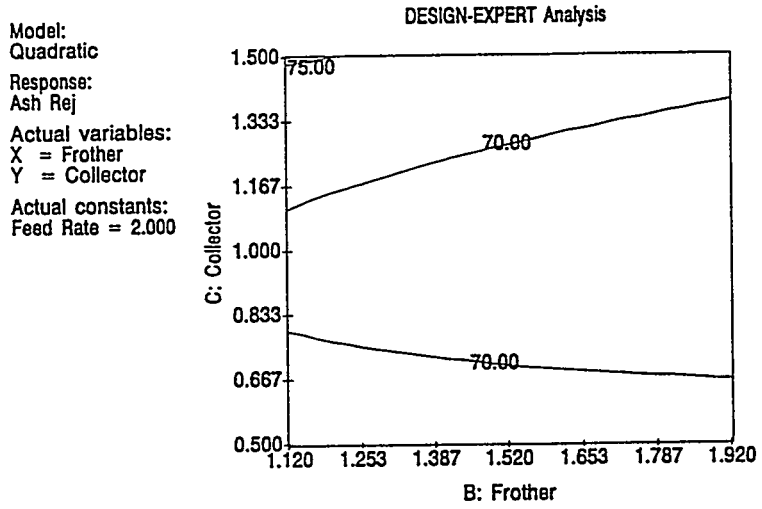


c)

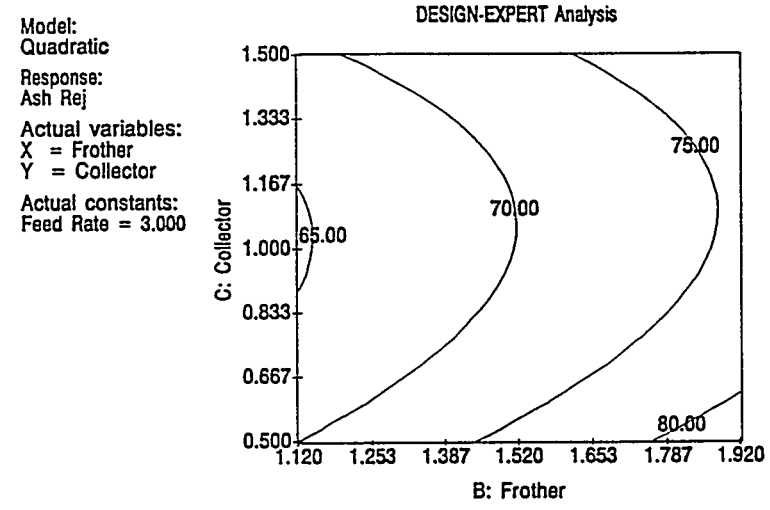


Figure 2.24

Effects of Collector Dosage and Frother Dosage on Ash Rejection for the Pittsburg No. 8 Coal at Feed Rates of (a) 1.0, (b) 2.0, and (c) 3.0 tph

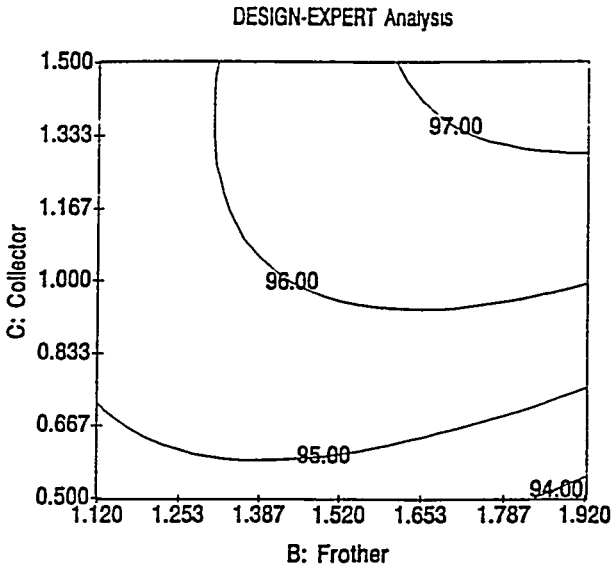
a)

Model:
Quadratic

Response:
Recovery

Actual variables:
X = Frother
Y = Collector

Actual constants:
Feed Rate = 2.000



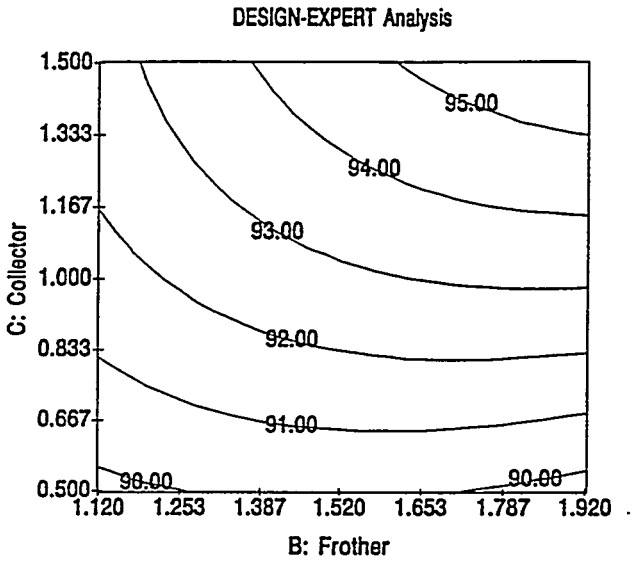
b)

Model:
Quadratic

Response:
Recovery

Actual variables:
X = Frother
Y = Collector

Actual constants:
Feed Rate = 1.000



c)

Model:
Quadratic

Response:
Recovery

Actual variables:
X = Frother
Y = Collector

Actual constants:
Feed Rate = 3.000

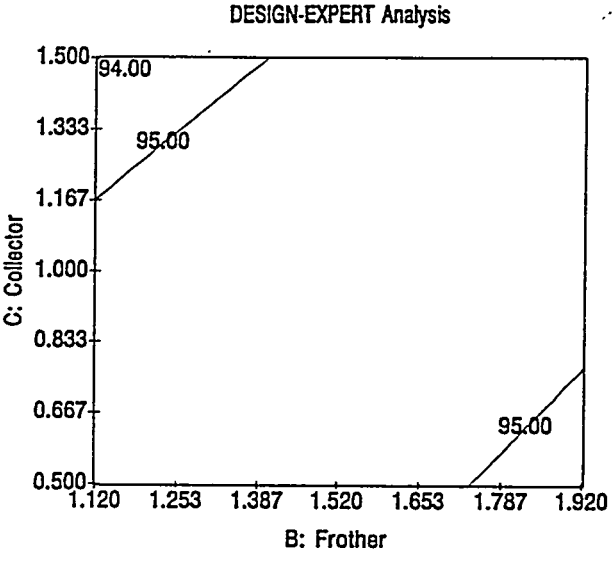


Figure 2.23

Effects of Collector Dosage and Frother Dosage on Energy Recovery for the Pittsburgh No. 8 Coal at Feed Rates of (a) 1.0, (b) 2.0, and (c) 3.0 tph

Pittsburgh No. 8 Seam
Box-Behnken Tests

Test Number	Design Number	Goodness-of-Fit			Material Balance
		Ash	Other	Total	
93081601	1	23.71	14.44	38.15	Poor
93081602	10	7.43	5.83	13.26	Fair
93081603	11	1.16	4.60	5.76	Good
93081604	8	1.87	7.65	9.52	Good
93081605	2	7.92	4.41	12.33	Fair
93081606	0	9.86	18.65	28.51	Poor
93081607	3	17.66	4.56	22.22	Poor
93081608	0	2.93	4.67	7.60	Good
93081609	7	3.02	3.07	6.09	Good
93081610	5	4.74	2.39	7.13	Good
93081611	6	5.53	5.39	10.92	Fair
93081612	12	8.20	14.40	22.60	Poor
93081613	4	12.14	13.73	25.87	Poor
93081614	9	6.93	6.07	13.00	Fair
93081615	0	0.62	4.66	5.28	Good
Average		7.58	7.63	15.22	

Pittsburgh No. 8 Seam										
Box-Behnken Tests										
	Planned	Planned	Planned	Planned	Planned	Planned	Planned	Planned	Planned	Planned
	Plant	Column	Column	Column	Column	Column	Column	Column	Column	Column
	Feed	Feed	Aeration	Wash	Air	Frother	Frother	Collector	Frother	Collector
Test	Rate	Rate	Rate	Rate	Holdup	Type	Dosage	Dosage	Dosage	Dosage
Number	(tph)	(tph)	(scfm)	(gpm)	(%)	(*)	(lb/ton)	(lb/ton)	(ml/min)	(ml/min)
93081601	1.50	1.00	140	100	N/A	MIBC	1.12	1.00	10.50	9.50
93081602	3.10	2.00	140	100	N/A	MIBC	1.92	0.50	36.00	9.50
93081603	3.10	2.00	140	100	N/A	MIBC	1.12	1.50	21.00	28.40
93081604	4.70	3.00	140	100	N/A	MIBC	1.52	1.50	42.70	42.60
93081605	4.70	3.00	140	100	N/A	MIBC	1.12	1.00	31.50	28.40
93081606	3.10	2.00	140	100	N/A	MIBC	1.52	1.00	28.50	18.90
93081607	1.50	1.00	140	100	N/A	MIBC	1.92	1.00	18.00	9.50
93081608	3.10	2.00	140	100	N/A	MIBC	1.52	1.00	28.50	18.90
93081609	1.50	1.00	140	100	N/A	MIBC	1.52	1.50	14.20	14.20
93081610	1.50	1.00	140	100	N/A	MIBC	1.52	0.50	14.20	4.70
93081611	4.70	3.00	140	100	N/A	MIBC	1.52	0.50	42.70	14.20
93081612	3.10	2.00	140	100	N/A	MIBC	1.92	1.50	36.00	28.40
93081613	4.70	3.00	140	100	N/A	MIBC	1.92	1.00	54.00	28.40
93081614	3.10	2.00	140	100	N/A	MIBC	1.12	0.50	21.00	9.50
93081615	3.10	2.00	140	100	N/A	MIBC	1.52	1.00	28.50	18.90
Average	3.10	2.00	140	100	N/A	MIBC	1.52	1.00	28.49	18.93

Pittsburgh No. 8 Seam									
Box-Behnken Tests									
	Relative	Relative	Relative	Relative	Relative	Relative	Relative	Relative	Relative
	Plant	Deslime	HMC	WOC	WOC	Column	Column	Column	Thickener
Test	Feed	U/F	Reject	O/F	U/F	Feed	Product	Reject	Feed
Number	(%)	(%)	(%)	(%)	(%)	(%)	(%)	(%)	(%)
93081601	100.00	73.57	26.43	66.75	6.81	66.75	51.46	15.29	22.10
93081602	100.00	66.76	33.24	63.19	3.57	63.19	49.43	13.76	17.33
93081603	100.00	78.73	21.27	75.63	3.10	75.63	60.19	15.44	18.53
93081604	100.00	75.21	24.79	71.78	3.43	71.78	56.75	15.03	18.46
93081605	100.00	73.50	26.50	67.66	5.84	67.66	54.04	13.62	19.46
93081606	100.00	72.64	27.36	67.68	4.96	67.68	54.64	13.04	18.00
93081607	100.00	75.18	24.82	69.50	5.68	69.50	58.82	10.68	16.36
93081608	100.00	73.78	26.22	68.76	5.02	68.76	56.65	12.11	17.13
93081609	100.00	73.14	26.86	69.14	4.00	69.14	54.45	14.69	18.70
93081610	100.00	67.75	32.25	64.08	3.67	64.08	49.70	14.39	18.05
93081611	100.00	72.35	27.65	69.62	2.73	69.62	55.88	13.74	16.47
93081612	100.00	71.96	28.04	67.21	4.75	67.21	55.52	11.69	16.44
93081613	100.00	72.07	27.93	65.90	6.17	65.90	52.28	13.62	19.79
93081614	100.00	73.32	26.68	68.23	5.09	68.23	55.62	12.61	17.69
93081615	100.00	77.06	22.94	70.54	6.52	70.54	58.94	11.60	18.12
Average	100.00	73.13	26.87	68.38	4.76	68.38	54.96	13.42	18.18

Pittsburgh No. 8 Seam									
Box-Behnken Tests									
	Relative	Relative	Relative	Relative	Relative	Relative	Relative	Relative	Relative
	Plant	Deslime	HMC	WOC	WOC	Column	Column	Column	Thickener
Test	Feed	U/F	Reject	O/F	U/F	Feed	Product	Reject	Feed
Number	(tph)	(tph)	(tph)	(tph)	(tph)	(tph)	(tph)	(tph)	(tph)
93081601	1.50	1.10	0.40	1.00	0.10	1.00	0.77	0.23	0.33
93081602	3.10	2.07	1.03	1.96	0.11	1.96	1.53	0.43	0.54
93081603	3.10	2.44	0.66	2.34	0.10	2.34	1.87	0.48	0.57
93081604	4.70	3.53	1.17	3.37	0.16	3.37	2.67	0.71	0.87
93081605	4.70	3.45	1.25	3.18	0.27	3.18	2.54	0.64	0.91
93081606	3.10	2.25	0.85	2.10	0.15	2.10	1.69	0.40	0.56
93081607	1.50	1.13	0.37	1.04	0.09	1.04	0.88	0.16	0.25
93081608	3.10	2.29	0.81	2.13	0.16	2.13	1.76	0.38	0.53
93081609	1.50	1.10	0.40	1.04	0.06	1.04	0.82	0.22	0.28
93081610	1.50	1.02	0.48	0.96	0.06	0.96	0.75	0.22	0.27
93081611	4.70	3.40	1.30	3.27	0.13	3.27	2.63	0.65	0.77
93081612	3.10	2.23	0.87	2.08	0.15	2.08	1.72	0.36	0.51
93081613	4.70	3.39	1.31	3.10	0.29	3.10	2.46	0.64	0.93
93081614	3.10	2.27	0.83	2.12	0.16	2.12	1.72	0.39	0.55
93081615	3.10	2.39	0.71	2.19	0.20	2.19	1.83	0.36	0.56
Average	3.10	2.27	0.83	2.13	0.15	2.13	1.71	0.42	0.56

Pittsburgh No. 8 Seam										
Box-Behnken Tests										
	Measured	Adjusted	Measured	Adjusted	Measured	Adjusted	Measured	Adjusted	Measured	Adjusted
	Plant	Plant	Deslime	Deslime	HMC	HMC	WOC	WOC	WOC	WOC
	Feed	Feed	U/F	U/F	Reject	Reject	O/F	O/F	U/F	U/F
Test	Ash	Ash	Ash	Ash	Ash	Ash	Ash	Ash	Ash	Ash
Number	(%)	(%)	(%)	(%)	(%)	(%)	(%)	(%)	(%)	(%)
93081601	35.89	35.86	19.28	19.86	80.33	80.37	16.83	18.06	39.26	37.56
93081602	41.38	41.65	22.52	21.59	82.29	81.94	22.24	20.42	42.17	42.30
93081603	34.94	35.29	23.38	22.71	82.26	81.85	20.85	21.65	48.42	48.46
93081604	38.10	38.31	24.72	23.76	82.67	82.43	22.18	22.43	51.64	51.57
93081605	39.22	39.00	24.45	23.08	82.87	83.13	19.00	20.88	48.63	48.66
93081606	38.84	38.48	22.80	22.08	81.56	82.00	18.29	20.26	47.16	47.02
93081607	35.84	35.90	19.59	20.43	82.84	82.76	16.91	18.74	41.41	41.06
93081608	37.41	37.46	20.92	20.56	85.10	85.03	17.73	18.75	45.50	45.30
93081609	38.28	38.51	23.89	22.81	81.53	81.25	20.27	21.62	73.31	43.44
93081610	40.92	40.93	19.97	20.46	83.95	93.94	18.15	19.26	41.49	41.42
93081611	37.82	38.20	21.93	20.96	83.85	83.33	18.27	19.94	46.77	46.89
93081612	37.08	36.96	17.80	19.07	82.70	82.87	16.72	17.35	44.34	43.51
93081613	40.66	40.70	26.78	24.12	83.54	83.49	18.77	21.17	54.29	55.54
93081614	37.92	38.00	20.14	21.25	84.13	84.03	21.53	19.22	49.18	48.47
93081615	35.70	35.71	20.86	21.17	84.61	84.59	19.41	18.87	46.08	45.96
Average	38.00	38.06	21.94	21.59	82.95	83.53	19.14	19.91	47.98	45.81

Pittsburgh No. 8 Seam								
Box-Behnken Tests								
	Measured	Adjusted	Measured	Adjusted	Measured	Adjusted	Measured	Adjusted
	Column	Column	Column	Column	Column	Column	Thickener	Thickener
	Feed	Feed	Product	Product	Reject	Reject	Feed	Feed
Test	Ash	Ash	Ash	Ash	Ash	Ash	Ash	Ash
Number	(%)	(%)	(%)	(%)	(%)	(%)	(%)	(%)
93081601	20.76	18.06	7.21	7.23	62.39	54.50	43.42	49.28
93081602	18.56	20.42	6.66	6.66	70.24	69.84	63.82	64.16
93081603	21.94	21.65	7.16	7.15	79.29	78.21	72.51	73.24
93081604	21.91	22.43	8.35	8.34	78.45	75.67	68.82	71.19
93081605	22.38	20.88	7.98	7.98	74.38	72.07	62.70	65.04
93081606	22.39	20.26	7.62	7.61	76.02	73.23	63.51	66.01
93081607	22.69	18.74	10.89	10.81	63.21	62.44	54.69	55.01
93081608	19.48	18.75	7.26	7.23	75.30	72.65	62.63	64.63
93081609	22.25	21.62	7.15	7.14	76.26	75.29	67.89	68.47
93081610	21.08	19.26	7.50	7.48	59.88	59.93	56.60	56.17
93081611	21.11	19.94	6.89	6.87	74.23	73.13	68.33	68.77
93081612	19.38	17.35	5.71	5.70	75.48	72.69	62.09	64.25
93081613	22.37	21.17	5.93	5.90	79.70	79.82	74.15	72.25
93081614	18.45	19.22	6.49	6.50	76.64	75.35	66.10	67.62
93081615	18.45	18.87	7.39	7.37	77.75	77.32	66.09	66.04
Average	20.88	19.91	7.35	7.33	73.28	71.48	63.56	64.81

Pittsburgh No. 8 Seam										
Box-Behnken Tests										
	Measured	Adjusted	Measured	Adjusted	Measured	Adjusted	Measured	Adjusted	Measured	Adjusted
	Plant	Plant	Deslime	Deslime	HMC	HMC	WOC	WOC	WOC	WOC
	Feed	Feed	U/F	U/F	Reject	Reject	O/F	O/F	U/F	U/F
Test	Sulfur	Sulfur	Sulfur	Sulfur	Sulfur	Sulfur	Sulfur	Sulfur	Sulfur	Sulfur
Number	(%)	(%)	(%)	(%)	(%)	(%)	(%)	(%)	(%)	(%)
93081601	3.50	3.49	3.24	3.37	3.84	3.84	2.97	2.99	8.00	7.09
93081602	3.27	3.13	3.06	3.09	3.17	3.21	2.74	2.88	6.78	6.68
93081603	3.37	3.01	3.00	2.92	3.29	3.36	2.73	2.71	8.23	7.97
93081604	3.44	3.21	3.19	3.04	3.66	3.72	2.64	2.81	8.14	7.75
93081605	3.12	3.15	1.55	1.77	3.34	3.33	2.81	2.66	8.44	8.03
93081606	3.14	3.08	3.23	2.97	3.37	3.39	2.68	2.63	7.98	7.61
93081607	3.15	2.98	3.23	2.90	3.17	3.21	2.61	2.53	7.36	7.35
93081608	2.78	2.69	2.89	2.76	2.49	2.51	2.67	2.43	7.41	7.17
93081609	2.71	2.73	2.66	2.65	2.95	2.94	2.50	2.44	6.40	6.18
93081610	2.71	2.60	2.55	2.51	2.75	2.79	2.49	2.29	6.31	6.35
93081611	2.78	2.64	2.71	2.56	2.82	2.86	2.52	2.41	6.61	6.44
93081612	2.89	2.53	2.97	2.61	2.25	2.31	2.61	2.38	6.22	5.90
93081613	2.70	2.96	2.98	2.79	3.55	3.42	2.74	2.42	7.35	6.74
93081614	2.76	2.58	2.59	2.62	2.44	2.48	2.51	2.34	6.59	6.34
93081615	2.87	2.90	3.44	2.88	2.96	2.95	2.59	2.54	6.57	6.54
Average	3.01	2.91	2.89	2.76	3.07	3.09	2.65	2.56	7.23	6.94

Pittsburgh No. 8 Seam								
Box-Behnken Tests								
	Measured	Adjusted	Measured	Adjusted	Measured	Adjusted	Measured	Adjusted
	Column	Column	Column	Column	Column	Column	Thickener	Thickener
	Feed	Feed	Product	Product	Reject	Reject	Feed	Feed
Test	Sulfur	Sulfur	Sulfur	Sulfur	Sulfur	Sulfur	Sulfur	Sulfur
Number	(%)	(%)	(%)	(%)	(%)	(%)	(%)	(%)
93081601	3.04	2.99	3.05	3.00	3.31	2.97	3.67	4.24
93081602	3.33	2.88	2.82	2.99	2.54	2.51	3.24	3.37
93081603	2.71	2.71	2.64	2.83	2.36	2.25	2.94	3.21
93081604	3.13	2.81	2.74	2.95	2.45	2.30	2.97	3.32
93081605	2.75	2.66	2.71	2.68	2.62	2.57	4.06	4.21
93081606	2.61	2.63	2.53	2.70	2.40	2.32	3.44	3.78
93081607	2.56	2.53	2.20	2.43	3.09	3.11	4.39	4.58
93081608	2.41	2.43	2.20	2.41	2.58	2.54	3.63	3.90
93081609	2.66	2.44	2.18	2.33	2.96	2.86	3.30	3.57
93081610	2.32	2.29	1.97	2.13	2.75	2.85	3.57	3.56
93081611	2.35	2.41	2.21	2.36	2.72	2.58	2.95	3.22
93081612	2.39	2.38	2.00	2.33	2.72	2.61	3.12	3.56
93081613	2.74	2.42	2.11	2.40	2.52	2.47	3.40	3.81
93081614	2.23	2.34	2.20	2.27	2.73	2.63	3.42	3.70
93081615	2.47	2.54	2.30	2.46	2.99	2.97	4.05	4.25
Average	2.65	2.56	2.39	2.55	2.72	2.64	3.48	3.75

Pittsburgh No. 8 Seam									
Box-Behnken Tests									
	Measured	Adjusted	Adjusted	Measured	Adjusted	Measured	Adjusted	Measured	Adjusted
	Plant	Plant	Deslime	HMC	HMC	WOC	WOC	WOC	WOC
	Feed	Feed	U/F	Reject	Reject	O/F	O/F	U/F	U/F
Test	Pyritic	Pyritic	Pyritic	Pyritic	Pyritic	Pyritic	Pyritic	Pyritic	Pyritic
Number	(%)	(%)	(%)	(%)	(%)	(%)	(%)	(%)	(%)
93081601	2.10	2.21	1.78	3.47	3.39	1.46	1.48	5.82	4.77
93081602	2.10	1.98	1.61	2.66	2.72	1.31	1.41	5.18	5.17
93081603	2.13	1.93	1.62	2.98	3.06	1.35	1.40	7.14	6.97
93081604	2.19	2.10	1.67	3.35	3.40	1.40	1.43	7.13	6.74
93081605	2.08	2.13	1.77	3.16	3.13	1.45	1.38	7.35	6.33
93081606	1.14	1.62	1.42	3.26	2.18	1.30	1.17	7.18	4.78
93081607	2.22	2.06	1.74	2.94	3.01	1.42	1.35	6.25	6.46
93081608	2.05	1.87	1.66	2.39	2.45	1.58	1.36	6.07	5.81
93081609	1.89	1.88	1.55	2.76	2.77	1.36	1.35	5.22	5.05
93081610	1.99	1.92	1.55	2.66	2.70	1.39	1.32	5.32	5.42
93081611	2.02	1.78	1.44	2.58	2.69	1.45	1.28	5.72	5.63
93081612	1.96	1.69	1.46	2.19	2.28	1.48	1.21	5.08	5.01
93081613	1.90	2.06	1.62	3.34	3.20	1.51	1.26	6.03	5.54
93081614	1.92	1.65	1.41	2.23	2.33	1.30	1.14	5.10	4.98
93081615	1.86	1.90	1.64	2.78	2.76	1.39	1.33	4.91	4.96
Average	1.97	1.92	1.60	2.85	2.80	1.41	1.32	5.97	5.57

Pittsburgh No. 8 Seam								
Box-Behnken Tests								
	Measured	Adjusted	Measured	Adjusted	Measured	Adjusted	Measured	Adjusted
	Column	Column	Column	Column	Column	Column	Thickener	Thickener
	Feed	Feed	Product	Product	Reject	Reject	Feed	Feed
Test	Pyritic	Pyritic	Pyritic	Pyritic	Pyritic	Pyritic	Pyritic	Pyritic
Number	(%)	(%)	(%)	(%)	(%)	(%)	(%)	(%)
93081601	1.48	1.48	1.38	1.30	2.55	2.09	2.42	2.91
93081602	2.01	1.41	1.15	1.25	1.93	2.00	2.63	2.65
93081603	1.44	1.40	1.18	1.26	2.01	1.94	2.52	2.78
93081604	1.37	1.43	1.28	1.32	1.99	1.82	2.39	2.74
93081605	1.49	1.38	1.25	1.23	2.09	1.97	2.96	3.28
93081606	1.31	1.17	1.09	1.08	1.89	1.56	1.97	2.45
93081607	1.50	1.35	0.97	1.11	2.53	2.69	3.95	4.00
93081608	1.34	1.36	1.01	1.14	2.40	2.38	2.99	3.39
93081609	1.58	1.35	0.94	1.00	2.66	2.65	2.94	3.16
93081610	1.40	1.32	0.89	0.96	2.39	2.56	3.18	3.14
93081611	1.30	1.28	0.88	1.03	2.26	2.29	2.52	2.84
93081612	1.33	1.21	0.78	0.94	2.31	2.46	2.86	3.19
93081613	1.67	1.26	0.84	1.01	2.10	2.20	2.80	3.25
93081614	1.06	1.14	0.87	0.92	2.15	2.11	2.70	2.94
93081615	1.31	1.33	1.03	1.11	2.38	2.42	3.20	3.34
Average	1.44	1.32	1.04	1.11	2.24	2.21	2.80	3.07

Pittsburgh No. 8 Seam

Box-Behnken Tests

Test Number	Measured Plant Feed Energy (Btu/lb)	Adjusted Plant Feed Energy (Btu/lb)	Measured Deslime U/F Energy (Btu/lb)	Adjusted Deslime U/F Energy (Btu/lb)	Measured HMC Reject Energy (Btu/lb)	Adjusted HMC Reject Energy (Btu/lb)	Measured WOC O/F Energy (Btu/lb)	Adjusted WOC O/F Energy (Btu/lb)	Measured WOC U/F Energy (Btu/lb)
93081601	8790	8820	11810	11550	1230	1230	12100	11820	8280
93081602	7720	7880	11310	11200	1220	1210	11500	11390	7890
93081603	9170	9080	11160	11200	1250	1250	11260	11370	6830
93081604	8800	8650	10810	11070	1300	1300	11370	11290	6230
93081605	8700	8470	10930	11070	1280	1280	11080	11430	6680
93081606	8550	8620	11300	11270	1600	1600	11840	11580	6720
93081607	9010	8970	11720	11510	1300	1300	12040	11800	7880
93081608	8770	8810	11500	11510	1200	1200	11980	11830	7270
93081609	8630	8620	11070	11230	1510	1510	11680	11420	7750
93081610	8300	8240	11600	11580	1240	1240	12090	11790	7830
93081611	8730	8670	11290	11490	1290	1290	11950	11650	7170
93081612	8950	8770	11540	11750	1110	1110	12250	12000	7840
93081613	7970	8160	10610	10860	1200	1200	11940	11360	5560
93081614	8790	8760	11720	11520	1190	1190	11550	11850	6730
93081615	9110	9160	11400	11510	1290	1290	11970	11890	7460
Average	8666	8645	11318	11355	1281	1280	11773	11631	7208

Pittsburgh No. 8 Seam									
Box-Behnken Tests									
	Adjusted	Measured	Adjusted	Measured	Adjusted	Measured	Adjusted	Measured	Adjusted
	WOC	Column	Column	Column	Column	Column	Column	Thickener	Thickener
	U/F	Feed	Feed	Product	Product	Reject	Reject	Feed	Feed
Test	Energy	Btu/lb	Btu/lb	Btu/lb	Btu/lb	Btu/lb	Btu/lb	Btu/lb	Btu/lb
Number	(Btu/lb)	(Btu/lb)	(Btu/lb)	(Btu/lb)	(Btu/lb)	(Btu/lb)	(Btu/lb)	(Btu/lb)	(Btu/lb)
93081601	8880	11500	11820	13690	13830	4620	5030	8010	6220
93081602	7860	11830	11390	13150	13550	3660	3640	4460	4510
93081603	7000	11360	11370	13750	13680	2260	2350	3370	3130
93081604	6440	11360	11290	13580	13620	2370	2500	3630	3240
93081605	6880	11300	11430	13960	13540	2960	3050	4520	4200
93081606	7110	11310	11580	13800	13690	2570	2720	4590	3930
93081607	7900	11280	11800	13200	13090	4710	4710	5830	5820
93081608	7210	11920	11830	13630	13810	2590	2570	3870	3930
93081609	7830	11350	11420	13800	13830	2480	2520	3740	3650
93081610	7840	11460	11790	13670	13690	5210	5220	5780	5750
93081611	7210	11580	11650	13670	13770	2990	3030	3790	3720
93081612	8230	11780	12000	13940	13950	2640	2750	4840	4330
93081613	5600	11280	11360	13940	13860	1740	1760	3010	2960
93081614	7130	11950	11850	13960	13970	2370	2490	4410	3820
93081615	7420	12020	11890	13720	13760	2350	2340	4140	4170
Average	7369	11552	11631	13697	13709	3035	3112	4533	4225

Pittsburgh No. 8 Seam							
Box-Behnken Tests							
	Plant Product Yield (%)	Plant Reject Yield (%)	Plant Energy Recovery (%)	Plant Ash Rejection (%)	Plant Sulfur Rejection (%)	Plant Pyritic Rejection (%)	Plant Separate Efficiency (%)
Test Number							
93081601	51.46	48.54	80.69	89.63	55.77	69.73	50.42
93081602	49.43	50.57	85.00	92.04	52.78	68.79	53.79
93081603	60.19	39.81	90.68	87.68	43.41	60.70	51.39
93081604	56.75	43.25	89.36	87.58	47.85	64.33	53.69
93081605	54.04	45.96	86.39	89.00	54.02	68.79	55.18
93081606	54.64	45.36	86.78	89.29	52.10	63.57	50.35
93081607	58.82	41.18	85.84	82.26	52.04	68.31	54.14
93081608	56.65	43.35	88.80	89.05	49.25	65.46	54.27
93081609	54.45	45.55	87.36	89.84	53.53	71.04	58.40
93081610	49.70	50.30	82.57	90.92	59.28	75.15	57.72
93081611	55.88	44.12	88.75	89.85	50.05	67.66	56.42
93081612	55.52	44.48	88.31	91.47	48.87	69.12	57.43
93081613	52.28	47.72	88.80	92.41	57.61	74.37	63.17
93081614	55.62	44.38	88.70	90.47	51.06	68.99	57.69
93081615	58.94	41.06	88.54	87.83	50.00	65.57	54.11
Average	54.96	45.04	87.10	89.29	51.84	68.11	55.21

Pittsburgh No. 8 Seam							
Box-Behnken Tests							
	HMC	HMC	HMC	HMC	HMC	HMC	HMC
	Product	Reject	Energy	Ash	Sulfur	Pyritic	Separate
Test	Yield	Yield	Recovery	Rejection	Rejection	Rejection	Efficiency
Number	(%)	(%)	(%)	(%)	(%)	(%)	(%)
93081601	73.57	26.43	96.34	3.69	29.08	40.54	36.88
93081602	66.76	33.24	94.89	5.10	34.09	45.66	40.55
93081603	78.73	21.27	97.11	2.93	23.74	33.72	30.84
93081604	75.21	24.79	96.25	3.73	28.73	40.14	36.39
93081605	73.50	26.50	96.06	4.00	28.01	38.94	35.00
93081606	72.64	27.36	94.97	5.08	30.11	36.82	31.79
93081607	75.18	24.82	96.47	3.60	26.74	36.27	32.73
93081608	73.78	26.22	96.39	3.57	24.47	34.35	30.74
93081609	73.14	26.86	95.29	4.71	28.93	39.58	34.86
93081610	67.75	32.25	95.21	4.85	34.61	45.35	40.56
93081611	72.35	27.65	95.88	4.11	29.95	41.79	37.67
93081612	71.96	28.04	96.41	3.55	25.60	37.83	34.24
93081613	72.07	27.93	95.92	4.11	32.27	43.39	39.30
93081614	73.32	26.68	96.42	3.62	25.65	37.68	34.10
93081615	77.06	22.94	96.83	3.23	23.34	33.32	30.15
Average	73.13	26.87	96.03	3.99	28.35	39.02	35.05

Pittsburgh No. 8 Seam

Box-Behnken Tests

Test Number	WOC Product Yield (%)	WOC Reject Yield (%)	WOC Energy Recovery (%)	WOC Ash Rejection (%)	WOC Sulfur Rejection (%)	WOC Pyritic Rejection (%)	WOC Separate Efficiency (%)
93081601	90.73	9.27	92.85	17.51	19.47	24.81	17.66
93081602	94.65	5.35	96.26	10.48	11.56	17.17	13.43
93081603	96.06	3.94	97.52	8.40	10.75	16.94	14.46
93081604	95.44	4.56	97.34	9.90	11.63	18.41	15.74
93081605	92.05	7.95	95.05	16.75	36.05	28.42	23.46
93081606	93.17	6.83	95.73	14.54	17.50	22.99	18.72
93081607	92.44	7.56	94.77	15.18	19.15	28.05	22.82
93081608	93.20	6.80	95.79	14.99	17.68	23.81	19.60
93081609	94.53	5.47	96.13	10.42	12.75	17.82	13.95
93081610	94.58	5.42	96.30	10.97	13.70	18.94	15.24
93081611	96.23	3.77	97.57	8.44	9.49	14.75	12.32
93081612	93.40	6.60	95.39	15.06	14.92	22.65	18.04
93081613	91.44	8.56	95.65	19.71	20.68	29.28	24.93
93081614	93.06	6.94	95.72	15.83	16.80	24.52	20.24
93081615	91.54	8.46	94.56	18.37	19.21	25.59	20.15
Average	93.50	6.50	95.77	13.77	16.76	22.28	18.05

Pittsburgh No. 8 Seam							
Box-Behnken Tests							
	Column	Column	Column	Column	Column	Column	Column
	Product	Reject	Energy	Ash	Sulfur	Pyritic	Separate
Test	Yield	Yield	Recovery	Rejection	Rejection	Rejection	Efficiency
Number	(%)	(%)	(%)	(%)	(%)	(%)	(%)
93081601	77.09	22.91	90.20	69.12	22.75	32.35	22.55
93081602	78.22	21.78	93.06	74.48	18.98	30.89	23.95
93081603	79.58	20.42	95.75	73.75	16.95	28.29	24.04
93081604	79.06	20.94	95.38	70.64	17.14	26.65	22.03
93081605	79.87	20.13	94.61	69.48	19.45	28.74	23.35
93081606	80.73	19.27	95.44	69.64	17.00	25.69	21.13
93081607	84.63	15.37	93.89	51.20	18.89	30.62	24.51
93081608	82.39	17.61	96.18	68.24	18.41	30.82	27.00
93081609	78.75	21.25	95.37	73.99	24.90	41.71	37.08
93081610	77.56	22.44	90.06	69.88	27.95	43.55	33.61
93081611	80.26	19.74	94.87	72.38	21.13	35.31	30.18
93081612	82.61	17.39	96.03	72.87	19.07	35.36	31.39
93081613	79.33	20.67	96.79	77.93	21.09	36.09	32.88
93081614	81.52	18.48	96.10	72.46	20.77	34.21	30.31
93081615	83.56	16.44	96.70	67.38	19.23	29.92	26.62
Average	80.35	19.65	94.70	70.23	20.25	32.68	27.37

PITTSBURGH NO. 8 SEAM 24-HOUR GRIND RESULTS

PITTSBURGH SEAM 24–HOUR RUN DATA: MICROTRAC OF MILL CIRCUIT FEED

Shift >	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
Microns																	
296.0		76.3	69.2	84.8	62.2	60.3			69.0	77.1	80.9	75.9	70.4	79.2	79.3	79.7	73.2
209.3		63.0	52.8	70.2	45.6	41.8			55.3	63.4	66.8	60.6	56.3	61.7	63.9	64.6	55.4
148.0		51.6	39.7	55.7	34.0	29.1			44.3	52.2	53.9	46.8	45.0	45.5	51.4	51.0	40.1
104.7		43.3	30.0	44.4	26.9	21.4			36.3	43.4	43.6	36.7	37.2	33.7	42.6	40.4	28.6
74.0		36.7	22.5	36.2	22.8	16.5			30.2	36.0	34.9	29.3	31.3	25.9	35.0	31.6	20.2
52.3		31.2	17.0	30.0	19.6	13.2			25.2	30.7	28.1	23.7	25.8	20.5	29.1	24.9	14.1
37.0		26.9	13.4	24.7	16.9	10.6			21.3	26.6	23.2	19.3	21.6	16.6	24.8	20.1	9.7
26.2		23.3	10.6	20.7	14.9	8.8			18.3	22.6	19.2	16.1	18.3	13.3	21.0	16.6	7.0
18.5		19.8	8.3	17.7	12.9	7.4			15.2	19.0	15.6	13.5	15.2	10.7	17.6	13.6	5.2
13.1		16.0	6.2	14.3	10.5	5.8			11.7	15.2	12.0	10.4	11.8	8.1	13.8	10.5	3.3
9.3		12.4	4.5	11.1	8.3	4.4			8.7	11.7	8.8	7.8	8.7	5.9	10.6	7.8	1.8
6.5		9.5	3.2	8.5	6.4	3.3			6.5	8.9	6.4	5.8	6.5	4.2	8.0	5.6	0.9
4.6		6.5	1.9	5.9	4.3	2.0			4.3	6.2	4.2	3.8	4.3	2.6	5.4	3.7	0.3
3.3		4.0	1.0	3.7	2.6	1.0			2.6	3.9	2.4	2.2	2.6	1.4	3.3	2.1	0.1
dv		0.091	0.093	0.100	0.122	0.145			0.107	0.093	0.096	0.119	0.097	0.113	0.100	0.109	0.118
05%		3.9	10.4	4.1	5.2	11.0			5.1	3.9	5.2	5.6	5.2	7.8	4.4	5.9	18.0
50%		139.9	195.9	125.9	232.4	247.3			179.7	136.6	131.1	162.0	174.5	164.3	140.8	143.8	187.0
95%		519.0	558.0	449.5	572.2	586.0			586.6	510.9	476.0	534.0	540.2	468.0	491.0	473.1	531.3
mv		181.1	225.2	157.0	246.2	263.7			219.1	178.8	168.8	195.3	207.2	187.2	174.7	176.5	216.0

PITTSBURGH SEAM 24–HOUR RUN DATA: MICROTRAC OF MILL CIRCUIT FEED

Shift >	18	19	20	21	22	23	24							avg	max	min	std
Microns																	
296.0	86.9	81.8	87.1	74.3		70.6	63.1	296.0						75.1	87.1	60.3	7.6
209.3	77.8	68.2	76.0	56.4		53.9	43.7	209.3						59.9	77.8	41.8	9.5
148.0	69.0	56.0	64.9	43.0		41.2	31.5	148.0						47.3	69.0	29.1	10.0
104.7	62.8	47.4	54.7	34.9		32.7	24.6	104.7						38.3	62.8	21.4	9.8
74.0	59.5	41.4	45.4	28.7		27.2	19.7	74.0						31.6	59.5	16.5	9.7
52.3	55.6	35.8	37.4	24.1		22.9	16.0	52.3						26.2	55.6	13.2	9.4
37.0	50.6	30.8	30.7	20.9		19.3	13.3	37.0						22.1	50.6	9.7	8.8
26.2	46.7	27.1	25.1	18.1		16.5	11.1	26.2						18.8	46.7	7.0	8.2
18.5	42.4	23.4	19.9	15.4		13.9	9.2	18.5						15.8	42.4	5.2	7.6
13.1	36.4	19.1	14.7	12.4		11.0	6.9	13.1						12.5	36.4	3.3	6.6
9.3	30.5	15.3	10.4	9.8		8.3	5.1	9.3						9.6	30.5	1.8	5.7
6.5	25.0	12.0	7.3	7.5		6.2	3.7	6.5						7.3	25.0	0.9	4.7
4.6	18.4	8.4	4.6	4.9		4.0	2.1	4.6						4.9	18.4	0.3	3.6
3.3	12.5	5.3	2.7	3.0		2.3	1.1	3.3						3.0	12.5	0.1	2.5
dv	0.047	0.076	0.132	0.104		0.105	0.104							0.104	0.145	0.047	0.020
05%	1.8	3.1	4.9	4.7		5.4	9.2							6.2	18.0	1.8	3.5
50%	35.5	118.1	88.1	181.4		190.4	237.5							160.6	247.3	35.5	49.5
95%	457.5	486.5	428.7	511.2		538.6	555.3							513.7	586.6	428.7	45.1
mv	116.1	158.9	135.7	199.6		213.2	247.1							193.4	263.7	116.1	36.7

PITTSBURGH SEAM 24–HOUR RUN DATA: MICROTRAC OF COLUMN FLOTATION FEED

Shift >	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
Microns																	
296.0	100.0	100.0	100.0	100.0	100.0	100.0	99.7	100.0	99.8	100.0	99.7	100.0	100.0	99.8	100.0	99.9	99.8
209.3	100.0	99.8	99.6	99.3	99.4	99.8	97.7	99.1	98.6	98.8	97.6	99.2	99.5	98.1	99.2	98.5	98.2
148.0	99.8	98.7	97.9	97.1	97.8	98.9	94.2	97.2	96.5	96.3	93.8	97.8	97.8	94.5	97.3	95.4	95.0
104.7	98.5	95.9	94.0	93.0	94.9	96.3	89.6	94.1	93.0	92.2	88.7	95.3	94.2	88.4	94.0	90.7	90.2
74.0	94.5	90.0	86.4	85.2	89.2	90.6	82.3	88.0	86.3	84.6	80.4	89.2	87.5	79.1	87.8	83.1	82.6
52.3	86.8	80.4	75.6	74.7	80.3	81.6	72.6	78.5	76.5	74.4	69.4	79.6	77.5	68.0	78.4	72.9	72.4
37.0	76.3	68.8	63.4	63.4	69.0	70.4	61.9	66.8	65.1	63.0	57.7	67.8	65.7	56.6	67.0	61.8	61.0
26.2	65.3	58.2	52.4	53.0	58.1	59.5	51.9	56.0	54.5	52.5	47.4	56.6	54.9	46.9	56.4	51.9	50.4
18.5	54.2	48.3	42.6	43.7	47.9	49.3	42.7	46.1	44.7	43.0	38.4	46.4	45.0	38.2	46.4	42.8	41.0
13.1	42.5	37.8	32.9	34.2	37.5	38.7	33.3	35.8	34.8	33.4	29.4	36.0	34.9	29.4	36.0	33.4	31.4
9.3	32.6	28.9	24.7	26.1	28.5	29.7	25.4	27.3	26.3	25.3	22.0	27.2	26.5	22.0	27.3	25.5	23.4
6.5	24.7	22.0	18.5	19.8	21.4	22.6	19.1	20.7	19.7	19.0	16.4	20.4	19.9	16.4	20.6	19.1	17.4
4.6	17.4	15.4	12.8	13.8	14.9	15.9	13.3	14.5	13.6	13.1	11.2	14.1	13.8	11.3	14.4	13.3	12.0
3.3	11.7	10.2	8.4	9.1	9.8	10.5	8.7	9.6	8.9	8.5	7.2	9.2	9.0	7.2	9.5	8.8	7.7
dv	0.126	0.152	0.152	0.152	0.161	0.124	0.136	0.156	0.136	0.169	0.158	0.139	0.162	0.163	0.150	0.164	0.162
05%	1.8	2.0	2.3	2.2	2.1	2.0	2.2	2.1	2.2	2.3	2.5	2.2	2.2	2.5	2.2	2.3	2.4
50%	16.4	19.6	24.0	23.4	19.8	18.9	24.4	21.1	22.2	23.9	28.8	20.9	22.0	29.6	20.9	24.3	25.8
95%	76.5	97.2	112.2	120.4	105.5	94.9	159.6	113.1	123.9	129.2	164.6	102.2	111.0	154.1	113.8	143.1	148.2
mv	25.0	31.5	36.6	37.7	32.9	30.3	43.5	35.0	37.6	39.3	46.8	33.5	35.1	46.9	35.0	41.5	43.0

PITTSBURGH SEAM 24–HOUR RUN DATA: MICROTRAC OF COLUMN FLOTATION FEED

Shift >	18	19	20	21	22	23	24							avg	max	min	std
Microns																	
296.0	100.0	99.8	99.8	100.0	100.0	99.9	99.5							99.9	100.0	99.5	0.1
209.3	99.5	98.1	97.9	99.7	99.3	98.4	97.0							98.8	100.0	97.0	0.8
148.0	97.7	94.4	94.0	98.2	97.1	95.5	92.3							96.5	99.8	92.3	1.9
104.7	93.8	89.2	88.7	94.4	93.2	90.8	86.0							92.4	98.5	86.0	3.0
74.0	86.5	81.2	80.6	87.9	86.0	82.8	77.8							85.4	94.5	77.8	4.0
52.3	76.1	70.5	69.9	78.3	76.2	72.4	67.1							75.4	86.8	67.1	4.6
37.0	64.4	58.7	58.2	66.8	65.3	61.1	55.7							64.0	76.3	55.7	4.7
26.2	53.9	48.5	48.0	56.4	55.1	51.1	46.1							53.5	65.3	46.1	4.4
18.5	44.5	39.6	38.9	46.8	45.7	42.0	37.5							44.0	54.2	37.5	3.9
13.1	34.9	30.6	29.8	36.7	35.9	32.6	28.5							34.2	42.5	28.5	3.3
9.3	26.8	23.0	22.3	28.0	27.4	24.7	21.2							25.9	32.6	21.2	2.7
6.5	20.4	17.1	16.6	21.2	20.7	18.6	15.7							19.5	24.7	15.7	2.1
4.6	14.2	11.6	11.4	14.7	14.4	12.8	10.6							13.5	17.4	10.6	1.6
3.3	9.3	7.5	7.4	9.5	9.4	8.3	6.7							8.8	11.7	6.7	1.1
dv	0.137	0.188	0.158	0.139	0.155	0.150	0.158							0.152	0.188	0.124	0.014
05%	2.1	2.5	2.4	2.1	2.1	2.3	2.6							2.2	2.6	1.8	0.2
50%	22.6	27.8	28.2	20.7	21.6	25.1	30.5							23.4	30.5	16.4	3.5
95%	114.0	155.2	160.9	108.0	119.6	141.2	177.4							126.9	177.4	76.5	25.5
mv	36.1	45.0	46.1	33.8	36.4	41.9	50.8							38.4	50.8	25.0	6.1

PITTSBURGH NO. 8 SEAM
24-HOUR DEMONSTRATION RUN RESULTS

Pittsburgh No. 8 Seam
Long–Duration Tests

Test Number	Goodness–of–Fit		
	Ash	Other	Total
93082401	7.05	3.56	10.61
93082402	19.98	12.78	32.76
93082403	15.26	20.87	36.13
93082404	3.35	3.88	7.23
93082405	10.52	3.64	14.16
93082406	18.81	5.83	24.64
93082407	13.40	16.77	30.17
93082408	98.53	24.44	122.97
93082409	4.18	41.42	45.60
93082410	5.14	7.02	12.16
93082411	1.47	16.77	18.24
93082412	2.65	20.62	23.27
93082413	1.76	47.34	49.10
93082414	13.53	17.36	30.89
93082415	4.05	9.12	13.17
93082416	5.00	20.81	25.81
93082417	49.24	9.31	58.55
93082418	31.07	47.45	78.52
93082419	11.30	23.16	34.46
93082420	11.33	14.52	25.85
93082421	12.84	25.08	37.92
93082422	8.74	11.83	20.57
93082423	7.56	8.57	16.13
93082424	29.75	20.28	50.03
Average	16.1	18.0	34.1

Pittsburgh No. 8 Seam
Long–Duration Tests

Test Number	Relative Plant Feed (%)	Relative Deslime U/F (%)	Relative HMC Reject (%)	Relative WOC O/F (%)	Relative WOC U/F (%)	Relative Column Feed (%)	Relative Column Product (%)	Relative Column Reject (%)	Rel Thic Fe ('
93082401	100.00	71.98	28.02	69.05	2.93	69.05	54.38	14.67	-
93082402	100.00	69.83	30.17	66.42	3.41	66.42	53.52	12.90	-
93082403	100.00	70.07	29.93	65.71	4.36	65.71	51.49	14.22	-
93082404	100.00	66.89	33.11	62.73	4.16	62.73	48.48	14.25	-
93082405	100.00	63.60	36.40	62.08	1.52	62.08	46.96	15.12	1
93082406	100.00	63.07	36.93	59.23	3.83	59.23	47.61	11.62	1
93082407	100.00	57.98	42.02	55.75	2.22	55.75	41.43	14.32	1
93082408	100.00	57.01	42.99	53.70	3.31	53.70	43.88	9.82	1
93082409	100.00	71.13	28.87	60.66	10.47	60.66	42.76	17.90	2
93082410	100.00	74.79	25.21	69.41	5.38	69.41	51.58	17.83	2
93082411	100.00	64.71	35.29	57.58	7.13	57.58	43.46	14.12	2
93082412	100.00	68.31	31.69	65.92	2.39	65.92	51.13	14.79	1
93082413	100.00	63.52	36.48	60.17	3.35	60.17	43.94	16.23	1
93082414	100.00	62.87	37.13	58.24	4.63	58.24	44.24	14.00	1
93082415	100.00	72.80	27.20	64.56	8.24	64.56	46.89	17.67	2
93082416	100.00	70.06	29.94	64.54	5.52	64.54	46.18	18.36	2
93082417	100.00	55.26	44.74	53.83	1.43	53.83	45.13	8.71	1
93082418	100.00	75.09	24.91	70.76	4.32	70.76	49.11	21.66	2
93082419	100.00	79.17	20.83	72.81	6.37	72.81	50.02	22.79	2
93082420	100.00	76.64	23.36	70.28	6.36	70.28	49.81	20.47	2
93082421	100.00	69.57	30.43	65.51	4.06	65.51	50.23	15.28	1
93082422	100.00	74.13	25.87	68.27	5.86	68.27	45.55	22.72	2
93082423	100.00	79.47	20.53	75.36	4.11	75.36	54.53	20.83	2
93082424	100.00	75.54	24.46	72.66	2.88	72.66	54.36	18.30	2

Average	100.0	68.9	31.1	64.4	4.5	64.4	48.2	16.2	2
Maximum	100.0	79.5	44.7	75.4	10.5	75.4	54.5	22.8	2
Minimum	100.0	55.3	20.5	53.7	1.4	53.7	41.4	8.7	1
Range	0.0	24.2	24.2	21.7	9.0	21.7	13.1	14.1	1
Std.Deviation	0.0	6.6	6.6	6.0	2.1	6.0	3.9	3.7	
# of Points	24	24	24	24	24	24	24	24	

Pittsburgh No. 8 Seam
Long–Duration Tests

Test Number	Measured Plant Feed Ash (%)	Adjusted Plant Feed Ash (%)	Measured Deslime U/F Ash (%)	Adjusted Deslime U/F Ash (%)	Measured HMC Reject Ash (%)	Adjusted HMC Reject Ash (%)	Measured WOC O/F Ash (%)	Adjusted WOC O/F Ash (%)	Measured WOC U/F Ash (%)	Adjusted WOC U/F Ash (%)
93082401	40.42	40.33	21.61	23.65	83.07	83.17	22.76	22.51	50.99	50.58
93082402	40.11	40.24	22.12	22.16	82.24	82.08	18.43	20.92	46.26	46.23
93082403	42.01	42.01	27.04	24.19	83.76	83.76	19.96	22.89	43.39	43.79
93082404	46.32	46.22	26.17	26.65	85.64	85.76	23.80	24.95	52.54	52.29
93082405	45.63	46.72	25.46	26.21	83.90	82.56	23.74	25.57	52.63	52.52
93082406	47.36	47.20	27.38	24.81	85.26	85.45	20.02	23.20	49.21	49.66
93082407	50.64	51.37	24.79	27.79	84.76	83.90	28.02	26.83	52.51	51.69
93082408	51.52	50.88	32.59	23.36	86.59	87.37	16.41	21.48	52.30	53.80
93082409	49.22	48.89	31.77	33.59	86.26	86.56	30.98	30.05	55.81	54.09
93082410	44.15	43.77	27.01	29.40	86.01	86.37	29.38	27.74	51.58	50.86
93082411	50.57	50.34	31.22	30.16	87.11	87.35	26.23	27.43	51.95	52.25
93082412	43.42	43.95	25.33	25.07	85.29	84.64	22.80	24.11	51.46	51.43
93082413	47.46	48.27	27.99	27.79	84.86	83.92	26.10	26.32	54.48	54.26
93082414	48.85	49.44	26.07	29.20	84.35	83.70	27.89	27.45	52.45	51.29
93082415	46.43	46.38	29.45	31.63	85.80	85.85	29.37	29.15	51.98	51.04
93082416	48.19	47.92	29.53	31.60	85.86	86.11	29.50	29.73	54.29	53.53
93082417	48.37	49.63	21.92	22.39	85.02	83.28	18.51	21.50	56.18	55.96
93082418	44.57	44.81	27.73	31.95	83.78	83.57	39.82	30.62	54.61	53.67
93082419	44.07	44.35	34.73	33.73	84.93	84.71	36.68	32.04	53.32	53.12
93082420	44.99	45.11	30.11	33.30	83.91	83.82	35.57	31.64	52.96	51.67
93082421	43.74	44.37	28.40	27.56	83.48	82.78	23.01	25.90	54.33	54.38
93082422	49.25	48.49	40.11	35.49	85.18	85.76	30.69	33.39	59.14	59.93
93082423	42.05	42.02	32.25	30.75	85.62	85.65	26.71	29.33	56.72	56.79
93082424	42.39	42.42	33.37	28.29	86.08	86.05	23.02	27.28	53.65	53.95

Average	45.91	46.05	28.51	28.36	84.95	84.76	26.23	26.75	52.70	52.45
Maximum	51.52	51.37	40.11	35.49	87.11	87.37	39.82	33.39	59.14	59.93
Minimum	40.11	40.24	21.61	22.16	82.24	82.08	16.41	20.92	43.39	43.79
Range	11.41	11.13	18.50	13.33	4.87	5.29	23.41	12.47	15.75	16.14
Std.Deviation	3.22	3.22	4.25	3.80	1.17	1.50	5.82	3.49	3.16	3.14
# of Points	24	24	24	24	24	24	24	24	24	24

Pittsburgh No. 8 Seam
Long–Duration Tests

Test Number	Measured Column Feed Ash (%)	Adjusted Column Feed Ash (%)	Measured Column Product Ash (%)	Adjusted Column Product Ash (%)	Measured Column Reject Ash (%)	Adjusted Column Reject Ash (%)	Measured Thickener Feed Ash (%)	Adju Thick Fe As (%
93082401	24.78	22.51	7.63	7.63	77.10	77.66	73.74	7
93082402	25.44	20.92	6.30	6.28	82.50	81.65	74.00	7
93082403	24.59	22.89	6.77	6.74	83.26	81.33	71.92	7
93082404	26.89	24.95	7.50	7.50	85.50	84.31	75.79	7
93082405	29.61	25.57	7.32	7.32	82.68	82.27	79.28	7
93082406	26.14	23.20	7.61	7.59	88.26	87.12	77.24	7
93082407	29.79	26.83	7.65	7.65	87.44	82.33	73.98	7
93082408	29.14	21.48	7.08	7.02	87.33	86.07	78.85	7
93082409	30.62	30.05	7.41	7.41	87.84	84.14	69.17	7
93082410	28.79	27.74	7.56	7.57	86.74	86.10	76.78	7
93082411	27.95	27.43	7.95	7.95	87.71	87.39	75.35	7
93082412	25.43	24.11	6.50	6.49	86.31	85.03	79.54	8
93082413	26.00	26.32	5.73	5.71	86.49	82.13	74.84	7
93082414	31.68	27.45	8.95	8.97	86.78	85.84	75.62	7
93082415	31.09	29.15	7.23	7.23	88.32	87.32	74.61	7
93082416	32.25	29.73	7.18	7.18	88.37	86.43	76.83	7
93082417	31.06	21.50	10.51	10.51	79.91	78.45	73.87	7
93082418	29.79	30.62	6.71	6.70	85.53	84.87	79.89	7
93082419	29.25	32.04	7.90	7.94	86.42	84.95	74.69	7
93082420	32.68	31.64	9.92	9.98	86.58	84.36	72.91	7
93082421	29.46	25.90	7.94	7.91	86.88	85.02	77.76	7
93082422	33.08	33.39	7.63	7.62	86.34	85.05	79.31	7
93082423	31.82	29.33	8.11	8.12	86.51	84.85	78.27	8
93082424	31.00	27.28	8.56	8.57	85.65	82.83	75.96	7

Average	29.10	26.75	7.65	7.65	85.69	84.06	75.84	7
Maximum	33.08	33.39	10.51	10.51	88.37	87.39	79.89	8
Minimum	24.59	20.92	5.73	5.71	77.10	77.66	69.17	7
Range	8.49	12.47	4.78	4.80	11.27	9.73	10.72	7
Std.Deviation	2.57	3.49	1.04	1.05	2.70	2.50	2.62	2
# of Points	24	24	24	24	24	24	24	

Pittsburgh No. 8 Seam
Long–Duration Tests

Test Number	Measured Plant Feed Sulfur (%)	Adjusted Plant Feed Sulfur (%)	Measured Deslime U/F Sulfur (%)	Adjusted Deslime U/F Sulfur (%)	Measured HMC Reject Sulfur (%)	Adjusted HMC Reject Sulfur (%)	Measured WOC O/F Sulfur (%)	Adjusted WOC O/F Sulfur (%)	Measured WOC U/F Sulfur (%)	Adjusted WOC U/F Sulfur (%)
93082401	3.04	2.90	2.93	2.79	3.14	3.18	2.61	2.55	8.43	8.44
93082402	3.14	3.12	3.22	2.68	4.14	4.15	2.84	2.42	7.85	7.76
93082403	3.18	3.05	3.88	2.82	3.54	3.59	2.88	2.50	7.43	7.66
93082404	2.88	2.91	3.12	2.96	2.83	2.82	2.67	2.55	9.57	9.09
93082405	2.70	2.80	2.81	2.55	3.29	3.24	2.44	2.39	9.26	9.21
93082406	2.70	2.75	2.62	2.68	2.88	2.86	2.62	2.31	8.87	8.40
93082407	2.86	2.65	3.18	2.64	2.60	2.67	2.34	2.35	9.32	10.09
93082408	2.63	2.79	3.00	2.65	3.07	2.98	2.91	2.31	9.83	8.21
93082409	2.73	2.99	3.04	2.93	3.23	3.13	2.89	2.04	9.46	8.11
93082410	2.87	2.91	2.93	2.85	3.10	3.09	2.67	2.39	9.16	8.72
93082411	2.88	3.35	3.99	3.36	3.57	3.32	3.16	2.72	9.15	8.57
93082412	2.93	2.78	2.74	2.51	3.30	3.36	2.43	2.25	10.34	9.61
93082413	3.02	2.80	2.88	2.58	3.10	3.18	2.97	2.21	10.95	9.32
93082414	2.83	3.19	3.36	2.97	3.81	3.57	2.17	2.54	8.58	8.45
93082415	2.83	2.88	3.15	2.93	2.76	2.75	2.34	2.22	9.11	8.54
93082416	2.92	3.04	2.95	2.74	3.80	3.74	2.29	2.15	10.42	9.64
93082417	2.71	2.90	3.01	2.92	2.96	2.86	2.62	2.73	10.21	10.08
93082418	2.71	2.54	2.91	2.20	3.50	3.57	1.27	1.75	9.60	9.59
93082419	2.84	2.65	1.94	2.40	3.56	3.62	1.64	1.84	9.32	8.77
93082420	2.74	3.11	3.20	3.32	2.48	2.41	3.26	2.86	9.10	8.38
93082421	2.82	2.86	3.32	2.58	3.52	3.50	1.90	2.16	10.31	9.28
93082422	2.66	2.97	3.22	2.81	3.60	3.45	2.36	2.25	10.05	9.27
93082423	2.72	2.89	2.52	2.71	3.67	3.61	2.57	2.30	10.85	10.20
93082424	3.06	2.81	2.17	2.66	3.20	3.27	2.67	2.37	10.76	10.09

Average	2.85	2.90	3.00	2.76	3.28	3.25	2.52	2.34	9.50	8.98
Maximum	3.18	3.35	3.99	3.36	4.14	4.15	3.26	2.86	10.95	10.20
Minimum	2.63	2.54	1.94	2.20	2.48	2.41	1.27	1.75	7.43	7.66
Range	0.55	0.81	2.05	1.16	1.66	1.74	1.99	1.11	3.52	2.54
Std.Deviation	0.15	0.18	0.43	0.25	0.40	0.39	0.45	0.25	0.88	0.74
# of Points	24	24	24	24	24	24	24	24	24	24

Pittsburgh No. 8 Seam
Long–Duration Tests

Test Number	Measured Column Feed Sulfur (%)	Adjusted Column Feed Sulfur (%)	Measured Column Product Sulfur (%)	Adjusted Column Product Sulfur (%)	Measured Column Reject Sulfur (%)	Adjusted Column Reject Sulfur (%)	Measured Thickener Feed Sulfur (%)	Adju Thick Fe Sul (%
93082401	2.38	2.55	2.62	2.66	2.16	2.14	3.13	
93082402	2.38	2.42	2.12	2.47	2.18	2.20	3.17	
93082403	2.36	2.50	2.22	2.58	2.12	2.20	3.44	
93082404	2.41	2.55	2.64	2.67	2.23	2.13	3.39	
93082405	2.36	2.39	2.37	2.48	2.13	2.11	2.67	
93082406	2.13	2.31	2.51	2.47	1.71	1.66	3.13	
93082407	2.17	2.35	2.39	2.50	1.74	1.88	3.58	
93082408	2.13	2.31	2.23	2.46	1.78	1.64	2.75	
93082409	2.41	2.04	1.77	2.12	1.77	1.84	3.67	
93082410	2.36	2.39	2.40	2.57	1.91	1.88	3.21	
93082411	2.74	2.72	2.72	3.00	1.85	1.84	3.79	
93082412	2.14	2.25	2.22	2.39	1.92	1.77	2.49	
93082413	2.29	2.21	1.85	2.22	2.39	2.17	2.70	
93082414	3.10	2.54	2.92	2.83	1.64	1.61	3.22	
93082415	2.23	2.22	2.29	2.44	1.63	1.61	3.48	
93082416	2.67	2.15	2.00	2.32	1.70	1.71	3.18	
93082417	2.60	2.73	3.26	2.90	1.94	1.89	2.97	
93082418	2.38	1.75	2.09	1.82	1.74	1.57	2.65	
93082419	2.30	1.84	2.21	1.94	1.67	1.62	3.27	
93082420	3.21	2.86	3.11	3.29	1.83	1.81	3.17	
93082421	2.24	2.16	2.36	2.38	1.56	1.44	2.64	
93082422	2.40	2.25	2.23	2.40	2.01	1.95	3.07	
93082423	2.27	2.30	2.54	2.50	1.82	1.76	2.99	
93082424	2.78	2.37	2.45	2.52	1.98	1.93	2.88	
Average	2.43	2.34	2.40	2.50	1.89	1.85	3.11	3
Maximum	3.21	2.86	3.26	3.29	2.39	2.20	3.79	4
Minimum	2.13	1.75	1.77	1.82	1.56	1.44	2.49	2
Range	1.08	1.11	1.49	1.47	0.83	0.76	1.30	1
Std.Deviation	0.28	0.25	0.35	0.31	0.21	0.22	0.34	0
# of Points	24	24	24	24	24	24	24	

Pittsburgh No. 8 Seam
Long–Duration Tests

Test Number	Measured Plant Feed Pyritic (%)	Adjusted Plant Feed Pyritic (%)	Measured Deslime U/F Pyritic (%)	Adjusted Deslime U/F Pyritic (%)	Measured HMC Reject Pyritic (%)	Adjusted HMC Reject Pyritic (%)	Measured WOC O/F Pyritic (%)	Adjusted WOC O/F Pyritic (%)	Measured WOC U/F Pyritic (%)	Adjusted WOC U/F Pyritic (%)
93082401	1.94	1.88	1.47	1.60	2.55	2.58	1.54	1.41	6.34	6.25
93082402	2.14	2.22	2.06	1.57	3.81	3.73	1.63	1.33	6.52	6.27
93082403	1.79	2.00	2.50	1.55	3.25	3.04	1.53	1.19	7.30	7.08
93082404	1.99	1.94	1.60	1.71	2.40	2.42	1.27	1.34	7.45	7.25
93082405	1.92	2.05	1.83	1.47	3.20	3.07	1.44	1.31	7.83	7.87
93082406	1.85	2.12	1.91	1.83	2.86	2.62	1.76	1.45	8.11	7.79
93082407	2.00	1.95	1.90	1.75	2.20	2.23	1.53	1.44	8.56	9.32
93082408	2.11	2.15	2.24	1.62	2.89	2.86	1.74	1.30	7.64	6.90
93082409	1.92	2.11	1.89	1.80	3.00	2.87	1.80	0.89	9.18	7.11
93082410	1.92	1.94	1.64	1.66	2.81	2.80	1.57	1.20	8.01	7.57
93082411	1.92	2.32	2.75	2.05	3.21	2.81	1.85	1.41	8.00	7.24
93082412	2.08	1.76	1.66	1.29	2.62	2.78	1.47	1.07	9.33	7.46
93082413	2.02	1.88	1.74	1.28	2.84	2.94	1.73	0.88	9.53	8.41
93082414	2.06	2.31	1.96	1.84	3.37	3.12	1.20	1.44	7.54	6.90
93082415	2.08	1.99	2.15	1.92	2.18	2.21	1.35	1.21	8.71	7.44
93082416	2.11	2.19	1.81	1.65	3.52	3.45	1.31	1.10	9.44	8.11
93082417	2.08	2.25	1.96	1.96	2.75	2.61	1.64	1.78	9.18	8.96
93082418	1.91	1.81	1.88	1.24	3.46	3.54	0.55	0.77	9.03	9.04
93082419	1.84	1.76	0.97	1.29	3.48	3.54	0.74	0.80	8.54	6.92
93082420	1.90	2.16	1.94	2.12	2.38	2.28	2.07	1.60	8.49	7.92
93082421	1.93	1.94	2.07	1.40	3.19	3.18	0.73	0.96	9.23	8.40
93082422	1.88	2.14	2.35	1.76	3.47	3.24	1.47	1.27	7.93	7.45
93082423	1.98	2.02	1.77	1.65	3.45	3.43	1.58	1.27	9.53	8.62
93082424	1.96	2.01	1.26	1.67	3.10	3.07	1.51	1.40	9.53	8.32

Average	1.97	2.04	1.89	1.65	3.00	2.93	1.46	1.24	8.37	7.69
Maximum	2.14	2.32	2.75	2.12	3.81	3.73	2.07	1.78	9.53	9.32
Minimum	1.79	1.76	0.97	1.24	2.18	2.21	0.55	0.77	6.34	6.25
Range	0.35	0.56	1.78	0.88	1.63	1.52	1.52	1.01	3.19	3.07
Std.Deviation	0.09	0.16	0.37	0.24	0.44	0.42	0.35	0.25	0.92	0.81
# of Points	24	24	24	24	24	24	24	24	24	24

Pittsburgh No. 8 Seam
Long–Duration Tests

Test Number	Measured Column Feed Pyritic (%)	Adjusted Column Feed Pyritic (%)	Measured Column Product Pyritic (%)	Adjusted Column Product Pyritic (%)	Measured Column Reject Pyritic (%)	Adjusted Column Reject Pyritic (%)	Measured Thickener Feed Pyritic (%)	Adju Thick Fe Pyr (%
93082401	1.32	1.41	1.34	1.28	1.89	1.86	2.58	
93082402	1.43	1.33	0.97	1.16	1.99	2.02	2.57	
93082403	1.19	1.19	0.88	1.03	1.70	1.75	2.68	
93082404	1.49	1.34	1.14	1.13	2.08	2.05	3.16	
93082405	1.32	1.31	1.03	1.15	1.72	1.79	2.26	
93082406	1.28	1.45	1.46	1.41	1.62	1.58	3.01	
93082407	1.44	1.44	1.27	1.37	1.49	1.66	3 43	
93082408	1.25	1.30	1.02	1.21	1.73	1.68	2.51	
93082409	1.35	0.89	0.48	0.57	1.42	1.65	3.08	
93082410	1.24	1.20	0.97	1.09	1.46	1.51	2.72	
93082411	1.59	1.41	1.18	1.41	1.37	1.42	2.99	
93082412	1.13	1.07	0.80	1.00	1.48	1.30	1.63	
93082413	1.04	0.88	0.49	0.59	1.52	1.65	2.20	
93082414	2.03	1.44	1.52	1.47	1.42	1.34	2.46	
93082415	1.32	1.21	0.94	1.07	1.58	1.59	2.84	
93082416	1.73	1.10	0.74	0.88	1.53	1.64	2.61	
93082417	1.73	1.78	2.15	1.80	1.72	1.64	2.58	
93082418	1.31	0.77	0.61	0.55	1.54	1.25	2.21	
93082419	1.03	0.80	0.66	0.60	1.33	1.25	2.61	
93082420	1.74	1.60	1.51	1.61	1.53	1.58	3.11	
93082421	1.18	0.96	1.03	0.92	1.29	1.12	2.21	
93082422	1.24	1.27	0.89	0.96	1.91	1.89	2.63	
93082423	1.17	1.27	1.14	1.21	1.52	1.43	2.26	
93082424	1.89	1.40	1.45	1.33	1.74	1.62	2.40	

Average	1.39	1.24	1.07	1.12	1.61	1.59	2.61	2
Maximum	2.03	1.78	2.15	1.80	2.08	2.05	3.43	3
Minimum	1.03	0.77	0.48	0.55	1.29	1.12	1.63	2
Range	1.00	1.01	1.67	1.25	0.79	0.93	1.80	1
Std.Deviation	0.26	0.25	0.37	0.32	0.20	0.23	0.39	0
# of Points	24	24	24	24	24	24	24	

Pittsburgh No. 8 Seam
Long–Duration Tests

Test Number	Measured Plant Feed Btu/lb	Adjusted Plant Feed Btu/lb	Measured Deslime U/F Btu/lb	Adjusted Deslime U/F Btu/lb	Measured HMC Reject Btu/lb	Adjusted HMC Reject Btu/lb	Measured WOC O/F Btu/lb	Adjusted WOC O/F Btu/lb	Measured WOC U/F Btu/lb	Adjusted WOC U/F Btu/lb
93082401	8270	8260	11340	11020	1170	1170	11200	11210	6280	6510
93082402	8000	8160	11100	11110	1330	1330	11960	11310	7160	7250
93082403	8020	8120	10530	11000	1370	1370	11700	11060	10910	10140
93082404	7490	7410	10500	10600	960	960	11080	10880	6110	6400
93082405	7440	7420	10780	10640	1800	1800	11090	10760	5760	5810
93082406	7140	7180	10530	10860	890	890	11730	11140	6430	6540
93082407	6560	6340	10870	10410	710	710	10510	10630	5700	5050
93082408	6490	6270	9680	10590	550	550	12170	10860	5890	6150
93082409	6950	6890	9650	9380	770	770	9830	9990	5160	5870
93082410	7730	7740	10510	10100	750	750	10060	10370	6150	6600
93082411	6760	6750	9790	9970	830	840	10470	10400	6200	6480
93082412	7890	7700	10900	10850	910	910	11090	11000	6150	6680
93082413	7200	6990	10500	10430	990	990	10700	10680	5310	5900
93082414	7030	6750	10680	10180	950	950	10360	10480	5910	6340
93082415	7370	7320	10080	9790	720	720	10200	10240	5690	6240
93082416	7100	7080	10020	9800	730	730	10260	10120	5570	6100
93082417	7360	6690	11450	11190	1120	1120	11950	11340	5220	5390
93082418	7540	7390	10470	9510	1030	1030	8620	9740	5500	5700
93082419	7740	7640	9230	9360	1110	1110	9110	9630	5780	6250
93082420	7650	7460	10070	9460	910	910	9180	9740	5790	6350
93082421	7650	7490	10050	10320	1040	1040	11080	10600	5330	5800
93082422	7070	7030	8630	9130	990	990	10010	9480	4900	5080
93082423	7920	8040	9750	9890	910	910	10560	10130	5050	5340
93082424	7820	7770	9240	10030	800	800	10930	10190	5630	5930

Average	7,425	7,329	10,265	10,234	973	973	10,660	10,499	5,983	6,246
Maximum	8,270	8,260	11,450	11,190	1,800	1,800	12,170	11,340	10,910	10,140
Minimum	6,490	6,270	8,630	9,130	550	550	8,620	9,480	4,900	5,050
Range	1,780	1,990	2,820	2,060	1,250	1,250	3,550	1,860	6,010	5,090
Std.Deviation	463	540	677	600	257	257	906	537	1,138	961
# of Points	24	24	24	24	24	24	24	24	24	24

Pittsburgh No. 8 Seam
Long–Duration Tests

Test Number	Measured Column Feed Btu/lb	Adjusted Column Feed Btu/lb	Measured Column Product Btu/lb	Adjusted Column Product Btu/lb	Measured Column Reject Btu/lb	Adjusted Column Reject Btu/lb	Measured Thickener Feed Btu/lb	Adju Thick Fe Btu
93082401	10890	11210	13720	13660	2030	2150	3230	
93082402	10790	11310	13930	13640	1650	1660	2900	
93082403	11020	11060	13840	13740	1410	1370	3160	
93082404	10680	10880	13740	13720	1170	1200	2620	
93082405	10320	10760	13710	13730	1500	1530	1980	
93082406	10700	11140	14000	13580	1130	1140	2560	
93082407	10260	10630	13730	14030	910	800	1170	
93082408	10170	10860	13770	13090	910	930	2440	
93082409	9990	9990	13670	13860	710	730	3470	
93082410	10310	10370	13720	13670	810	830	2470	
93082411	10450	10400	13600	13530	760	770	2860	
93082412	10680	11000	13890	13950	760	810	2040	
93082413	10650	10680	13870	14270	880	970	2700	
93082414	9870	10480	13450	13440	109	113	2800	
93082415	9990	10240	13780	13800	780	810	3000	
93082416	9760	10120	13830	13820	770	810	2480	
93082417	9980	11340	13210	13090	2150	2320	3180	
93082418	10080	9740	13720	13530	1100	1140	2060	
93082419	10190	9630	13740	13580	930	970	2540	
93082420	9640	9740	13240	13270	1090	1150	2970	
93082421	9970	10600	13680	13510	950	1000	2500	
93082422	9680	9480	13380	13590	1200	1240	2220	
93082423	9980	10130	13630	13560	1100	1170	2200	
93082424	10090	10190	13580	13160	1270	1360	2380	

Average	10,256	10,499	13,685	13,618	1,087	1,124	2,580	2,
Maximum	11,020	11,340	14,000	14,270	2,150	2,320	3,470	3,
Minimum	9,640	9,480	13,210	13,090	109	113	1,170	1,
Range	1,380	1,860	790	1,180	2,041	2,207	2,300	2,
Std.Deviation	386	537	194	276	428	455	490	
# of Points	24	24	24	24	24	24	24	

Pittsburgh No. 8 Seam
Long–Duration Tests

Test Number	Plant Product Yield (%)	Plant Reject Yield (%)	Plant Energy Recovery (%)	Plant Ash Rejection (%)	Plant Sulfur Rejection (%)	Plant Pyritic Rejection (%)	Plant Separate Efficiency (%)
93082401	54.38	45.62	89.93	89.73	50.12	62.98	52.91
93082402	53.52	46.48	89.46	91.62	57.63	72.03	61.50
93082403	51.49	48.51	87.13	91.74	56.44	73.48	60.61
93082404	48.48	51.52	89.76	92.15	55.52	71.76	61.52
93082405	46.96	53.04	86.89	92.47	58.41	73.66	60.55
93082406	47.61	52.39	90.05	92.37	57.24	68.33	58.38
93082407	41.43	58.57	91.68	93.74	60.92	70.89	62.57
93082408	43.88	56.12	91.61	94.02	61.31	75.30	66.91
93082409	42.76	57.24	86.02	93.56	69.68	88.45	74.47
93082410	51.58	48.42	91.10	91.16	54.45	71.02	62.12
93082411	43.46	56.54	87.11	93.17	61.08	73.59	60.70
93082412	51.13	48.87	92.63	92.36	56.04	70.95	63.58
93082413	43.94	56.06	89.70	94.71	65.16	86.21	75.91
93082414	44.24	55.76	88.09	91.88	60.75	71.85	59.93
93082415	46.89	53.11	88.40	92.70	60.27	74.79	63.19
93082416	46.18	53.82	90.14	93.12	64.76	81.44	71.59
93082417	45.13	54.87	88.30	90.19	54.87	63.90	52.20
93082418	49.11	50.89	89.91	92.62	64.81	85.08	74.99
93082419	50.02	49.98	88.91	90.99	63.38	82.95	71.86
93082420	49.81	50.19	88.60	88.95	47.31	62.87	51.48
93082421	50.23	49.77	90.60	90.92	58.20	76.18	66.78
93082422	45.55	54.45	88.05	92.95	63.19	79.57	67.62
93082423	54.53	45.47	91.97	89.47	52.83	67.34	59.30
93082424	54.36	45.64	92.07	89.01	51.25	64.03	56.10

Average	48.2	51.8	89.5	91.9	58.6	73.7	63.2
Maximum	54.5	58.6	92.6	94.7	69.7	88.4	75.9
Minimum	41.4	45.5	86.0	89.0	47.3	62.9	51.5
Range	13.1	13.1	6.6	5.8	22.4	25.6	24.4
Std.Deviation	3.9	3.9	1.8	1.6	5.2	7.1	6.8
# of Points	24	24	24	24	24	24	24

Pittsburgh No. 8 Seam
Long–Duration Tests

Test Number	HMC Product Yield (%)	HMC Reject Yield (%)	HMC Energy Recovery (%)	HMC Ash Rejection (%)	HMC Sulfur Rejection (%)	HMC Pyritic Rejection (%)	HM Sepa Efficie (%
93082401	71.98	28.02	96.03	3.97	30.73	38.45	
93082402	69.83	30.17	95.07	4.92	40.13	50.69	
93082403	70.07	29.93	94.92	5.05	35.23	45.49	
93082404	66.89	33.11	95.69	4.29	32.09	41.30	
93082405	63.60	36.40	91.20	8.83	42.12	54.51	
93082406	63.07	36.93	95.40	4.58	38.41	45.64	
93082407	57.98	42.02	95.20	4.71	42.34	48.05	
93082408	57.01	42.99	96.29	3.77	45.92	57.19	
93082409	71.13	28.87	96.84	3.23	30.22	39.27	
93082410	74.79	25.21	97.59	2.44	26.77	36.39	
93082411	64.71	35.29	95.58	4.39	34.97	42.74	
93082412	68.31	31.69	96.26	3.75	38.30	50.06	
93082413	63.52	36.48	94.78	5.17	41.43	57.05	
93082414	62.87	37.13	94.82	5.23	41.55	50.15	
93082415	72.80	27.20	97.37	2.68	25.97	30.21	
93082416	70.06	29.94	96.98	3.09	36.83	47.17	
93082417	55.26	44.74	92.43	7.49	44.12	51.90	
93082418	75.09	24.91	96.63	3.47	35.01	48.72	
93082419	79.17	20.83	96.99	3.03	28.45	41.90	
93082420	76.64	23.36	97.19	2.85	18.10	24.66	
93082421	69.57	30.43	95.86	4.23	37.24	49.88	
93082422	74.13	25.87	96.27	3.64	30.05	39.17	
93082423	79.47	20.53	97.76	2.32	25.64	34.86	
93082424	75.54	24.46	97.51	2.52	28.46	37.36	

Average	68.9	31.1	95.9	4.2	34.6	44.3	
Maximum	79.5	44.7	97.8	8.8	45.9	57.2	
Minimum	55.3	20.5	91.2	2.3	18.1	24.7	
Range	24.2	24.2	6.6	6.5	27.8	32.5	
Std.Deviation	6.6	6.6	1.5	1.5	6.9	8.1	
# of Points	24	24	24	24	24	24	

Pittsburgh No. 8 Seam
Long–Duration Tests

Test Number	WOC Product Yield (%)	WOC Reject Yield (%)	WOC Energy Recovery (%)	WOC Ash Rejection (%)	WOC Sulfur Rejection (%)	WOC Pyritic Rejection (%)	WOC Separate Efficiency (%)
93082401	95.93	4.07	97.58	8.71	12.31	15.90	13.48
93082402	95.12	4.88	96.83	10.19	14.14	19.50	16.33
93082403	93.78	6.22	94.29	11.26	16.90	28.42	22.71
93082404	93.78	6.22	96.26	12.20	19.10	26.37	22.63
93082405	97.61	2.39	98.71	4.79	8.63	12.80	11.51
93082406	93.91	6.09	96.33	12.16	19.03	25.85	22.18
93082407	96.15	3.85	98.19	7.12	14.63	20.39	18.58
93082408	94.19	5.81	96.60	13.37	17.99	24.73	21.32
93082409	85.28	14.72	90.83	23.70	40.74	58.14	48.97
93082410	92.81	7.19	95.29	12.44	22.01	32.80	28.09
93082411	88.98	11.02	92.82	19.09	28.10	38.91	31.73
93082412	96.50	3.50	97.84	7.18	13.40	20.23	18.07
93082413	94.73	5.27	97.00	10.30	19.05	34.65	31.65
93082414	92.64	7.36	95.37	12.94	20.95	27.62	22.98
93082415	88.68	11.32	92.76	18.26	32.99	43.86	36.62
93082416	92.12	7.88	95.13	13.35	27.72	38.73	33.86
93082417	97.41	2.59	98.72	6.47	8.93	11.83	10.55
93082418	94.23	5.77	96.51	9.66	25.08	41.94	38.45
93082419	91.97	8.03	94.62	12.67	29.40	43.16	37.78
93082420	91.70	8.30	94.42	12.88	20.95	31.00	25.42
93082421	94.16	5.84	96.72	11.52	20.99	35.02	31.73
93082422	92.09	7.91	95.63	13.35	26.08	33.46	29.09
93082423	94.83	5.17	97.13	9.55	19.47	27.02	24.15
93082424	96.19	3.81	97.72	7.27	14.46	18.99	16.72

Average	93.5	6.5	96.0	11.7	20.5	29.6	25.6
Maximum	97.6	14.7	98.7	23.7	40.7	58.1	49.0
Minimum	85.3	2.4	90.8	4.8	8.6	11.8	10.5
Range	12.3	12.3	7.9	18.9	32.1	46.3	38.4
Std.Deviation	2.8	2.8	1.9	4.1	7.5	10.9	9.3
# of Points	24	24	24	24	24	24	24

Pittsburgh No. 8 Seam
Long–Duration Tests

Test Number	Column Product Yield (%)	Column Reject Yield (%)	Column Energy Recovery (%)	Column Ash Rejection (%)	Column Sulfur Rejection (%)	Column Pyritic Rejection (%)	Colu Sepa Efficie (%
93082401	78.75	21.25	95.97	73.30	17.83	28.03	
93082402	80.58	19.42	97.18	75.80	17.66	29.50	
93082403	78.36	21.64	97.35	76.89	19.04	31.82	
93082404	77.28	22.72	97.46	76.76	18.97	34.75	
93082405	75.64	24.36	96.52	78.36	21.50	33.28	
93082406	80.38	19.62	97.99	73.67	14.10	21.38	
93082407	74.31	25.69	98.08	78.82	20.55	29.61	
93082408	81.71	18.29	98.49	73.27	12.98	23.63	
93082409	70.49	29.51	97.80	82.62	26.62	54.71	
93082410	74.31	25.69	97.96	79.73	20.21	32.32	
93082411	75.48	24.52	98.19	78.13	16.59	24.70	
93082412	77.56	22.44	98.36	79.13	17.65	27.26	
93082413	73.03	26.97	97.57	84.17	26.49	50.58	
93082414	75.96	24.04	97.42	75.17	15.24	22.37	1
93082415	72.63	27.37	97.88	81.99	19.85	35.97	
93082416	71.55	28.45	97.71	82.70	22.63	42.41	4
93082417	83.84	16.16	96.78	59.04	11.20	14.91	1
93082418	69.40	30.60	96.41	84.84	27.46	49.69	4
93082419	68.70	31.30	96.88	82.99	27.56	48.91	4
93082420	70.87	29.13	96.56	77.66	18.43	28.76	2
93082421	76.68	23.32	97.72	76.57	15.55	27.21	2
93082422	66.72	33.28	95.65	84.77	28.84	49.53	4
93082423	72.36	27.64	96.86	79.96	21.15	31.12	2
93082424	74.81	25.19	96.62	76.47	20.51	29.14	2

Average	75.1	24.9	97.3	78.0	19.9	33.4	
Maximum	83.8	33.3	98.5	84.8	28.8	54.7	
Minimum	66.7	16.2	95.6	59.0	11.2	14.9	
Range	17.1	17.1	2.8	25.8	17.6	39.8	
Std.Deviation	4.2	4.2	0.8	5.3	4.7	10.3	
# of Points	24	24	24	24	24	24	

Pittsburgh No. 8 Seam
Long--Duration Tests

Test Number	% (abs.) of Raw Coal's Energy to:			% (abs.) of Raw Coal's Pyrite to:		
	HMC Reject	WOC Reject	Column Reject	HMC Reject	WOC Reject	Column Reject
93082401	4.0	2.3	3.8	38.7	9.5	14.8
93082402	4.9	3.0	2.6	50.6	9.6	11.8
93082403	5.1	5.4	2.4	45.7	15.2	12.6
93082404	4.3	3.6	2.3	41.0	15.6	15.1
93082405	8.8	1.2	3.1	54.4	5.9	13.3
93082406	4.6	3.5	1.9	45.6	13.9	8.8
93082407	4.8	1.8	1.8	48.0	10.9	12.1
93082408	3.7	3.2	1.4	57.0	10.5	7.8
93082409	3.2	8.9	1.9	39.3	35.1	14.0
93082410	2.4	4.6	1.9	36.0	21.1	14.0
93082411	4.4	6.8	1.6	42.8	22.2	8.6
93082412	3.7	2.1	1.5	49.9	10.0	11.0
93082413	5.2	2.8	2.2	56.8	15.1	14.4
93082414	5.2	4.3	2.4	49.9	13.8	8.2
93082415	2.6	7.0	1.9	29.8	31.0	14.0
93082416	3.0	4.8	2.1	47.2	20.4	13.9
93082417	7.6	1.2	3.0	51.9	5.6	6.5
93082418	3.4	3.3	3.4	48.6	21.3	15.2
93082419	3.0	5.2	2.9	42.0	24.9	16.0
93082420	2.8	5.4	3.2	24.8	23.2	14.9
93082421	4.1	3.1	2.1	49.8	17.8	8.6
93082422	3.7	4.2	4.0	39.0	20.5	20.1
93082423	2.2	2.7	3.1	35.1	17.5	14.7
93082424	2.5	2.2	3.2	37.2	12.2	14.6

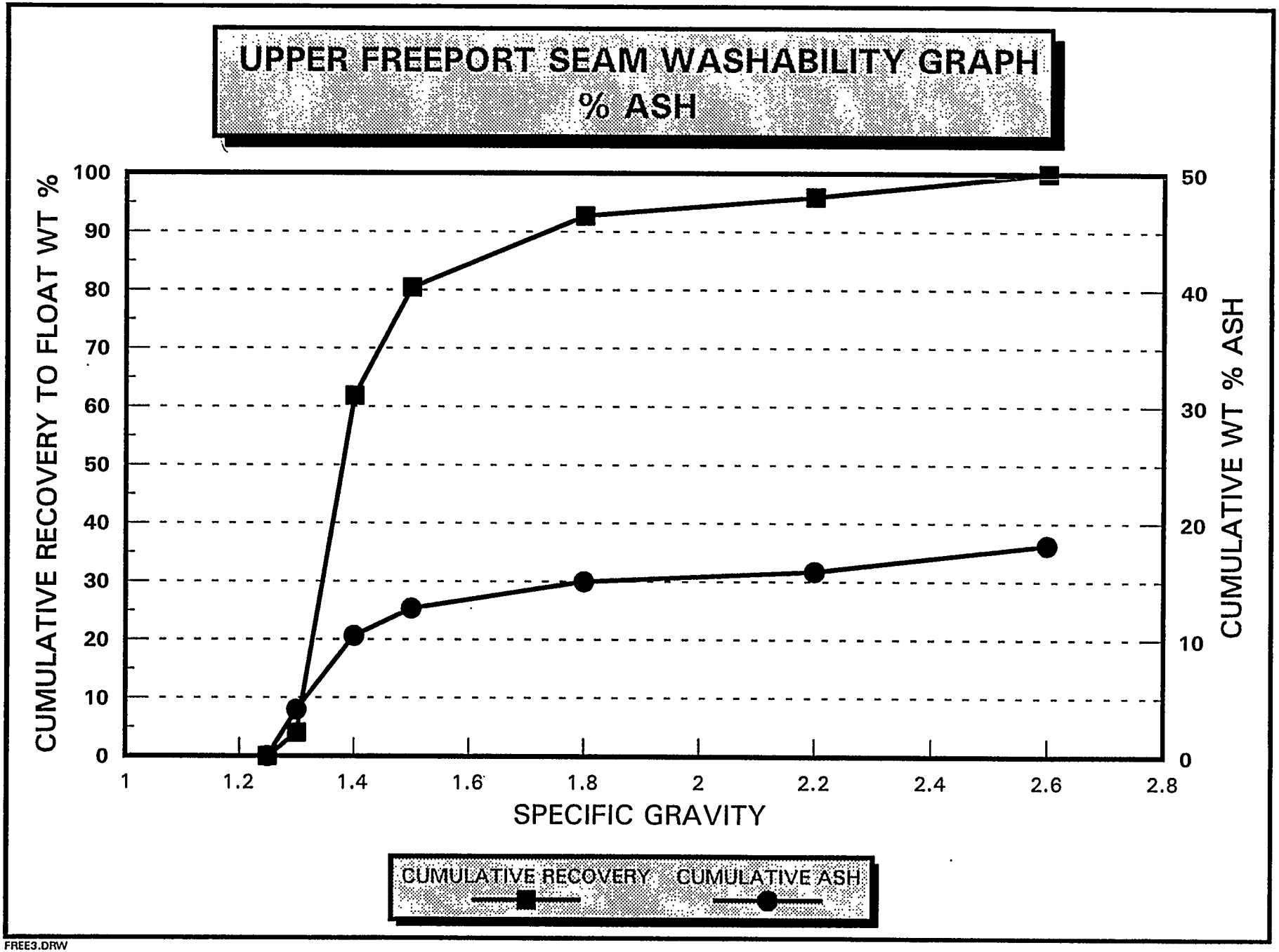
Average	4.1	3.9	2.5	44.2	16.8	12.7
Maximum	8.8	8.9	4.0	57.0	35.1	20.1
Minimum	2.2	1.2	1.4	24.8	5.6	6.5
Range	6.6	7.8	2.6	32.3	29.5	13.6
Std.Deviation	1.5	1.9	0.7	8.0	7.2	3.2
# of Points	24	24	24	24	24	24

Pittsburgh No. 8 Seam
Long–Duration Tests

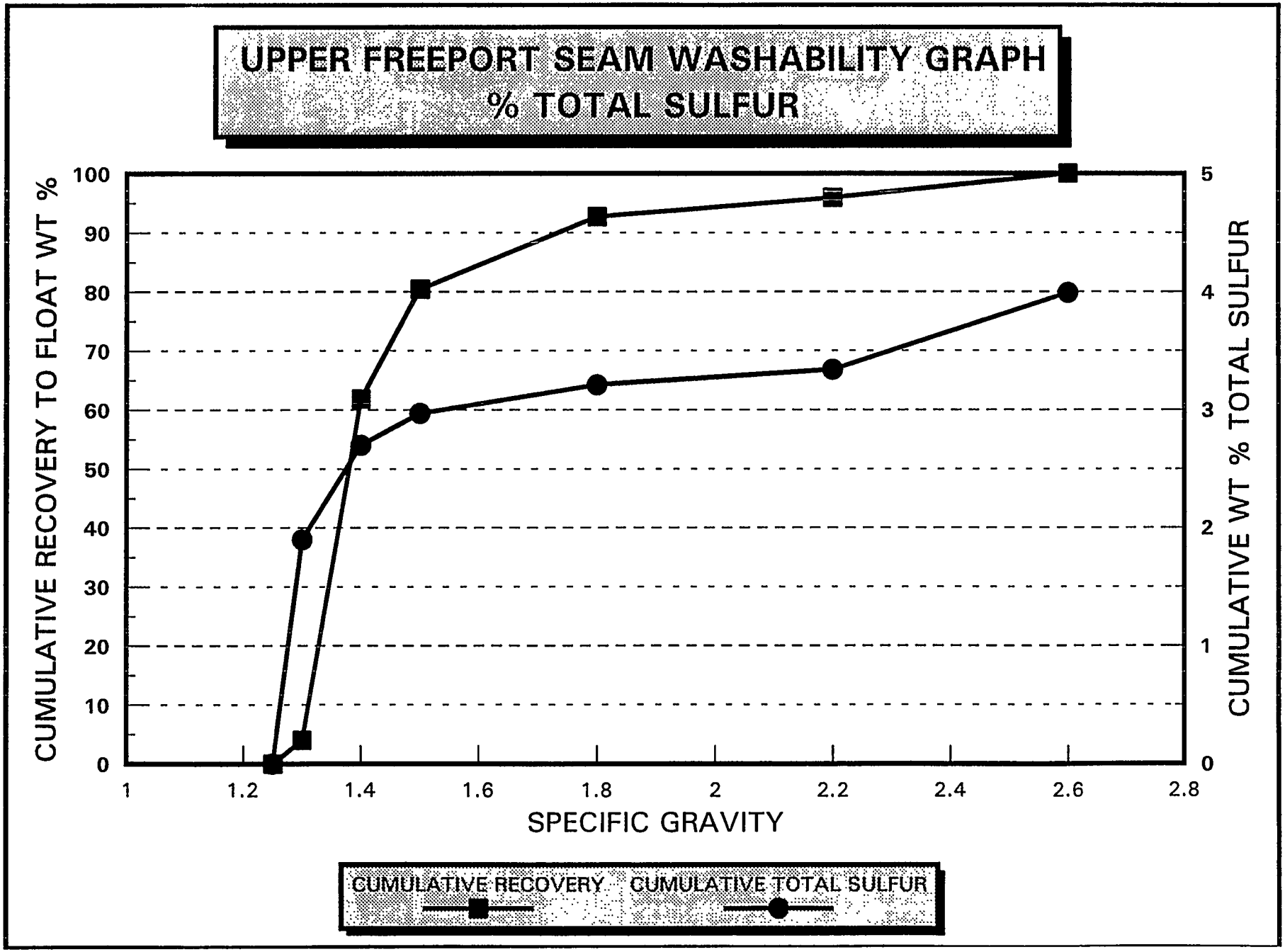
Test Number	% of Total Energy Losses			% of Total Pyrite Rejectio		
	HMC Reject	WOC Reject	Column Reject	HMC Reject	WOC Reject	Col Re
93082401	39.4	22.9	37.7	61.5	15.0	
93082402	46.7	28.8	24.5	70.3	13.3	
93082403	39.4	42.3	18.3	62.2	20.7	
93082404	42.1	35.1	22.8	57.2	21.8	
93082405	67.1	9.1	23.8	73.8	8.1	
93082406	46.3	35.1	18.7	66.7	20.4	
93082407	57.7	21.3	21.0	67.7	15.3	
93082408	44.2	38.7	17.1	75.8	13.9	
93082409	22.6	63.8	13.6	44.5	39.7	
93082410	27.0	51.5	21.4	50.7	29.7	
93082411	34.3	53.1	12.6	58.2	30.1	
93082412	50.8	28.1	21.0	70.4	14.1	
93082413	50.7	27.5	21.8	65.8	17.5	
93082414	43.5	36.5	20.0	69.5	19.2	
93082415	22.7	60.5	16.7	39.8	41.4	
93082416	30.7	48.2	21.1	58.0	25.0	
93082417	64.7	9.9	25.4	81.2	8.7	
93082418	33.4	33.0	33.6	57.1	25.1	
93082419	27.1	47.0	25.9	50.6	30.1	
93082420	24.7	47.5	27.8	39.4	36.8	
93082421	44.1	33.5	22.5	65.4	23.3	
93082422	31.2	35.4	33.4	49.1	25.7	
93082423	27.9	34.0	38.1	52.1	26.0	
93082424	31.4	27.7	40.9	58.2	19.0	

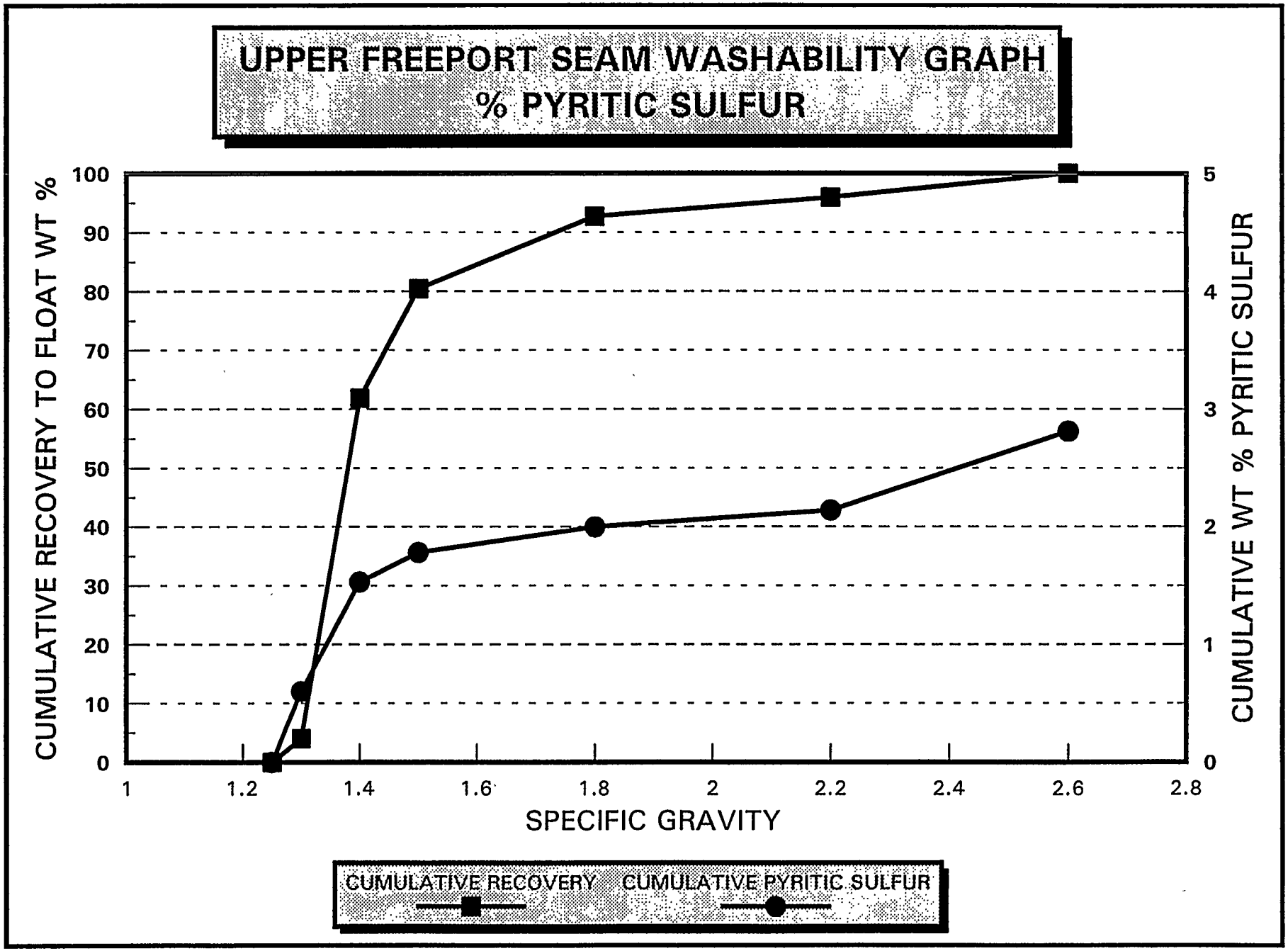
Average	39.6	36.3	24.1	60.2	22.5	
Maximum	67.1	63.8	40.9	81.2	41.4	
Minimum	22.6	9.1	12.6	39.4	8.1	
Range	44.5	54.7	28.3	41.8	33.4	
Std.Deviation	12.3	13.6	7.4	10.8	8.8	
# of Points	24	24	24	24	24	

UPPER FREEPORT SEAM WASHABILITY


UPPER FREEPORT SEAM WASHABILITY GRAPH
% ASH
CUMULATIVE RECOVERY TO FLOAT WT %
CUMULATIVE WT % ASH
SPECIFIC GRAVITY
100
90
80
70
60
50
40
30
20
10
0
50
40
30
20
10
0
1
1.2
1.4
1.6
1.8
2
2.2
2.4
2.6
2.8
CUMULATIVE RECOVERY
CUMULATIVE ASH

FREE3.DRW


UPPER FREEPORT SEAM WASHABILITY GRAPH
% TOTAL SULFUR
CUMULATIVE RECOVERY TO FLOAT WT %
CUMULATIVE WT % TOTAL SULFUR
SPECIFIC GRAVITY
100
90
80
70
60
50
40
30
20
10
0
5
4
3
2
1
0
1
1.2
1.4
1.6
1.8
2
2.2
2.4
2.6
2.8
CUMULATIVE RECOVERY
CUMULATIVE TOTAL SULFUR


UPPER FREEPORT SEAM WASHABILITY GRAPH
% PYRITIC SULFUR
CUMULATIVE RECOVERY TO FLOAT WT %
CUMULATIVE WT % PYRITIC SULFUR
SPECIFIC GRAVITY
0
10
20
30
40
50
60
70
80
90
100
0
1
2
3
4
5
1
1.2
1.4
1.6
1.8
2
2.2
2.4
2.6
2.8
CUMULATIVE RECOVERY
CUMULATIVE PYRITIC SULFUR

FREE1.DRW

STANDARD LABORATORIES, INC.
147 Eleventh Avenue, South Charleston, WV 25303
Telephone: (304) 744-5472 • Fax# (304) 744-4319

FOR: ICF KAISER ENGINEERS
P.O. BOX 1488
BEVERLY, OHIO 45715

LAB NO. 31017902

SAMPLE ID: RUN NO: 93101501
COAL SEAM: UPPER FREEPORT SEAM
SAMPLE NAME: AS RECEIVED RAW COAL
OCTOBER 15, 1993

SAMPLED BY: ICF KAISER ENGINEERS

SIZE CONSIST

SIZE	ELEMENTARY % WEIGHT	CUMULATIVE % WEIGHT
+ 1/4" RD	86.14	86.14
1/4" RD X 48 MESH	7.80	93.94
48 MESH X 200 MESH	1.65	95.59
200 MESH X 0	4.41	100.00

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BEVERLY, OH 45715

CALCULATED COMPOSITE
Top x 0 = 100% OF TOTAL SAMPLE

SAMPLE ID:
RUN NO: 93101501
COAL SEAM: UPPER FREEPORT SEAM
SAMPLE NAME: AS RECEIVED RAW COAL
OCTOBER 15, 1993

LAB NO.: 31017902

SAMPLED BY: ICF-KE

SPECIFIC GRAVITY		ELEMENTARY DRY BASIS				CUMULATIVE RETAINED DRY BASIS				CUMULATIVE REJECT DRY BASIS			
SINK	FLOAT	% WT.	% ASH	% SUL.	BTU	% WT.	% ASH	% SUL.	BTU	% WT.	% ASH	% SUL.	BTU
	1.25	0.00				0.00				100.00	18.12	3.99	11975
1.25	1.30	4.01	3.98	1.90	14397	4.01	3.98	1.90	14397	95.99	18.71	4.08	11873
1.30	1.40	57.85	10.76	2.75	13205	61.86	10.32	2.70	13282	38.14	30.78	6.09	9854
1.40	1.50	18.53	20.57	3.88	11614	80.39	12.68	2.97	12897	19.61	40.42	8.18	8192
1.50	1.80	12.30	30.02	4.80	10048	92.69	14.98	3.21	12519	7.31	57.91	13.86	5068
1.80	2.20	3.22	41.06	7.03	7971	95.91	15.86	3.34	12367	4.09	71.17	19.23	2782
2.20		4.09	71.17	19.23	2782	100.00	18.12	3.99	11975				

		% PYRITE	% PYRITE	% PYRITE
	1.25	0.00	0.00	0.00
1.25	1.30	0.60	0.60	2.81
1.30	1.40	1.60	1.53	2.91
1.40	1.50	2.61	1.78	4.89
1.50	1.80	3.43	2.00	7.05
1.80	2.20	6.15	2.14	13.14
2.20		18.64	2.81	18.64

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FOR: ICF KAISER ENGINEERS
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BEVERLY, OH 45715

+1/4" RD = 86.14% OF TOTAL SAMPLE

SAMPLE ID:
RUN NO: 93101501
COAL SEAM: UPPER FREEPORT SEAM
SAMPLE NAME: AS RECEIVED RAW COAL
OCTOBER 15, 1993

LAB NO.: 31017902

SAMPLED BY: ICF-KE

SPECIFIC GRAVITY		ELEMENTARY DRY BASIS				CUMULATIVE RETAINED DRY BASIS				CUMULATIVE REJECT DRY BASIS			
SINK	FLOAT	% WT.	% ASH	% SUL.	BTU	% WT.	% ASH	% SUL.	BTU	% WT.	% ASH	% SUL.	BTU
	1.25	0.00				0.00				100.00	17.07	4.05	12173
1.25	1.30	2.46	4.65	2.13	14337	2.46	4.65	2.13	14337	97.54	17.39	4.10	12118
1.30	1.40	62.98	10.98	2.79	13180	65.44	10.74	2.77	13223	34.56	29.06	6.48	10183
1.40	1.50	20.11	20.94	3.96	11577	85.55	13.14	3.05	12836	14.45	40.37	9.98	8243
1.50	1.80	9.91	29.19	5.67	10262	95.46	14.81	3.32	12569	4.54	64.76	19.39	3837
1.80	2.20	1.07	48.40	17.08	6543	96.53	15.18	3.47	12502	3.47	69.81	20.10	3003
2.20		3.47	69.81	20.10	3003	100.00	17.07	4.05	12173				

		% PYRITE	% PYRITE	% PYRITE
	1.25	0.00	0.00	0.00
1.25	1.30	0.79	0.79	2.85
1.30	1.40	1.65	1.62	2.90
1.40	1.50	2.68	1.87	5.19
1.50	1.80	4.09	2.10	8.68
1.80	2.20	15.76	2.25	18.70
2.20		19.61	2.85	19.61

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FOR: ICF KAISER ENGINEERS
P.O. BOX 1488
BEVERLY, OH 45715

1/4" RD X 48 MESH = 7.80% OF TOTAL SAMPLE

LAB NO.: 31017902

SAMPLE ID:
RUN NO: 93101501
COAL SEAM: UPPER FREEPORT SEAM
SAMPLE NAME: AS RECEIVED RAW COAL
OCTOBER 15, 1993

SAMPLED BY: ICF-KE

SPECIFIC GRAVITY		ELEMENTARY DRY BASIS				CUMULATIVE RETAINED DRY BASIS				CUMULATIVE REJECT DRY BASIS			
SINK	FLOAT	% WT.	% ASH	% SUL.	BTU	% WT.	% ASH	% SUL.	BTU	% WT.	% ASH	% SUL.	BTU
	1.25	0.00				0.00				100.00	18.07	4.22	11796
1.25	1.30	21.31	3.44	1.69	14427	21.31	3.44	1.69	14427	78.69	22.03	4.90	11083
1.30	1.40	40.09	7.82	2.26	13495	61.40	6.30	2.06	13818	38.60	36.78	7.65	8578
1.40	1.50	13.26	16.18	2.85	11979	74.66	8.05	2.20	13492	25.34	47.56	10.16	6798
1.50	1.80	12.43	27.86	5.10	10211	87.09	10.88	2.62	13024	12.91	66.54	15.03	3513
1.80	2.20	3.64	49.67	9.09	6510	90.73	12.44	2.88	12762	9.27	73.16	17.36	2336
2.20		9.27	73.16	17.36	2336	100.00	18.07	4.22	11796				

		% PYRITE	% PYRITE	% PYRITE
	1.25	0.00	0.00	0.00
1.25	1.30	0.43	0.43	2.92
1.30	1.40	0.87	0.72	3.59
1.40	1.50	1.76	0.90	6.42
1.50	1.80	3.41	1.26	8.86
1.80	2.20	7.43	1.51	14.11
2.20		16.73	2.92	16.73

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BEVERLY, OH 45715

48 MESH X 200 MESH = 1.65% OF TOTAL SAMPLE

SAMPLE ID:
RUN NO: 93101501
COAL SEAM: UPPER FREEPORT SEAM
SAMPLE NAME: AS RECEIVED RAW COAL
OCTOBER 15, 1993

LAB NO.: 31017902

SAMPLED BY: ICF-KE

SPECIFIC GRAVITY		ELEMENTARY DRY BASIS				CUMULATIVE RETAINED DRY BASIS				CUMULATIVE REJECT DRY BASIS			
SINK	FLOAT	% WT.	% ASH	% SUL.	BTU	% WT.	% ASH	% SUL.	BTU	% WT.	% ASH	% SUL.	BTU
	1.25	0.00				0.00				100.00	25.07	3.90	10709
1.25	1.30	13.91	1.63	1.32	14739	13.91	1.63	1.32	14739	86.09	28.85	4.32	10058
1.30	1.40	28.44	4.46	1.57	14117	42.35	3.53	1.49	14321	57.65	40.89	5.67	8055
1.40	1.50	10.63	10.34	1.77	13071	52.98	4.90	1.54	14070	47.02	47.80	6.56	6921
1.50	1.80	18.47	20.54	1.69	11314	71.45	8.94	1.58	13358	28.55	65.43	9.70	4079
1.80	2.20	9.82	38.34	2.65	8466	81.27	12.49	1.71	12767	18.73	79.63	13.40	1779
2.20		18.73	79.63	13.40	1779	100.00	25.07	3.90	10709				

		% PYRITE	% PYRITE	% PYRITE
	1.25	0.00	0.00	0.00
1.25	1.30	0.15	0.15	2.79
1.30	1.40	0.35	0.28	3.21
1.40	1.50	0.67	0.36	4.62
1.50	1.80	0.90	0.50	5.52
1.80	2.20	1.99	0.68	8.50
2.20		11.92	2.79	11.92

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P.O. BOX 1468
BEVERLY, OH 45715

200 MESH X 0 = 4.41% OF TOTAL SAMPLE

SAMPLE ID:

LAB NO.: 31017902

RUN NO: 93101501
COAL SEAM: UPPER FREEPORT SEAM
SAMPLE NAME: AS RECEIVED RAW COAL
OCTOBER 15, 1993

SAMPLED BY: ICF-KE

SPECIFIC GRAVITY		ELEMENTARY DRY BASIS				CUMULATIVE RETAINED DRY BASIS				CUMULATIVE REJECT DRY BASIS			
SINK	FLOAT	% WT.	% ASH	% SUL.	BTU	% WT.	% ASH	% SUL.	BTU	% WT.	% ASH	% SUL.	BTU
	1.25	0.00				0.00							
1.25	1.30	0.00				0.00							
1.30	1.40	0.00				0.00							
1.40	1.50	0.00				0.00				100.00	36.00	2.46	8903
1.50	1.80	56.50	34.87	2.09	9098	56.50	34.87	2.09	9098	43.50	37.47	2.95	8651
1.80	2.20	42.10	36.33	2.11	8860	98.60	35.49	2.10	8996	1.40	71.61	28.26	2355
2.20		1.40	71.61	28.26	2355	100.00	36.00	2.46	8903				

		% PYRITE	% PYRITE	% PYRITE
	1.25	0.00	0.00	0.00
1.25	1.30	0.00	0.00	0.00
1.30	1.40	0.00	0.00	0.00
1.40	1.50	0.00	0.00	1.89
1.50	1.80	1.51	1.51	2.38
1.80	2.20	1.55	1.53	27.48
2.20		27.48	1.89	

IM # 15

UPPER FREEPORT SEAM
GRINDING OPTIMIZATION RESULTS

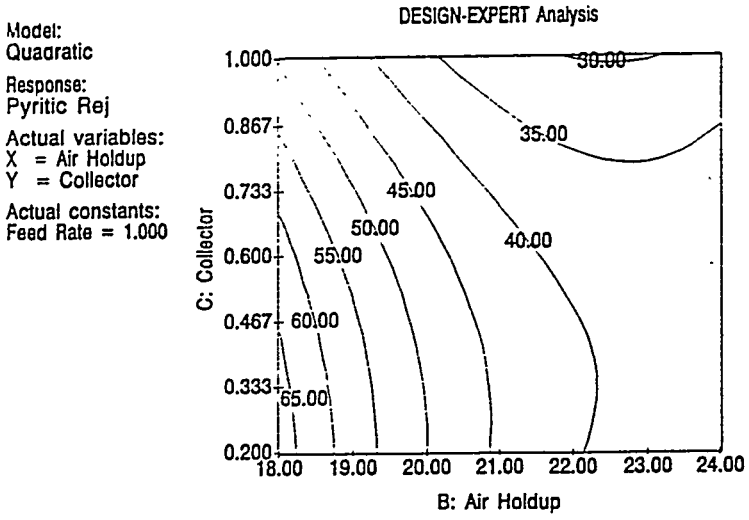
Mill Circuit Test Results - Upper Freeport

TEST NUMBER	93100701	93100702	93100601	93100602	93100603	93100604	93100605	93100606
MILL SPEED – RPM	27.7	18.0	27.7	27.7	27.7	27.7	27.7	27.7
COL. FD. RATE – TPH	3.86	4.76	0.89	3.35	1.72	2.76	1.12	1.82

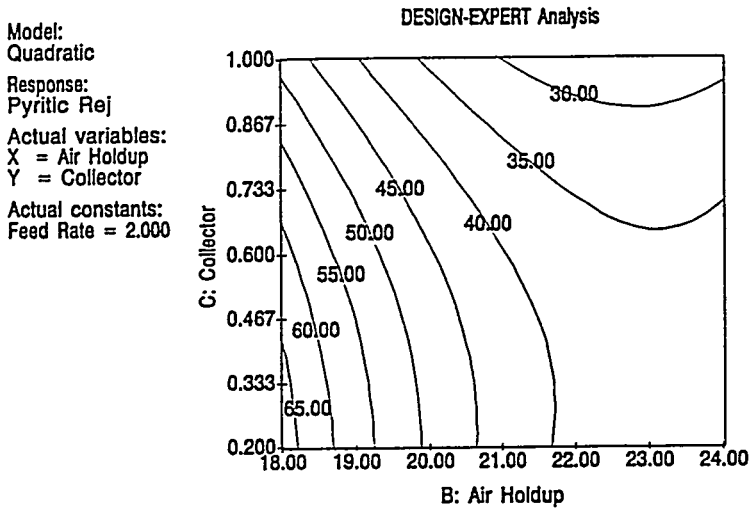
SIZE FRACTION MICRONS	WT% PASSING	WT% PASSING	WT% PASSING	WT% PASSING	WT% PASSING	WT% PASSING	WT% PASSING	WT% PASSING
296.00	92.56	98.78	100.00	98.94	99.79	99.24	99.92	100.00
248.90	87.32	96.16	100.00	97.04	99.22	98.46	99.61	99.89
209.30	81.10	91.52	99.60	94.00	97.98	96.57	98.73	98.99
176.00	74.02	85.01	98.93	90.04	96.24	93.63	97.41	97.33
148.00	66.31	76.80	98.07	85.46	94.20	89.66	95.76	94.81
124.45	57.47	67.40	96.84	80.24	91.53	84.68	93.54	91.33
104.65	51.02	57.42	95.02	74.42	87.89	78.73	90.49	86.77
88.00	44.06	47.51	92.47	68.06	83.17	72.08	86.53	81.16
74.00	37.71	38.30	89.00	61.20	77.22	65.00	81.52	74.51
62.23	31.99	30.32	84.57	54.23	70.41	57.81	75.75	67.19
52.33	26.88	24.09	79.17	47.53	63.14	50.83	69.53	59.56
44.00	22.49	19.26	73.00	41.30	55.78	44.32	63.01	52.04
37.00	18.88	15.51	66.26	35.72	48.67	38.47	56.34	45.02
31.11	15.96	12.66	59.54	31.00	42.27	33.45	50.01	38.85
26.16	13.64	10.52	53.45	27.36	37.01	29.41	44.51	33.91
22.00	11.65	8.78	47.67	24.14	32.39	25.88	39.44	29.60
18.50	9.73	7.19	41.91	20.73	27.93	22.41	34.46	25.39
15.56	7.95	5.75	36.32	17.41	23.73	19.10	29.65	21.39
13.08	6.37	4.46	31.00	14.41	19.80	15.98	25.01	17.66
11.00	5.02	3.39	26.26	11.82	16.38	13.28	20.91	14.47
9.25	3.97	2.64	22.40	9.79	13.71	11.23	17.70	12.11
7.78	3.12	2.06	19.12	8.13	11.51	9.56	15.02	10.21
6.54	2.40	1.55	16.19	6.71	9.53	8.06	12.58	8.48
5.50	1.74	1.08	13.42	5.37	7.69	6.59	10.26	6.86
4.62	1.06	0.58	10.59	3.90	5.85	4.96	7.86	5.25
3.89	0.52	0.19	8.15	2.64	4.29	3.54	5.80	3.88
3.27	0.27	0.04	6.52	1.92	3.30	2.72	4.50	3.01
2.75	0.15	0.00	5.27	1.49	2.58	2.18	3.57	2.35
2.31	0.06	0.00	4.05	1.17	1.87	1.71	2.68	1.68
1.94	0.00	0.00	2.95	0.89	1.26	1.28	1.90	1.09
1.64	0.00	0.00	2.06	0.59	0.80	0.87	1.27	0.67
1.38	0.00	0.00	1.31	0.32	0.45	0.50	0.74	0.37
1.16	0.00	0.00	0.65	0.12	0.17	0.19	0.29	0.14
0.97	0.00	0.00	0.19	0.00	0.00	0.00	0.00	0.00
0.82	0.00	0.00	0.04	0.00	0.00	0.00	0.00	0.00
SUMMARY DATA								
dv	0.1035	0.1346	0.1711	0.0790	0.2287	0.0672	0.1458	0.1831
5%	10.97	14.11	2.65	5.27	4.23	4.64	3.53	4.50
50%	102.12	91.99	23.60	55.85	38.26	51.23	31.10	41.90
95%	328.69	236.70	104.47	220.34	157.75	189.50	138.66	149.70
mv	128.69	104.30	34.64	75.78	52.25	67.75	45.00	53.83
ma	43.43	49.38	10.62	21.64	16.25	18.99	13.33	17.61
cs	0.1380	0.1220	0.5650	0.2770	0.3690	0.3160	0.4500	0.3410
sd	97.53	67.06	27.29	63.17	39.88	54.40	36.01	41.83

UPPER FREEPORT SEAM
COLUMN FLOTATION
BOX-BEHNKEN TEST MATRIX RESULTS

a)



b)



c)

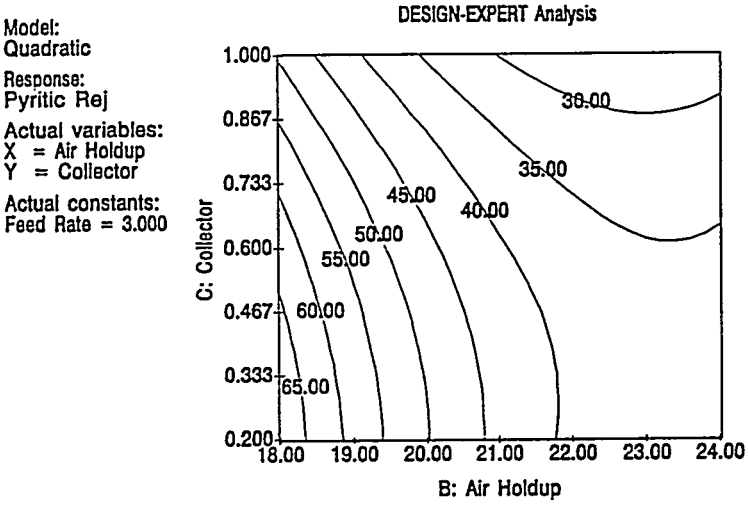
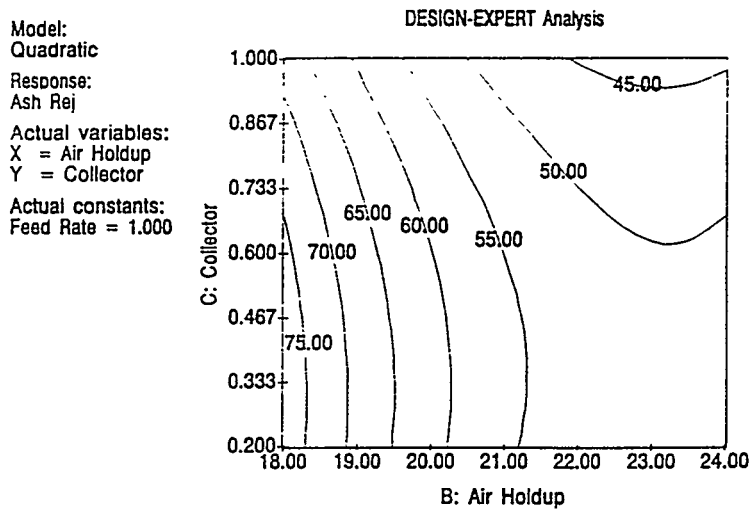


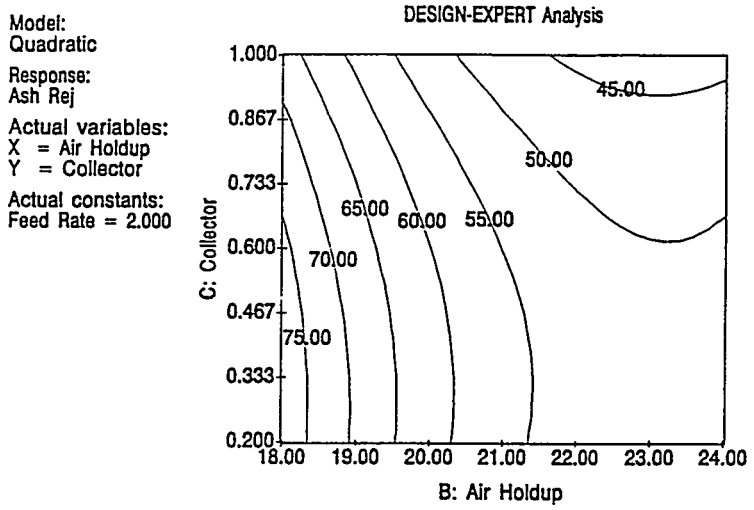
Figure 3.6

Effects of Collector Dosage and Air Holdup on Pyritic Sulfur Rejection for the Upper Freeport Coal at Feed Rates of (a) 1.0, (b) 2.0, and (c) 3.0 tph

a)



b)



c)

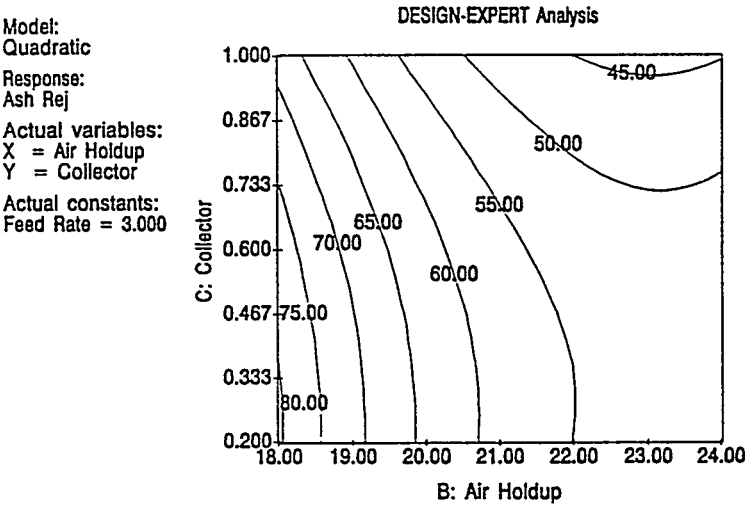


Figure 3.5

Effects of Collector Dosage and Air Holdup on Ash Rejection for the Upper Freeport Coal at Feed Rates of (a) 1.0, (b) 2.0, and (c) 3.0 tph

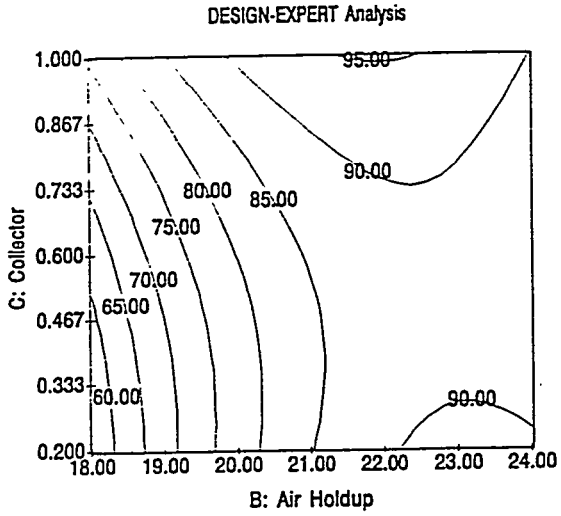
a)

Model:
Quadratic

Response:
Recovery

Actual variables:
X = Air Holdup
Y = Collector

Actual constants:
Feed Rate = 1.000



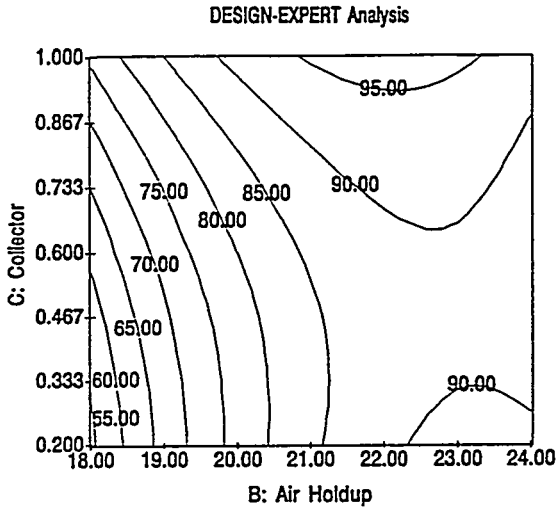
b)

Model:
Quadratic

Response:
Recovery

Actual variables:
X = Air Holdup
Y = Collector

Actual constants:
Feed Rate = 2.000



c)

Model:
Quadratic

Response:
Recovery

Actual variables:
X = Air Holdup
Y = Collector

Actual constants:
Feed Rate = 3.000

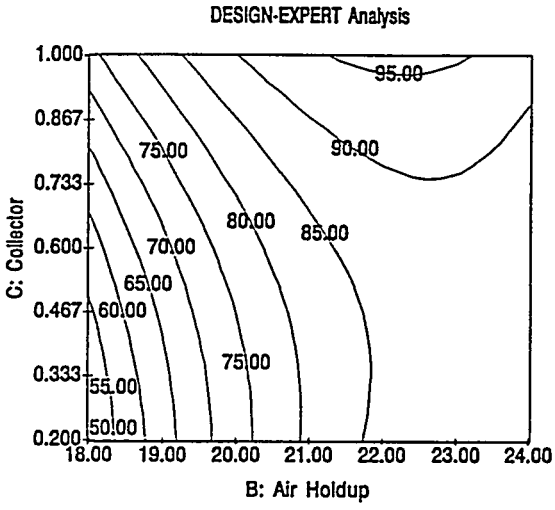


Figure 3.4
Effects of Collector Dosage and Air Holdup on Energy Recovery for the Upper Freeport Coal at Feed Rates of (a) 1.0, (b) 2.0, and (c) 3.0 tph

Upper Freeport Seam

Box-Behnken Tests

Test Number	Design Number	Goodness-of-Fit			Material Balance
		Ash	Other	Total	
93100606	9	4.40	0.75	5.15	Good
93100607	12	27.25	7.73	34.98	Poor
93100608	3	10.65	8.09	18.74	Fair
93100609	5	10.25	5.86	16.11	Fair
93100610	1	4.04	2.81	6.85	Good
93100611	7	4.01	4.54	8.55	Good
93100612	2	4.24	2.75	6.99	Good
93100613	9	6.65	3.36	10.01	Good
93100614	12	5.94	5.23	11.17	Fair
93100615	10	0.54	4.47	5.01	Good
93100616	0	1.21	4.40	5.61	Good
93100617	11	2.82	10.32	13.14	Fair
93100618	9	0.46	4.13	4.59	Good
93100619	12	23.39	19.29	42.68	Poor
93100620	10	2.35	11.69	14.04	Fair
93100621	0	3.09	2.20	5.29	Good
93100622	6	0.65	3.19	3.84	Good
93100623	8	0.66	2.17	2.83	Good
93100624	11	0.54	3.52	4.06	Good
93100625	0	3.19	5.88	9.07	Good
93100626	4	4.35	7.68	12.03	Fair
Average		5.75	5.72	11.46	

Upper Freeport Seam										
Box-Behnken Tests										
	Planned	Planned	Planned	Planned	Planned	Planned	Planned	Planned	Planned	Planned
	Plant	Column	Column	Column	Column	Column	Column	Column	Column	Column
	Feed	Feed	Aeration	Wash	Air	Frother	Frother	Collector	Frother	Collector
Test	Rate	Rate	Rate	Rate	Holdup	Type	Dosage	Dosage	Dosage	Dosage
Number	(tph)	(tph)	(scfm)	(gpm)	(%)	(*)	(lb/ton)	(lb/ton)	(ml/min)	(ml/min)
93100606	3.00	2.50	140	100	18	MIBC	N/A	0.20	N/A	4.70
93100607	3.00	2.50	140	100	24	MIBC	N/A	1.00	N/A	23.60
93100608	1.25	1.00	140	100	24	MIBC	N/A	0.60	N/A	5.70
93100609	1.25	1.00	140	100	21	MIBC	N/A	0.20	N/A	1.90
93100610	1.25	1.00	140	100	18	MIBC	N/A	0.60	N/A	5.70
93100611	1.25	1.00	140	100	21	MIBC	N/A	1.00	N/A	9.50
93100612	4.80	4.00	140	100	18	MIBC	N/A	0.60	N/A	22.70
93100613	3.00	2.50	140	100	18	MIBC	N/A	0.20	N/A	4.70
93100614	3.00	2.50	140	100	24	MIBC	N/A	1.00	N/A	23.60
93100615	3.00	2.50	140	100	24	MIBC	N/A	0.20	N/A	4.70
93100616	3.00	2.50	140	100	21	MIBC	N/A	0.60	N/A	14.20
93100617	3.00	2.50	140	100	18	MIBC	N/A	1.00	N/A	23.60
93100618	3.00	2.50	140	100	18	MIBC	N/A	0.20	N/A	4.70
93100619	3.00	2.50	140	100	24	MIBC	N/A	1.00	N/A	23.60
93100620	3.00	2.50	140	100	24	MIBC	N/A	0.20	N/A	4.70
93100621	3.00	2.50	140	100	21	MIBC	N/A	0.60	N/A	14.20
93100622	4.80	4.00	140	100	21	MIBC	N/A	0.20	N/A	7.60
93100623	4.80	4.00	140	100	21	MIBC	N/A	1.00	N/A	37.80
93100624	3.00	2.50	140	100	18	MIBC	N/A	1.00	N/A	23.60
93100625	3.00	2.50	140	100	21	MIBC	N/A	0.60	N/A	14.20
93100626	4.80	4.00	140	100	24	MIBC	N/A	0.60	N/A	22.70
Average	3.01	2.50	140	100	21	MIBC	N/A	0.60	N/A	14.18

Upper Freeport Seam									
Box-Behnken Tests									
	Relative	Relative	Relative	Relative	Relative	Relative	Relative	Relative	Relative
	Plant	Deslime	HMC	WOC	WOC	Column	Column	Column	Thickener
Test	Feed	U/F	Reject	O/F	U/F	Feed	Product	Reject	Feed
Number	(%)	(%)	(%)	(%)	(%)	(%)	(%)	(%)	(%)
93100606	100.00	90.98	9.02	87.51	3.47	87.51	30.19	57.32	60.79
93100607	100.00	88.84	11.16	88.50	0.34	88.50	79.45	9.05	9.39
93100608	100.00	85.11	14.89	83.86	1.25	83.86	70.81	13.05	14.30
93100609	100.00	85.31	14.69	83.71	1.59	83.71	67.37	16.35	17.94
93100610	100.00	89.78	10.22	88.05	1.73	88.05	43.29	44.76	46.49
93100611	100.00	85.67	14.33	85.20	0.47	85.20	71.19	14.01	14.48
93100612	100.00	88.50	11.50	86.47	2.03	86.47	34.73	51.74	53.77
93100613	100.00	89.79	10.21	89.69	0.10	89.69	47.64	42.05	42.15
93100614	100.00	94.02	5.98	93.26	0.76	93.26	75.12	18.14	18.90
93100615	100.00	92.02	7.98	91.83	0.20	91.83	69.22	22.61	22.80
93100616	100.00	93.36	6.64	92.79	0.57	92.79	64.15	28.64	29.21
93100617	100.00	90.09	9.91	88.69	1.40	88.69	63.18	25.51	26.91
93100618	100.00	95.33	4.67	92.92	2.41	92.92	50.29	42.63	45.04
93100619	100.00	88.33	11.67	87.28	1.05	87.28	71.51	15.77	16.82
93100620	100.00	87.67	12.33	87.22	0.45	87.22	70.05	17.16	17.62
93100621	100.00	87.52	12.48	86.04	1.48	86.04	70.19	15.85	17.33
93100622	100.00	90.00	10.00	88.43	1.57	88.43	62.92	25.50	27.08
93100623	100.00	89.45	10.55	87.97	1.48	87.97	70.28	17.69	19.17
93100624	100.00	87.67	12.33	86.30	1.37	86.30	60.82	25.48	26.85
93100625	100.00	88.98	11.02	88.08	0.90	88.08	71.32	16.76	17.66
93100626	100.00	88.76	11.24	87.65	1.12	87.65	70.54	17.10	18.22
Average	100.00	89.39	10.61	88.16	1.23	88.16	62.58	25.58	26.81

Upper Freeport Seam									
Box-Behnken Tests									
	Relative	Relative	Relative	Relative	Relative	Relative	Relative	Relative	Relative
	Plant	Deslime	HMC	WOC	WOC	Column	Column	Column	Thickener
Test	Feed	U/F	Reject	O/F	U/F	Feed	Product	Reject	Feed
Number	(tph)	(tph)	(tph)	(tph)	(tph)	(tph)	(tph)	(tph)	(tph)
93100606	3.00	2.73	0.27	2.63	0.10	2.63	0.91	1.72	1.82
93100607	3.00	2.67	0.33	2.66	0.01	2.66	2.38	0.27	0.28
93100608	1.25	1.06	0.19	1.05	0.02	1.05	0.89	0.16	0.18
93100609	1.25	1.07	0.18	1.05	0.02	1.05	0.84	0.20	0.22
93100610	1.25	1.12	0.13	1.10	0.02	1.10	0.54	0.56	0.58
93100611	1.25	1.07	0.18	1.07	0.01	1.07	0.89	0.18	0.18
93100612	4.80	4.25	0.55	4.15	0.10	4.15	1.67	2.48	2.58
93100613	3.00	2.69	0.31	2.69	0.00	2.69	1.43	1.26	1.26
93100614	3.00	2.82	0.18	2.80	0.02	2.80	2.25	0.54	0.57
93100615	3.00	2.76	0.24	2.75	0.01	2.75	2.08	0.68	0.68
93100616	3.00	2.80	0.20	2.78	0.02	2.78	1.92	0.86	0.88
93100617	3.00	2.70	0.30	2.66	0.04	2.66	1.90	0.77	0.81
93100618	3.00	2.86	0.14	2.79	0.07	2.79	1.51	1.28	1.35
93100619	3.00	2.65	0.35	2.62	0.03	2.62	2.15	0.47	0.50
93100620	3.00	2.63	0.37	2.62	0.01	2.62	2.10	0.51	0.53
93100621	3.00	2.63	0.37	2.58	0.04	2.58	2.11	0.48	0.52
93100622	4.80	4.32	0.48	4.24	0.08	4.24	3.02	1.22	1.30
93100623	4.80	4.29	0.51	4.22	0.07	4.22	3.37	0.85	0.92
93100624	3.00	2.63	0.37	2.59	0.04	2.59	1.82	0.76	0.81
93100625	3.00	2.67	0.33	2.64	0.03	2.64	2.14	0.50	0.53
93100626	4.80	4.26	0.54	4.21	0.05	4.21	3.39	0.82	0.87
Average	3.01	2.70	0.31	2.66	0.04	2.66	1.87	0.79	0.83

Upper Freeport Seam										
Box-Behnken Tests										
	Measured	Adjusted	Measured	Adjusted	Measured	Adjusted	Measured	Adjusted	Measured	Adjusted
	Plant	Plant	Deslime	Deslime	HMC	HMC	WOC	WOC	WOC	WOC
	Feed	Feed	U/F	U/F	Reject	Reject	O/F	O/F	U/F	U/F
Test	Ash	Ash	Ash	Ash	Ash	Ash	Ash	Ash	Ash	Ash
Number	(%)	(%)	(%)	(%)	(%)	(%)	(%)	(%)	(%)	(%)
93100606	22.55	22.44	18.25	18.17	65.47	65.55	16.08	16.82	51.86	52.30
93100607	23.12	23.22	15.51	17.69	67.33	67.24	17.86	17.56	51.93	51.70
93100608	23.73	24.54	17.72	17.85	63.64	62.78	16.27	17.41	47.27	46.95
93100609	22.87	23.61	15.99	16.72	64.48	63.62	15.31	16.09	49.93	49.60
93100610	22.72	22.30	16.75	17.35	65.41	65.76	15.97	16.71	50.08	50.13
93100611	23.10	23.58	16.32	16.90	64.10	63.57	16.27	16.72	48.84	48.76
93100612	24.24	24.03	19.01	18.48	66.52	66.70	16.74	17.71	51.04	51.39
93100613	21.85	22.72	17.04	17.97	65.23	64.44	18.11	17.93	53.73	53.72
93100614	19.79	20.16	17.12	17.45	63.01	62.79	16.68	17.20	48.47	48.28
93100615	20.37	20.51	16.65	16.93	61.91	61.81	17.21	16.86	51.98	51.97
93100616	19.86	20.07	17.06	17.10	61.89	61.76	16.53	16.91	47.48	47.44
93100617	21.32	21.95	17.64	17.39	63.95	63.39	16.15	16.90	48.69	48.58
93100618	21.06	20.56	17.98	18.34	65.47	65.70	17.34	17.37	55.97	55.92
93100619	22.88	23.42	18.18	17.61	67.89	67.34	15.84	17.20	52.26	51.77
93100620	23.81	24.33	18.91	18.39	67.04	66.53	17.23	18.21	54.30	54.33
93100621	23.24	23.63	17.71	17.65	65.96	65.57	16.80	17.02	53.44	53.74
93100622	22.93	23.15	18.02	18.26	67.35	67.16	17.64	17.66	52.13	52.19
93100623	23.97	24.11	18.56	19.00	67.56	67.45	18.23	18.43	52.66	52.61
93100624	24.33	24.80	19.46	19.11	65.69	65.26	18.20	18.59	52.20	52.21
93100625	22.94	23.43	17.66	18.07	67.19	66.73	17.19	17.72	52.79	52.64
93100626	24.55	24.82	19.16	19.60	66.26	66.04	19.55	19.18	52.30	52.03
Average	22.63	22.92	17.65	17.91	65.40	65.10	17.01	17.44	51.40	51.35

Upper Freeport Seam								
Box-Behnken Tests								
	Measured Column Feed Ash (%)	Adjusted Column Feed Ash (%)	Measured Column Product Ash (%)	Adjusted Column Product Ash (%)	Measured Column Reject Ash (%)	Adjusted Column Reject Ash (%)	Measured Thickener Feed Ash (%)	Adjusted Thickener Feed Ash (%)
Test Number								
93100606	17.59	16.82	7.36	7.36	20.73	21.80	25.17	23.54
93100607	21.46	17.56	12.52	12.55	67.72	61.50	56.56	61.14
93100608	19.28	17.41	10.79	10.70	58.48	53.82	49.89	53.22
93100609	18.61	16.09	9.43	9.43	44.72	43.57	42.96	44.10
93100610	17.89	16.71	7.07	7.06	25.43	26.05	27.97	26.94
93100611	18.14	16.72	10.03	10.00	52.33	50.87	49.58	50.80
93100612	17.93	17.71	7.53	7.51	23.59	24.56	27.41	25.57
93100613	19.69	17.93	8.33	8.34	27.61	28.81	30.21	28.87
93100614	18.10	17.20	10.99	10.88	47.15	43.35	40.94	43.55
93100615	16.69	16.86	9.75	9.70	39.50	38.78	38.48	38.90
93100616	17.21	16.91	9.17	9.11	35.72	34.39	33.79	34.64
93100617	17.54	16.90	9.72	9.64	36.35	34.90	34.67	35.61
93100618	17.38	17.37	7.24	7.24	29.60	29.32	30.48	30.74
93100619	18.05	17.20	11.19	10.98	55.21	45.41	40.76	45.81
93100620	18.87	18.21	10.68	10.61	49.10	49.22	49.87	49.35
93100621	17.19	17.02	10.22	10.16	45.18	47.41	51.45	47.95
93100622	17.90	17.66	10.02	9.99	35.87	36.58	38.55	37.49
93100623	19.00	18.43	10.83	10.78	48.86	48.81	49.31	49.11
93100624	18.59	18.59	7.97	7.93	44.55	44.03	44.49	44.45
93100625	18.86	17.72	10.52	10.46	50.50	48.63	47.42	48.83
93100626	19.10	19.18	11.51	11.42	55.46	51.21	48.25	51.26
Average	18.34	17.44	9.66	9.61	42.56	41.10	40.87	41.52

Upper Freeport Seam										
Box-Behnken Tests										
	Measured	Adjusted	Measured	Adjusted	Measured	Adjusted	Measured	Adjusted	Measured	Adjusted
	Plant	Plant	Deslime	Deslime	HMC	HMC	WOC	WOC	WOC	WOC
	Feed	Feed	U/F	U/F	Reject	Reject	O/F	O/F	U/F	U/F
Test	Sulfur	Sulfur	Sulfur	Sulfur	Sulfur	Sulfur	Sulfur	Sulfur	Sulfur	Sulfur
Number	(%)	(%)	(%)	(%)	(%)	(%)	(%)	(%)	(%)	(%)
93100606	4.95	4.99	3.44	3.47	20.46	20.39	2.87	2.87	18.94	18.64
93100607	4.61	4.74	2.71	2.87	19.83	19.57	3.08	2.81	19.63	19.67
93100608	4.75	5.33	3.18	2.86	21.13	19.43	2.68	2.68	15.21	14.97
93100609	4.62	5.22	2.88	2.89	20.52	18.77	2.71	2.61	17.80	17.78
93100610	4.49	4.65	3.25	2.93	20.10	19.77	2.82	2.65	17.23	17.21
93100611	4.53	5.01	2.91	2.74	19.91	18.58	2.65	2.67	15.12	15.00
93100612	4.75	4.78	3.06	2.89	19.31	19.26	2.70	2.53	18.54	18.35
93100613	4.41	4.43	2.98	2.91	17.84	17.81	2.63	2.89	20.76	20.75
93100614	4.01	3.93	3.30	2.93	19.43	19.55	2.79	2.81	17.81	17.63
93100615	4.46	4.40	3.08	3.02	20.28	20.38	3.23	2.97	22.19	22.20
93100616	4.29	4.01	3.07	2.75	21.21	21.66	2.85	2.68	15.58	15.61
93100617	4.54	4.77	3.14	2.89	22.47	21.91	2.73	2.65	18.34	18.07
93100618	3.57	3.81	3.00	3.04	19.72	19.38	2.92	2.61	19.99	19.83
93100619	3.81	4.44	3.17	2.75	19.19	17.31	2.62	2.59	16.50	15.82
93100620	4.80	4.97	3.38	2.75	21.17	20.77	2.74	2.68	15.42	15.33
93100621	4.59	4.73	2.67	2.61	19.97	19.63	2.48	2.34	18.14	18.00
93100622	4.66	4.68	3.20	2.98	19.96	19.93	2.96	2.70	18.72	18.74
93100623	4.90	4.75	3.19	3.07	18.80	19.03	2.92	2.81	18.28	18.42
93100624	4.53	4.59	2.67	2.57	19.09	18.96	2.35	2.39	14.46	14.15
93100625	4.31	4.53	3.09	2.76	19.38	18.89	2.88	2.61	17.00	17.00
93100626	4.53	4.41	3.06	2.76	17.22	17.42	2.96	2.59	15.72	15.80
Average	4.48	4.63	3.07	2.88	19.86	19.45	2.79	2.67	17.68	17.57

Upper Freeport Seam								
Box-Behnken Tests								
	Measured Column Feed Sulfur (%)	Adjusted Column Feed Sulfur (%)	Measured Column Product Sulfur (%)	Adjusted Column Product Sulfur (%)	Measured Column Reject Sulfur (%)	Adjusted Column Reject Sulfur (%)	Measured Thickener Feed Sulfur (%)	Adjusted Thickener Feed Sulfur (%)
Test Number								
93100606	2.87	2.87	2.43	2.42	3.24	3.10	3.81	3.99
93100607	2.89	2.81	2.61	2.68	3.83	3.93	4.63	4.50
93100608	2.85	2.68	2.30	2.43	4.18	4.04	4.70	5.00
93100609	2.84	2.61	2.18	2.25	3.96	4.08	5.43	5.30
93100610	2.59	2.65	2.22	2.30	2.95	2.99	3.36	3.52
93100611	2.70	2.67	2.35	2.35	4.64	4.30	4.34	4.65
93100612	2.62	2.53	2.11	2.20	2.70	2.75	3.10	3.34
93100613	3.17	2.89	2.35	2.35	3.62	3.50	3.44	3.54
93100614	2.82	2.81	2.43	2.60	3.90	3.69	3.91	4.25
93100615	3.19	2.97	2.35	2.58	3.97	4.18	4.33	4.34
93100616	2.64	2.68	2.19	2.40	3.17	3.29	3.44	3.53
93100617	2.74	2.65	2.20	2.33	3.54	3.44	3.89	4.20
93100618	2.45	2.61	2.11	2.08	3.26	3.23	4.17	4.12
93100619	2.64	2.59	2.30	2.37	4.21	3.58	3.77	4.35
93100620	2.60	2.68	2.33	2.52	3.51	3.33	3.36	3.63
93100621	2.28	2.34	2.08	2.12	3.36	3.33	4.47	4.58
93100622	2.65	2.70	2.39	2.56	2.98	3.05	3.88	3.96
93100623	2.90	2.81	2.45	2.64	3.39	3.50	4.69	4.65
93100624	2.47	2.39	2.00	2.05	3.51	3.19	3.37	3.75
93100625	2.69	2.61	2.15	2.40	3.39	3.48	4.09	4.17
93100626	2.47	2.59	2.20	2.43	3.16	3.25	3.98	4.02
Average	2.72	2.67	2.27	2.38	3.55	3.49	4.01	4.16

Upper Freeport Seam									
Box-Behnken Tests									
	Measured	Adjusted	Adjusted	Measured	Adjusted	Measured	Adjusted	Measured	Adjusted
	Plant	Plant	Deslime	HMC	HMC	WOC	WOC	WOC	WOC
	Feed	Feed	U/F	Reject	Reject	O/F	O/F	U/F	U/F
Test	Pyritic	Pyritic	Pyritic	Pyritic	Pyritic	Pyritic	Pyritic	Pyritic	Pyritic
Number	(%)	(%)	(%)	(%)	(%)	(%)	(%)	(%)	(%)
93100606	3.72	3.78	2.21	19.79	19.64	1.63	1.62	17.76	17.09
93100607	3.42	3.60	1.68	19.53	18.88	1.94	1.62	17.89	17.91
93100608	3.66	4.16	1.75	20.18	17.93	1.58	1.58	13.63	13.43
93100609	3.40	3.99	1.76	19.91	16.94	1.51	1.49	16.14	16.12
93100610	3.40	3.46	1.72	19.00	18.80	1.63	1.44	15.80	15.68
93100611	3.41	3.82	1.60	18.90	17.09	1.53	1.53	14.62	14.47
93100612	3.53	3.67	1.78	18.71	18.25	1.58	1.41	18.05	17.45
93100613	3.20	3.26	1.75	16.76	16.58	1.59	1.73	18.82	18.80
93100614	2.58	2.64	1.67	18.09	17.91	1.42	1.55	16.28	15.86
93100615	3.06	3.06	1.67	19.08	19.09	1.35	1.62	20.96	20.98
93100616	2.64	2.80	1.56	20.95	20.26	1.65	1.48	14.51	14.46
93100617	3.07	3.50	1.72	21.82	19.67	1.61	1.49	16.28	16.65
93100618	3.30	3.09	2.23	20.37	20.74	2.22	1.77	19.24	19.99
93100619	3.05	3.42	1.61	18.80	17.15	1.40	1.45	15.93	15.18
93100620	3.45	3.83	1.73	20.42	18.77	1.70	1.66	14.90	14.96
93100621	3.28	3.67	1.66	19.43	17.73	1.50	1.39	17.80	17.55
93100622	3.06	3.40	1.85	18.69	17.41	1.89	1.57	17.95	17.67
93100623	3.99	3.84	2.08	18.47	18.81	2.01	1.81	17.95	17.84
93100624	3.77	3.80	1.76	18.37	18.30	1.59	1.57	13.98	13.76
93100625	2.87	3.24	1.60	18.05	16.45	1.35	1.46	15.14	15.03
93100626	3.34	3.35	1.65	16.75	16.73	1.88	1.48	14.86	14.73
Average	3.30	3.49	1.76	19.15	18.24	1.65	1.56	16.59	16.46

Upper Freeport Seam								
Box-Behnken Tests								
	Measured	Adjusted	Measured	Adjusted	Measured	Adjusted	Measured	Adjusted
	Column	Column	Column	Column	Column	Column	Thickener	Thickener
	Feed	Feed	Product	Product	Reject	Reject	Feed	Feed
Test	Pyritic	Pyritic	Pyritic	Pyritic	Pyritic	Pyritic	Pyritic	Pyritic
Number	(%)	(%)	(%)	(%)	(%)	(%)	(%)	(%)
93100606	1.68	1.62	1.10	1.11	1.95	1.89	2.58	2.75
93100607	1.74	1.62	1.35	1.41	3.28	3.44	4.15	3.96
93100608	1.72	1.58	1.15	1.24	3.45	3.41	4.02	4.29
93100609	1.73	1.49	1.04	1.06	3.09	3.25	4.71	4.39
93100610	1.36	1.44	1.02	1.05	1.82	1.82	2.17	2.34
93100611	1.56	1.53	1.14	1.16	3.66	3.40	3.48	3.76
93100612	1.50	1.41	0.96	1.01	1.63	1.68	2.02	2.27
93100613	2.07	1.73	1.19	1.16	2.48	2.38	2.44	2.42
93100614	1.80	1.55	1.25	1.30	2.92	2.61	2.79	3.15
93100615	1.89	1.62	1.20	1.19	3.09	2.96	3.02	3.12
93100616	1.49	1.48	1.05	1.14	2.21	2.25	2.33	2.49
93100617	2.61	1.49	1.10	1.32	1.66	1.90	2.77	2.67
93100618	1.71	1.77	1.17	1.25	2.08	2.38	3.56	3.32
93100619	1.54	1.45	1.17	1.23	2.72	2.41	2.78	3.21
93100620	1.62	1.66	1.24	1.38	2.76	2.83	3.03	3.15
93100621	1.43	1.39	0.98	1.05	2.83	2.87	3.91	4.12
93100622	1.59	1.57	1.21	1.28	2.19	2.26	3.10	3.16
93100623	1.85	1.81	1.38	1.51	2.93	3.00	3.98	4.15
93100624	1.64	1.57	0.96	1.02	2.95	2.86	3.04	3.42
93100625	1.64	1.46	1.16	1.17	2.78	2.71	3.22	3.34
93100626	1.40	1.48	1.08	1.21	2.59	2.62	3.13	3.36
Average	1.69	1.56	1.14	1.20	2.62	2.62	3.15	3.28

Upper Freeport Seam									
Box-Behnken Tests									
	Measured Plant Feed	Adjusted Plant Feed	Measured Deslime U/F	Adjusted Deslime U/F	Measured HMC Reject	Adjusted HMC Reject	Measured WOC O/F	Adjusted WOC O/F	Measured WOC U/F
Test Number	Energy (Btu/lb)	Energy (Btu/lb)	Energy (Btu/lb)	Energy (Btu/lb)	Energy (Btu/lb)	Energy (Btu/lb)	Energy (Btu/lb)	Energy (Btu/lb)	Energy (Btu/lb)
93100606	11220	11240	11990	11990	3740	3740	12310	12210	6450
93100607	11300	11150	12410	12080	3800	3800	12150	12100	6280
93100608	11050	10860	12080	12080	3870	3870	12390	12150	7060
93100609	11150	11010	12380	12240	3870	3870	12470	12350	6730
93100610	11350	11350	12330	12220	3700	3700	12410	12340	6350
93100611	11300	11120	12340	12310	4000	4010	12360	12340	6670
93100612	11090	11100	11980	12090	3460	3460	12430	12230	5950
93100613	11450	11240	12140	12110	3570	3570	12210	12110	5720
93100614	11860	11740	12190	12230	4050	4050	12520	12270	6580
93100615	11500	11590	12280	12220	4220	4220	12240	12240	5710
93100616	11600	11660	12190	12190	4160	4160	12300	12220	6780
93100617	11460	11370	12180	12220	3680	3680	12400	12300	6660
93100618	11630	11640	11990	12040	3510	3510	12200	12210	5260
93100619	11180	11070	11920	12100	3280	3280	12430	12180	5870
93100620	11060	10960	11870	12020	3490	3490	12150	12050	5690
93100621	10910	11030	12090	12110	3450	3450	12340	12220	5830
93100622	11210	11190	12080	12050	3430	3430	12180	12150	6330
93100623	11130	11070	12050	11980	3350	3350	12030	12080	6300
93100624	11080	10930	11860	11950	3660	3670	12100	12050	6000
93100625	11360	11130	11980	12090	3370	3370	12250	12160	6000
93100626	10980	10890	11840	11820	3580	3580	11770	11890	6230
Average	11280	11207	12103	12102	3678	3679	12269	12183	6212

Upper Freeport Seam									
Box-Behnken Tests									
	Adjusted	Measured	Adjusted	Measured	Adjusted	Measured	Adjusted	Measured	Adjusted
	WOC	Column	Column	Column	Column	Column	Column	Thickener	Thickener
	U/F	Feed	Feed	Product	Product	Reject	Reject	Feed	Feed
Test	Energy	Energy	Energy	Energy	Energy	Energy	Energy	Energy	Energy
Number	(Btu/lb)	(Btu/lb)	(Btu/lb)	(Btu/lb)	(Btu/lb)	(Btu/lb)	(Btu/lb)	(Btu/lb)	(Btu/lb)
93100606	6450	12120	12210	13810	13810	11560	11360	10900	11080
93100607	6320	11620	12100	12930	12910	4410	4940	6050	4990
93100608	7140	11770	12150	13330	13360	5180	5610	6490	5750
93100609	6740	11970	12350	13450	13460	7560	7760	7900	7670
93100610	6350	12130	12340	13950	13930	10980	10800	10470	10630
93100611	6690	12140	12340	13460	13480	6230	6530	6910	6540
93100612	5940	12210	12230	13860	13880	11250	11120	10780	10930
93100613	5720	11900	12110	13660	13750	10480	10260	10000	10250
93100614	6590	12140	12270	13220	13400	7200	7610	8080	7560
93100615	5710	12260	12240	13420	13400	8460	8670	8870	8640
93100616	6780	12190	12220	13610	13590	8920	9150	9370	9110
93100617	6670	12260	12300	13470	13570	8940	9180	9320	9050
93100618	5260	12180	12210	13910	13840	10350	10290	9980	10020
93100619	5930	12100	12180	13340	13420	5730	6530	8270	6490
93100620	5690	11910	12050	13420	13330	6930	6830	6710	6800
93100621	5810	12260	12220	13340	13360	7420	7130	6750	7020
93100622	6330	12210	12150	13260	13370	9120	9140	8980	8980
93100623	6310	12000	12080	13290	13280	7050	7320	7580	7240
93100624	6000	12040	12050	13760	13860	7820	7720	7520	7630
93100625	6010	11930	12160	13380	13340	6800	7100	7440	7050
93100626	6260	11850	11890	13260	13210	6010	6460	7120	6450
Average	6224	12057	12183	13482	13502	8019	8167	8357	8090

Upper Freeport Seam							
Box-Behnken Tests							
	Plant	Plant	Plant	Plant	Plant	Plant	Plant
	Product	Reject	Energy	Ash	Sulfur	Pyritic	Separate
Test	Yield	Yield	Recovery	Rejection	Rejection	Rejection	Efficiency
Number	(%)	(%)	(%)	(%)	(%)	(%)	(%)
93100606	30.19	69.81	37.09	90.15	85.36	91.13	28.23
93100607	79.45	20.55	91.99	56.87	55.08	68.88	60.87
93100608	70.81	29.19	87.11	68.07	67.72	78.89	66.00
93100609	67.37	32.63	82.36	72.22	70.96	82.10	64.46
93100610	43.29	56.71	53.13	86.55	78.59	86.86	39.99
93100611	71.19	28.81	86.30	69.18	66.61	78.38	64.68
93100612	34.73	65.27	43.43	89.24	84.02	90.44	33.87
93100613	47.64	52.36	58.28	81.82	74.73	83.05	41.33
93100614	75.12	24.88	85.74	58.70	50.30	63.01	48.75
93100615	69.22	30.78	80.03	67.04	59.41	73.08	53.11
93100616	64.15	35.85	74.77	70.57	61.61	73.88	48.65
93100617	63.18	36.82	75.40	71.43	69.14	76.17	51.58
93100618	50.29	49.71	59.79	82.71	72.55	79.66	39.45
93100619	71.51	28.49	86.69	65.68	61.83	74.28	60.97
93100620	70.05	29.95	85.20	68.78	64.48	74.76	59.96
93100621	70.19	29.81	85.02	69.31	68.54	79.92	64.94
93100622	62.92	37.08	75.18	72.59	65.58	76.31	51.49
93100623	70.28	29.72	84.31	68.39	60.94	72.36	56.67
93100624	60.82	39.18	77.12	80.18	72.84	83.67	60.80
93100625	71.32	28.68	85.48	67.48	62.21	74.25	59.73
93100626	70.54	29.46	85.57	67.19	61.13	74.52	60.09
Average	62.58	37.42	75.24	72.58	67.31	77.89	53.12

Upper Freeport Seam							
Box-Behnken Tests							
	HMC	HMC	HMC	HMC	HMC	HMC	HMC
	Product	Reject	Energy	Ash	Sulfur	Pyritic	Separate
Test	Yield	Yield	Recovery	Rejection	Rejection	Rejection	Efficiency
Number	(%)	(%)	(%)	(%)	(%)	(%)	(%)
93100606	90.98	9.02	97.05	3.00	36.86	46.87	43.92
93100607	88.84	11.16	96.25	3.80	46.08	58.53	54.78
93100608	85.11	14.89	94.67	5.31	54.28	64.18	58.85
93100609	85.31	14.69	94.84	5.16	52.82	62.37	57.21
93100610	89.78	10.22	96.66	3.33	43.45	55.53	52.19
93100611	85.67	14.33	94.84	5.17	53.14	64.11	58.95
93100612	88.50	11.50	96.39	3.58	46.34	57.19	53.58
93100613	89.79	10.21	96.74	3.24	41.05	51.93	48.67
93100614	94.02	5.98	97.94	2.06	29.75	40.57	38.51
93100615	92.02	7.98	97.02	2.91	36.96	49.78	46.81
93100616	93.36	6.64	97.60	2.37	35.87	48.05	45.65
93100617	90.09	9.91	96.82	3.21	45.52	55.69	52.52
93100618	95.33	4.67	98.61	1.41	23.75	31.34	29.95
93100619	88.33	11.67	96.55	3.46	45.50	58.52	55.07
93100620	87.67	12.33	96.15	3.93	51.53	60.43	56.58
93100620	87.52	12.48	96.09	3.90	51.79	60.29	56.38
93100620	90.00	10.00	96.92	3.07	42.59	51.21	48.12
93100620	89.45	10.55	96.80	3.19	42.27	51.68	48.48
93100620	87.67	12.33	95.85	4.14	50.93	59.38	55.23
93100620	88.98	11.02	96.65	3.34	45.95	55.95	52.61
93100620	88.76	11.24	96.34	3.70	44.40	56.13	52.47
Average	89.39	10.61	96.51	3.49	43.85	54.27	50.79

Upper Freeport Seam							
Box-Behnken Tests							
Test Number	WOC Product Yield (%)	WOC Reject Yield (%)	WOC Energy Recovery (%)	WOC Ash Rejection (%)	WOC Sulfur Rejection (%)	WOC Pyritic Rejection (%)	WOC Separate Efficiency (%)
93100606	96.19	3.81	97.95	10.98	20.49	29.49	27.44
93100607	99.62	0.38	99.78	1.12	2.62	4.08	3.86
93100608	98.53	1.47	99.10	3.86	7.69	11.27	10.37
93100609	98.12	1.88	99.01	5.53	11.47	17.07	16.08
93100610	98.07	1.93	99.04	5.57	11.32	17.57	16.60
93100611	99.45	0.55	99.69	1.58	3.00	4.96	4.66
93100612	97.71	2.29	98.84	6.38	14.56	22.49	21.32
93100613	99.89	0.11	99.89	0.33	0.79	1.20	1.09
93100614	99.19	0.81	99.52	2.24	4.86	7.68	7.19
93100615	99.79	0.21	99.96	0.67	1.60	2.73	2.69
93100616	99.39	0.61	99.63	1.69	3.47	5.66	5.29
93100617	98.45	1.55	99.09	4.34	9.72	15.04	14.13
93100618	97.47	2.53	98.85	7.71	16.49	22.66	21.51
93100619	98.81	1.19	99.46	3.49	6.84	11.21	10.67
93100620	99.49	0.51	99.74	1.52	2.86	4.44	4.17
93100620	98.31	1.69	99.20	5.15	11.66	17.88	17.08
93100620	98.26	1.74	99.07	4.99	10.97	16.66	15.73
93100620	98.35	1.65	99.17	4.58	9.93	14.19	13.36
93100620	98.44	1.56	99.26	4.27	8.60	12.22	11.48
93100620	98.99	1.01	99.56	2.95	6.23	9.50	9.06
93100620	98.75	1.25	99.33	3.35	7.22	11.26	10.60
Average	98.63	1.37	99.29	3.92	8.21	12.35	11.64

Upper Freeport Seam							
Box-Behnken Tests							
	Column	Column	Column	Column	Column	Column	Column
	Product	Reject	Energy	Ash	Sulfur	Pyritic	Separate
Test	Yield	Yield	Recovery	Rejection	Rejection	Rejection	Efficiency
Number	(%)	(%)	(%)	(%)	(%)	(%)	(%)
93100606	34.50	65.50	39.02	84.89	70.75	76.42	15.44
93100607	89.77	10.23	95.78	35.81	14.30	21.71	17.50
93100608	84.44	15.56	92.85	48.11	23.46	33.59	26.43
93100609	80.48	19.52	87.71	52.89	30.53	42.60	30.32
93100610	49.17	50.83	55.50	79.25	57.36	64.25	19.75
93100611	83.56	16.44	91.28	50.03	26.48	36.54	27.82
93100612	40.16	59.84	45.58	82.98	65.04	71.29	16.88
93100613	53.12	46.88	60.31	75.33	56.78	64.50	24.81
93100614	80.55	19.45	87.97	49.02	25.54	32.75	20.72
93100615	75.38	24.62	82.52	56.63	34.65	44.99	27.51
93100616	69.13	30.87	76.89	62.77	37.89	46.92	23.81
93100617	71.24	28.76	78.59	59.40	37.34	36.68	15.27
93100618	54.12	45.88	61.35	77.44	56.78	61.69	23.04
93100619	81.93	18.07	90.27	47.70	24.97	30.03	20.30
93100620	80.31	19.69	88.85	53.18	24.45	33.54	22.39
93100620	81.58	18.42	89.19	51.31	26.22	38.04	27.22
93100620	71.15	28.85	78.30	59.73	32.57	41.51	19.81
93100620	79.89	20.11	87.83	53.26	25.05	33.33	21.16
93100620	70.48	29.52	81.06	69.93	39.41	53.78	34.85
93100620	80.97	19.03	88.83	52.22	25.37	35.32	24.15
93100620	80.48	19.52	89.41	52.09	24.48	34.54	23.95
Average	71.07	28.93	78.53	59.71	36.16	44.48	23.01

UPPER FREEPORT SEAM 24-HOUR GRIND RESULTS

UPPER FREEPORT SEAM 24–HOUR RUN DATA: MICROTRAC OF MILL CIRCUIT FEED

Shift >	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
Microns																	
296.0	70.8	70.6	65.4	75.2	72.0			69.9	67.3		73.0	74.6	100.0	100.0	68.8	100.0	100.0
209.3	54.6	52.7	47.5	61.3	56.3			53.7	52.1		55.8	59.5	77.7	75.9	50.5	79.7	77.7
148.0	41.8	37.2	34.5	49.3	43.3			40.7	40.9		41.2	46.1	58.4	55.7	35.8	60.1	59.0
104.7	33.0	25.6	25.9	40.2	33.8			31.6	32.7		30.9	35.7	44.1	41.7	26.1	44.3	45.3
74.0	26.5	17.1	19.5	32.6	26.4			24.8	26.1		23.1	27.6	33.6	31.6	19.4	32.2	35.0
52.3	21.6	11.2	14.7	25.9	20.5			19.2	20.8		17.1	21.0	25.4	23.6	14.4	22.6	26.8
37.0	17.8	6.9	11.2	20.1	15.5			14.8	16.1		12.5	15.6	18.9	17.2	10.5	15.6	20.0
26.2	14.5	4.3	8.4	15.4	11.6			11.3	12.3		9.1	11.6	13.9	12.8	7.6	11.2	14.8
18.5	11.4	2.7	6.1	11.6	8.7			8.6	9.4		6.6	8.5	10.1	9.7	5.5	8.0	10.6
13.1	8.4	1.3	3.9	8.0	5.8			5.9	6.5		4.2	5.4	6.4	6.4	3.5	5.1	6.8
9.3	5.9	0.6	2.3	5.1	3.7			3.7	4.1		2.4	3.1	3.6	3.8	1.9	3.1	4.0
6.5	4.1	0.3	1.3	3.3	2.4			2.3	2.5		1.4	1.7	2.0	2.1	1.0	1.9	2.2
4.6	2.5	0.1	0.3	1.5	1.2			1.1	1.2		0.5	0.6	0.6	0.8	0.3	0.7	0.8
3.3	1.2	0.0	0.0	0.5	0.4			0.3	0.4		0.0	0.0	0.0	0.1	0.0	0.1	0.1
dv	0.094	0.139	0.123	0.127	0.129			0.137	0.117		0.164	0.131	0.141	0.119	0.129	0.121	0.114
05%	7.9	29.7	15.7	9.0	11.7			11.5	10.8		14.8	12.5	11.3	11.1	17.0	12.9	10.7
50%	187.2	198.1	221.0	151.4	179.6			191.5	197.8		184.8	165.2	122.7	130.5	207.3	119.8	119.5
95%	508.7	515.0	536.9	504.3	518.3			532.2	547.4		506.7	502.8	273.9	275.8	509.2	270.7	274.4
mv	210.1	225.2	238.0	189.8	208.5			218.1	224.0		210.3	198.3	129.3	134.2	227.0	128.3	127.6

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UPPER FREEPORT SEAM 24–HOUR RUN DATA: MICROTRAC OF MILL CIRCUIT FEED

Shift >	18	19	20	21	22	23	24	25	26	27	28	29	30	avg	max	min	std
Microns																	
296.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0			100.0	100.0	100	88.3	100.0	65.4	14.4
209.3	74.9	75.0	76.6	75.8	81.4	76.2	83.0	79.3			80.7	75.8	73.2	68.3	83.0	47.5	11.8
148.0	53.1	53.2	57.1	54.7	64.2	56.8	65.4	60.7			62.8	53.1	50.8	51.0	65.4	34.5	9.2
104.7	37.9	38.4	42.9	39.8	51.0	43.3	49.7	46.4			48.7	36.3	34	38.4	51.0	25.6	7.3
74.0	27.2	27.5	32.7	29.3	40.6	33.4	36.8	35.5			38.0	23.8	22	28.9	40.6	17.1	6.1
52.3	19.5	19.2	24.9	21.2	31.9	25.2	26.9	26.9			29.5	15.1	14	21.6	31.9	11.2	5.1
37.0	13.9	13.6	18.6	14.7	24.4	18.9	19.3	20.5			22.5	9.7	8.59	15.9	24.4	6.9	4.3
26.2	10.2	9.9	13.7	10.5	18.5	14.4	14.1	15.9			17.5	6.1	5.36	11.8	18.5	4.3	3.6
18.5	7.5	7.0	10.1	7.5	13.8	10.6	10.2	12.1			13.5	3.9	3.34	8.7	13.8	2.7	2.9
13.1	4.8	4.3	6.5	4.4	9.2	7.0	6.5	8.2			9.1	2.1	1.65	5.6	9.2	1.3	2.1
9.3	2.8	2.5	3.8	2.3	5.7	4.1	3.8	5.1			5.8	0.9	0.6	3.4	5.9	0.6	1.5
6.5	1.7	1.4	2.2	1.2	3.5	2.4	2.2	3.0			3.6	0.5	0.21	2.0	4.1	0.2	1.0
4.6	0.5	0.4	0.9	0.3	1.5	1.0	0.9	1.2			1.6	0.2	0.06	0.8	2.5	0.1	0.6
3.3	0.0	0.0	0.1	0.0	0.3	0.1	0.1	0.1			0.4	0.0	0	0.2	1.2	0.0	0.3
dv	0.112	0.126	0.138	0.186	0.139	0.145	0.143	0.14			0.14	0.14	0.21	0.136	0.207	0.094	0.023
05%	13.5	14.4	11.1	14.0	8.3	10.5	11.1	9.16			8.27	22.5	24.8	13.4	29.7	7.9	5.2
50%	139.2	138.7	126.6	134.5	101.4	126.4	105.4	115			108	140	146	150.3	221.0	101.4	34.8
95%	275.9	275.6	275.4	275.4	268.5	275.8	265.5	272			270	275	278	371.3	547.4	265.5	120.3
mv	140.3	140.2	131.7	137.3	116.0	131.6	118.0	124			120	143	149	164.8	238.0	116.0	42.5

UPPER FREEPORT SEAM 24–HOUR RUN DATA: MICROTRAC OF COLUMN FLOTATION FEED

Shift >	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
Microns																	
296.0	100.0	100.0	99.9	99.6	99.2	100.0	99.7	100.0	100.0	100.0	99.0	99.9	100.0	100.0	100.0	100.0	100.0
209.3	99.4	99.2	99.3	98.3	97.3	99.1	97.8	99.3	99.8	99.6	96.0	99.0	99.3	99.4	99.4	98.6	96.1
148.0	97.9	95.9	97.3	95.9	94.0	97.4	95.0	97.9	98.6	98.7	91.6	96.4	97.1	96.9	97.0	95.5	91.1
104.7	95.1	89.1	93.1	92.5	89.0	94.3	91.6	95.3	95.5	96.8	86.5	91.5	92.4	91.0	92.7	90.7	85.3
74.0	88.0	76.7	84.4	85.8	79.5	87.5	84.9	89.3	88.4	91.4	78.1	82.4	83.2	79.7	84.5	81.4	76.3
52.3	76.7	60.9	72.1	74.7	65.9	76.9	74.4	79.4	77.2	82.0	66.5	69.5	70.9	64.1	72.4	68.9	64.5
37.0	63.3	45.5	58.8	61.6	51.2	64.0	61.8	66.4	63.9	69.6	53.9	55.4	57.4	48.3	59.2	55.6	51.8
26.2	51.3	33.9	46.7	49.6	38.7	51.7	49.8	53.6	51.4	57.0	42.6	43.5	45.6	35.9	47.5	43.7	40.7
18.5	41.2	25.7	36.5	39.2	29.2	40.7	39.4	42.8	40.5	45.5	32.9	33.9	35.9	27.0	37.5	33.9	31.6
13.1	31.1	18.5	26.9	29.0	20.7	29.7	29.3	32.1	30.0	33.9	23.6	24.7	26.5	19.2	27.7	24.6	22.8
9.3	22.9	13.0	19.3	21.0	14.2	20.8	21.1	23.3	21.4	24.4	16.2	17.3	18.8	13.2	19.8	17.3	15.8
6.5	16.9	9.3	14.0	15.3	9.8	14.6	15.2	17.0	15.2	17.4	11.2	12.2	13.4	9.3	14.2	12.3	11.0
4.6	11.4	6.0	9.2	10.0	6.1	9.2	9.8	11.3	9.8	11.1	7.0	7.7	8.7	5.8	9.1	7.7	6.9
3.3	7.2	3.6	5.7	6.1	3.5	5.3	5.9	7.1	5.9	6.6	3.9	4.5	5.2	3.3	5.4	4.5	4.0
dv	0.129	0.222	0.166	0.181	0.192	0.148	0.193	0.152	0.163	0.180	0.168	0.151	0.170	0.173	0.149	0.150	0.199
05%	2.5	4.1	3.0	2.8	4.1	3.1	2.9	2.5	2.9	2.7	3.8	3.6	3.2	4.3	3.1	3.5	3.8
50%	25.1	41.1	29.1	26.5	35.9	24.8	26.4	23.4	25.1	21.2	33.2	32.0	30.1	38.5	28.4	31.8	35.2
95%	103.9	138.5	119.9	133.4	163.8	110.7	148.5	102.1	100.9	89.7	194.2	130.4	121.9	128.7	122.4	140.8	194.6
mv	36.1	51.2	40.9	41.1	51.6	37.2	42.2	34.5	35.3	31.3	53.8	44.3	42.0	48.0	40.6	45.5	55.0

UPPER FREEPORT SEAM 24–HOUR RUN DATA: MICROTRAC OF COLUMN FLOTATION FEED

Shift >	18	19	20	21	22	23	24	25	26	27	28	29	30	avg	max	min	std
Microns																	
296.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100	99.9	100.0	99.0	0.2
209.3	98.0	99.0	97.4	98.6	98.6	97.9	98.6	98.1	99.3	97.7	97.9	98.1	96.4	98.4	99.8	96.0	1.0
148.0	95.3	96.8	93.7	96.0	95.9	94.8	95.8	95.3	97.0	93.7	94.1	93.6	90.1	95.5	98.7	90.1	2.1
104.7	91.7	93.2	89.1	91.3	91.8	90.3	91.6	91.1	93.0	87.9	88.0	86.2	83.1	91.0	96.8	83.1	3.1
74.0	84.7	85.8	81.4	82.3	83.9	82.3	83.2	83.3	85.2	78.0	77.5	74.8	73.6	82.6	91.4	73.6	4.3
52.3	74.1	74.2	70.1	69.5	72.2	71.0	70.8	72.1	73.3	64.8	63.7	60.6	61.7	70.5	82.0	60.6	5.4
37.0	61.3	60.6	57.1	55.2	58.5	58.0	57.3	59.3	59.2	51.2	49.5	46.8	49.6	57.0	69.6	45.5	5.8
26.2	49.3	48.3	45.5	43.0	46.2	46.1	45.4	47.5	46.8	39.6	38.1	36.2	39	45.1	57.0	33.9	5.5
18.5	39.0	38.2	35.5	33.2	35.9	35.9	35.6	37.5	36.5	30.4	29.2	28.1	30.3	35.3	45.5	25.7	4.8
13.1	29.0	28.3	25.8	24.1	26.0	26.1	26.2	27.7	26.6	21.9	20.8	20.5	22.2	25.8	33.9	18.5	3.8
9.3	20.8	20.3	18.2	16.8	18.1	18.2	18.6	19.8	18.7	15.1	14.2	14.4	15.8	18.3	24.4	13.0	3.0
6.5	15.1	14.8	12.8	11.8	12.7	12.8	13.2	14.1	13.3	10.5	9.9	10.3	11.4	13.0	17.4	9.3	2.3
4.6	9.9	9.7	8.1	7.4	8.0	8.1	8.3	9.1	8.5	6.5	6.0	6.5	7.31	8.3	11.4	5.8	1.6
3.3	6.0	6.0	4.8	4.2	4.6	4.7	4.8	5.4	5.1	3.7	3.4	3.8	4.38	4.9	7.2	3.3	1.1
dv	0.167	0.166	0.161	0.174	0.164	0.151	0.158	0.17	0.15	0.17	0.16	0.16	0.17	0.167	0.222	0.129	0.018
05%	2.8	2.9	3.4	3.7	3.5	3.4	3.4	3.07	3.25	3.99	4.19	3.97	3.6	3.4	4.3	2.5	0.5
50%	26.8	27.6	30.3	32.4	29.5	29.7	30.3	28.4	28.9	35.9	37.4	40.3	37.5	30.8	41.1	21.2	5.0
95%	142.0	121.4	167.0	134.7	134.2	152.0	136.0	143	121	165	160	162	194	139.2	194.6	89.7	26.8
mv	41.9	39.8	47.2	44.9	42.9	45.2	43.6	43.5	40.5	51.3	51.6	54.3	57.7	44.5	57.7	31.3	6.5

UPPER FREEPORT SEAM
24-HOUR DEMONSTRATION RUN RESULTS

Upper Freeport Seam
Long Duration Tests

Test Number	Goodness–of–Fit		
	Ash	Other	Total
93110801	0.72	2.38	3.10
93110802	18.46	14.92	33.38
93110803	1.30	3.00	4.30
93110804	1.18	2.01	3.19
93110805	2.41	8.49	10.90
93110806	3.12	5.70	8.82
93110807	1.71	4.34	6.05
93110808	2.73	1.54	4.27
93110809	1.73	1.70	3.43
93110810	2.53	11.45	13.98
93110811	2.83	2.22	5.05
93110812	2.41	2.57	4.98
93110813	3.78	6.10	9.88
93110814	3.13	4.84	7.97
93110815	1.10	1.61	2.71
93110816	2.69	1.88	4.57
93110817	1.30	2.76	4.06
93110818	3.67	2.17	5.84
93110819	4.80	2.98	7.78
93110820	11.64	7.16	18.80
93110821	3.94	3.49	7.43
93110822	9.57	6.35	15.92
93110823	4.66	4.36	9.02
93110824	4.97	4.78	9.75
93110825	5.36	3.83	9.19
93110826	18.48	11.34	29.82
93110827	4.09	8.85	12.94
93110828	2.37	3.34	5.71
93110830	3.34	6.18	9.52
Average	4.5	4.9	9.4

Upper Freeport Seam
Long Duration Tests

Test Number	Relative Plant Feed (%)	Relative Deslime U/F (%)	Relative HMC Reject (%)	Relative WOC O/F (%)	Relative WOC U/F (%)	Relative Column Feed (%)	Relative Column Product (%)	Relative Column Reject (%)	Rel. Thicl Fe (%
93110801	100.00	89.16	10.84	87.47	1.68	87.47	69.52	17.95	1
93110802	100.00	87.61	12.39	86.61	1.00	86.61	70.41	16.20	1
93110803	100.00	88.71	11.29	87.23	1.48	87.23	66.58	20.65	2
93110804	100.00	90.52	9.48	89.06	1.46	89.06	71.07	17.99	1
93110805	100.00	92.97	7.03	91.66	1.31	91.66	73.73	17.93	1
93110806	100.00	89.10	10.90	87.08	2.03	87.08	71.05	16.03	1
93110807	100.00	90.40	9.60	89.91	0.49	89.91	71.98	17.93	1
93110808	100.00	90.46	9.54	89.63	0.82	89.63	71.05	18.58	1
93110809	100.00	91.41	8.59	89.72	1.69	89.72	74.39	15.33	1
93110810	100.00	91.40	8.60	88.74	2.66	88.74	73.49	15.24	1
93110811	100.00	91.43	8.57	88.81	2.62	88.81	69.59	19.22	2
93110812	100.00	92.43	7.57	90.59	1.85	90.59	75.01	15.58	1
93110813	100.00	90.28	9.72	89.84	0.44	89.84	71.07	18.77	1
93110814	100.00	89.84	10.16	88.42	1.42	88.42	69.78	18.65	2
93110815	100.00	91.65	8.35	89.52	2.13	89.52	74.41	15.10	1
93110816	100.00	88.93	11.07	87.33	1.60	87.33	72.04	15.28	1
93110817	100.00	89.07	10.93	87.71	1.36	87.71	72.89	14.82	1
93110818	100.00	89.66	10.34	88.06	1.59	88.06	74.13	13.93	1
93110819	100.00	93.67	6.33	91.56	2.11	91.56	75.67	15.88	1
93110820	100.00	92.53	7.47	90.73	1.80	90.73	71.58	19.14	2
93110821	100.00	90.51	9.49	88.81	1.71	88.81	72.79	16.02	1
93110822	100.00	91.69	8.31	89.58	2.12	89.58	72.51	17.07	1
93110823	100.00	90.68	9.32	88.53	2.15	88.53	71.46	17.07	1
93110824	100.00	89.98	10.02	88.46	1.52	88.46	70.68	17.78	1
93110825	100.00	92.27	7.73	90.93	1.34	90.93	73.01	17.92	1
93110826	100.00	94.05	5.95	92.32	1.73	92.32	70.50	21.83	2
93110827	100.00	92.33	7.67	90.56	1.76	90.56	69.18	21.38	2
93110828	100.00	91.66	8.34	89.73	1.94	89.73	69.67	20.06	2
93110830	100.00	92.95	7.05	91.92	1.02	91.92	74.50	17.42	1

Average	100.0	90.9	9.1	89.3	1.6	89.3	71.9	17.5	1
Maximum	100.0	94.1	12.4	92.3	2.7	92.3	75.7	21.8	2
Minimum	100.0	87.6	6.0	86.6	0.4	86.6	66.6	13.9	1
Range	0.0	6.4	6.4	5.7	2.2	5.7	9.1	7.9	
Std.Deviation	0.0	1.6	1.6	1.5	0.5	1.5	2.1	2.0	
# of Points	29	29	29	29	29	29	29	29	

Upper Freeport Seam
Long Duration Tests

Test Number	Measured Plant Feed Ash (%)	Adjusted Plant Feed Ash (%)	Measured Deslime U/F Ash (%)	Adjusted Deslime U/F Ash (%)	Measured HMC Reject Ash (%)	Adjusted HMC Reject Ash (%)	Measured WOC O/F Ash (%)	Adjusted WOC O/F Ash (%)	Measured WOC U/F Ash (%)	Adjusted WOC U/F Ash (%)
93110801	26.00	25.73	19.96	20.20	71.01	71.23	19.70	19.54	54.17	54.02
93110802	23.92	25.37	19.09	19.33	69.59	68.07	17.55	18.94	54.21	53.85
93110803	23.57	24.29	18.97	18.61	69.55	68.84	17.68	18.08	50.32	50.26
93110804	23.20	23.44	18.45	19.15	64.57	64.39	19.03	18.64	50.61	50.45
93110805	23.21	23.59	19.57	20.38	66.28	66.06	21.06	19.93	52.12	51.93
93110806	24.23	24.19	20.38	19.37	63.54	63.57	18.11	18.48	57.51	57.42
93110807	22.97	23.53	19.74	19.13	65.39	64.96	18.69	18.96	51.06	51.03
93110808	24.05	23.69	19.08	19.17	66.21	66.47	18.90	18.86	53.38	53.25
93110809	23.54	23.54	19.21	19.46	66.94	66.94	18.95	18.87	50.77	50.53
93110810	23.52	23.59	20.42	19.43	67.80	67.75	18.06	18.44	52.64	52.55
93110811	24.60	24.62	20.86	20.57	67.86	67.85	18.48	19.54	55.67	55.51
93110812	23.48	23.34	19.43	19.59	69.06	69.15	18.99	18.90	54.01	53.70
93110813	23.68	24.21	19.36	19.32	70.06	69.61	19.05	19.15	55.12	55.04
93110814	25.18	25.42	20.06	20.53	68.89	68.71	19.24	19.99	54.23	54.05
93110815	23.54	23.36	19.66	19.17	69.23	69.36	17.88	18.32	55.01	54.95
93110816	24.92	24.49	18.82	18.93	68.81	69.17	17.80	18.27	55.07	54.81
93110817	23.90	24.26	19.28	19.00	67.50	67.18	18.32	18.48	52.63	52.49
93110818	23.63	23.36	18.43	18.27	67.27	67.50	16.96	17.64	53.10	52.83
93110819	22.64	22.54	19.58	19.34	69.96	70.02	17.97	18.56	53.18	52.76
93110820	23.34	23.19	19.18	19.57	67.98	68.07	18.66	18.95	51.27	50.70
93110821	22.96	23.37	18.53	18.75	67.80	67.46	17.77	18.10	52.87	52.50
93110822	23.51	23.46	19.58	19.55	66.51	66.55	17.64	18.78	52.75	52.25
93110823	25.27	24.86	20.30	20.38	68.28	68.56	19.25	19.67	49.56	49.21
93110824	24.69	24.84	19.67	20.05	68.00	67.88	19.31	19.48	53.33	52.97
93110825	24.03	24.12	19.87	20.44	68.01	67.96	19.54	19.97	52.76	52.47
93110826	25.02	24.36	20.70	21.51	69.17	69.47	19.75	20.97	50.41	49.94
93110827	25.92	25.89	22.07	22.29	69.15	69.17	21.76	21.67	54.64	54.35
93110828	26.11	26.30	23.07	22.46	68.66	68.55	21.26	21.78	54.04	53.90
93110830	24.03	24.20	20.77	21.10	65.25	65.16	20.74	20.73	53.88	53.68

Average	24.09	24.18	19.80	19.83	67.87	67.78	18.90	19.23	53.11	52.88
Maximum	26.11	26.30	23.07	22.46	71.01	71.23	21.76	21.78	57.51	57.42
Minimum	22.64	22.54	18.43	18.27	63.54	63.57	16.96	17.64	49.56	49.21
Range	3.47	3.76	4.64	4.19	7.47	7.66	4.80	4.14	7.95	8.21
Std.Deviation	0.93	0.89	1.01	1.01	1.72	1.72	1.16	1.02	1.80	1.85
# of Points	29	29	29	29	29	29	29	29	29	29

Upper Freeport Seam
Long Duration Tests

Test Number	Measured Column Feed Ash (%)	Adjusted Column Feed Ash (%)	Measured Column Product Ash (%)	Adjusted Column Product Ash (%)	Measured Column Reject Ash (%)	Adjusted Column Reject Ash (%)	Measured Thickener Feed Ash (%)	Adju Thicl Fe A (%
93110801	19.71	19.54	10.16	10.21	56.95	55.71	53.95	
93110802	21.99	18.94	10.99	10.89	59.90	53.90	49.98	
93110803	18.07	18.08	7.66	7.60	53.64	51.88	51.02	
93110804	18.99	18.64	9.60	9.57	55.55	54.47	53.34	
93110805	19.90	19.93	11.75	11.72	55.03	53.66	52.35	
93110806	17.86	18.48	10.34	10.28	57.43	54.82	52.99	
93110807	18.87	18.96	10.09	10.06	56.83	54.67	52.89	
93110808	18.89	18.86	9.23	9.27	58.84	55.54	52.40	
93110809	19.01	18.87	10.95	10.94	60.07	57.35	54.24	
93110810	17.94	18.44	10.50	10.45	59.22	56.95	54.36	
93110811	20.27	19.54	10.11	10.05	55.94	53.88	52.50	
93110812	18.78	18.39	10.95	10.92	60.64	57.28	54.06	
93110813	18.98	19.15	9.18	9.08	62.03	57.24	54.35	
93110814	21.23	19.99	10.07	10.01	59.59	57.35	55.55	
93110815	18.18	18.32	10.34	10.31	59.37	57.77	55.97	5
93110816	18.71	18.27	10.52	10.53	57.64	54.76	52.11	5
93110817	18.48	18.48	10.58	10.56	59.69	57.42	55.05	5
93110818	18.13	17.64	10.54	10.54	58.79	55.41	52.16	5
93110819	18.93	18.56	11.17	11.17	58.01	53.80	50.12	5
93110820	19.81	18.95	10.12	10.17	58.84	51.80	46.59	5
93110821	18.96	18.10	9.95	9.95	58.61	55.14	51.86	5
93110822	20.28	18.78	10.41	10.42	59.38	54.29	49.94	5
93110823	19.92	19.67	10.85	10.84	61.29	56.67	52.15	5
93110824	20.18	19.48	10.37	10.38	60.23	55.70	51.81	5
93110825	21.04	19.97	10.52	10.49	63.21	58.60	54.66	5
93110826	23.24	20.97	10.40	10.41	63.54	55.08	49.14	5
93110827	21.58	21.67	10.19	10.16	63.75	58.90	54.96	5
93110828	21.72	21.78	10.30	10.27	65.06	61.76	58.47	6
93110830	21.01	20.73	11.32	11.28	65.56	61.16	57.42	6
Average	19.68	19.21	10.32	10.29	59.47	55.96	52.98	5
Maximum	23.24	21.78	11.75	11.72	65.56	61.76	58.47	6
Minimum	17.86	17.64	7.66	7.60	53.64	51.80	46.59	51
Range	5.38	4.14	4.09	4.12	11.92	9.96	11.88	
Std.Deviation	1.36	1.03	0.74	0.75	2.85	2.31	2.46	
# of Points	29	29	29	29	29	29	29	

Upper Freeport Seam
Long Duration Tests

Test Number	Measured Plant Feed Sulfur (%)	Adjusted Plant Feed Sulfur (%)	Measured Deslime U/F Sulfur (%)	Adjusted Deslime U/F Sulfur (%)	Measured HMC Reject Sulfur (%)	Adjusted HMC Reject Sulfur (%)	Measured WOC O/F Sulfur (%)	Adjusted WOC O/F Sulfur (%)	Measured WOC U/F Sulfur (%)	Adjusted WOC U/F Sulfur (%)
93110801	4.34	4.30	2.50	2.64	17.90	17.97	2.28	2.35	17.95	18.05
93110802	4.52	4.96	3.32	2.90	20.70	19.56	2.74	2.74	16.50	16.36
93110803	4.79	4.71	2.91	2.69	20.42	20.59	2.65	2.45	16.66	16.58
93110804	4.46	4.32	2.71	2.74	19.11	19.36	2.69	2.54	15.37	15.47
93110805	4.45	4.33	2.80	3.00	21.72	21.92	3.48	2.79	17.57	17.69
93110806	4.93	4.96	3.25	2.91	21.83	21.76	2.68	2.57	17.73	17.49
93110807	4.44	4.57	2.95	2.67	22.79	22.46	2.71	2.58	18.21	18.16
93110808	4.67	4.75	2.91	2.94	22.04	21.88	2.68	2.78	20.75	20.73
93110809	4.36	4.33	2.75	2.83	20.19	20.25	2.71	2.56	17.09	17.02
93110810	4.41	4.35	3.11	2.81	20.68	20.79	2.47	2.39	17.27	16.72
93110811	5.06	5.03	3.43	3.51	21.12	21.17	3.14	2.98	21.68	21.75
93110812	4.02	4.17	3.19	2.99	18.90	18.65	2.69	2.68	18.22	18.14
93110813	4.38	4.19	3.00	2.76	17.25	17.53	2.73	2.68	19.09	19.08
93110814	4.67	4.53	3.06	3.03	17.56	17.76	2.71	2.79	17.96	18.00
93110815	4.38	4.44	3.24	3.06	19.71	19.61	2.70	2.71	17.82	17.65
93110816	4.68	4.77	2.90	2.88	20.12	19.94	2.65	2.60	18.12	18.14
93110817	4.53	4.51	2.90	2.86	17.98	18.01	2.61	2.61	18.86	18.81
93110818	4.45	4.56	2.87	2.89	19.25	19.04	2.66	2.61	18.60	18.41
93110819	4.03	4.07	3.05	3.10	18.54	18.48	2.77	2.75	18.56	18.42
93110820	4.21	4.33	3.09	3.11	19.67	19.47	2.84	2.80	18.85	18.80
93110821	4.80	4.47	2.84	2.97	18.28	18.74	2.66	2.65	19.50	19.70
93110822	4.36	4.38	3.03	3.10	18.60	18.57	2.53	2.70	19.82	19.88
93110823	4.41	4.46	3.02	3.02	18.55	18.47	2.84	2.67	17.71	17.61
93110824	4.86	4.57	2.84	2.92	18.96	19.40	2.80	2.69	16.26	16.43
93110825	3.87	3.86	3.03	2.91	15.13	15.15	2.69	2.73	14.92	14.88
93110826	3.96	3.90	2.94	3.06	17.21	17.27	2.74	2.81	16.44	16.36
93110827	4.00	4.16	3.08	3.14	16.67	16.46	2.97	2.84	18.77	18.74
93110828	4.36	4.20	3.11	3.12	15.92	16.10	2.85	2.77	19.26	19.26
93110830	3.79	3.63	2.96	2.81	14.40	14.56	2.91	2.68	14.49	14.50

Average	4.42	4.41	2.99	2.94	19.01	19.00	2.74	2.67	17.93	17.89
Maximum	5.06	5.03	3.43	3.51	22.79	22.46	3.48	2.98	21.68	21.75
Minimum	3.79	3.63	2.50	2.64	14.40	14.56	2.28	2.35	14.49	14.50
Range	1.27	1.40	0.93	0.87	8.39	7.90	1.20	0.63	7.19	7.25
Std.Deviation	0.31	0.32	0.19	0.17	2.01	1.94	0.21	0.13	1.58	1.60
# of Points	29	29	29	29	29	29	29	29	29	29

Upper Freeport Seam
Long Duration Tests

Test Number	Measured Column Feed Sulfur (%)	Adjusted Column Feed Sulfur (%)	Measured Column Product Sulfur (%)	Adjusted Column Product Sulfur (%)	Measured Column Reject Sulfur (%)	Adjusted Column Reject Sulfur (%)	Measured Thickener Feed Sulfur (%)	Adju Thick Fe Sul (%
93110801	2.40	2.35	2.25	2.15	3.07	3.10	4.55	
93110802	3.15	2.74	2.32	2.59	3.42	3.41	3.96	
93110803	2.43	2.45	1.76	1.89	4.24	4.27	4.82	
93110804	2.50	2.54	2.10	2.16	3.88	4.01	5.00	
93110805	1.69	1.75	2.28	2.39	4.15	4.40	5.62	
93110806	2.31	2.57	2.19	2.18	4.54	4.29	5.39	
93110807	2.44	2.58	2.07	2.14	4.54	4.39	4.52	
93110808	2.82	2.78	2.22	2.17	5.18	5.11	5.78	
93110809	2.48	2.56	2.26	2.25	4.11	4.09	5.36	
93110810	2.10	2.39	2.13	2.06	4.37	3.99	5.34	
93110811	3.13	2.98	2.37	2.49	4.57	4.74	6.91	
93110812	2.60	2.68	2.31	2.32	4.49	4.41	5.72	
93110813	2.65	2.68	2.03	2.16	4.67	4.65	4.78	
93110814	3.24	2.79	2.21	2.37	4.23	4.38	5.34	
93110815	2.64	2.71	2.28	2.29	4.90	4.76	6.10	
93110816	2.52	2.60	2.31	2.29	4.06	4.06	5.41	
93110817	2.56	2.61	2.26	2.25	4.40	4.35	5.48	
93110818	2.57	2.61	2.33	2.31	4.26	4.18	5.52	
93110819	2.79	2.75	2.42	2.43	4.30	4.27	5.87	
93110820	2.83	2.80	2.24	2.24	4.87	4.88	6.08	
93110821	2.68	2.65	2.23	2.24	4.43	4.55	6.25	
93110822	2.89	2.70	2.31	2.26	4.59	4.60	6.41	
93110823	2.54	2.67	2.37	2.36	3.98	3.95	5.41	
93110824	2.65	2.69	2.28	2.32	3.97	4.12	5.32	
93110825	2.79	2.73	2.36	2.43	4.03	3.99	4.63	
93110826	3.06	2.81	2.40	2.43	4.02	4.03	4.90	
93110827	3.44	2.84	2.28	2.48	3.77	3.98	5.17	
93110828	2.85	2.77	2.33	2.44	3.85	3.91	5.22	
93110830	2.51	2.68	2.37	2.50	3.41	3.42	3.96	

Average	2.66	2.64	2.25	2.30	4.22	4.22	5.34	
Maximum	3.44	2.98	2.42	2.59	5.18	5.11	6.91	
Minimum	1.69	1.75	1.76	1.89	3.07	3.10	3.96	
Range	1.75	1.23	0.66	0.70	2.11	2.01	2.95	
Std.Deviation	0.34	0.21	0.13	0.15	0.45	0.43	0.67	
# of Points	29	29	29	29	29	29	29	

Upper Freeport Seam
Long Duration Tests

Test Number	Measured Plant Feed Pyritic (%)	Adjusted Plant Feed Pyritic (%)	Measured Deslime U/F Pyritic (%)	Adjusted Deslime U/F Pyritic (%)	Measured HMC Reject Pyritic (%)	Adjusted HMC Reject Pyritic (%)	Measured WOC O/F Pyritic (%)	Adjusted WOC O/F Pyritic (%)	Measured WOC U/F Pyritic (%)	Adjusted WOC U/F Pyritic (%)
93110801	3.11	3.09	1.46	1.52	15.93	15.98	1.07	1.25	15.92	15.82
93110802	2.97	3.37	1.99	1.57	17.83	16.06	1.38	1.41	15.83	15.80
93110803	3.40	3.55	1.71	1.55	19.84	19.27	1.39	1.32	15.07	14.87
93110804	3.09	3.14	1.51	1.54	18.52	18.36	1.55	1.33	14.72	14.69
93110805	3.33	3.27	1.80	1.94	20.75	20.90	2.44	1.75	15.67	15.73
93110806	3.81	3.80	2.00	1.74	20.70	20.72	1.50	1.40	16.34	16.13
93110807	3.39	3.53	1.89	1.61	22.19	21.62	1.57	1.52	16.78	16.84
93110808	3.38	3.51	1.75	1.76	20.54	20.09	1.48	1.62	17.24	17.25
93110809	3.00	3.15	1.91	1.78	18.29	17.80	1.65	1.52	15.28	15.32
93110810	3.19	3.25	2.41	1.73	19.53	19.34	1.55	1.33	14.94	15.20
93110811	3.64	3.68	2.21	2.18	19.87	19.76	1.84	1.69	18.94	18.54
93110812	3.06	3.13	2.13	1.94	17.83	17.66	1.70	1.64	16.28	16.32
93110813	3.22	3.04	1.92	1.58	16.17	16.60	1.69	1.51	16.00	15.98
93110814	3.35	3.38	1.90	1.84	17.00	16.93	1.59	1.62	15.65	15.72
93110815	3.28	3.32	1.94	1.91	18.83	18.73	1.73	1.57	16.37	16.20
93110816	3.52	3.73	1.83	1.84	19.71	18.97	1.68	1.57	16.78	16.60
93110817	2.96	3.34	1.86	1.84	17.30	15.88	1.75	1.59	16.11	15.88
93110818	3.37	3.39	1.87	1.78	17.47	17.40	1.46	1.53	15.52	15.77
93110819	2.93	2.95	1.99	2.01	16.88	16.85	1.71	1.70	15.24	15.40
93110820	3.01	2.84	1.79	1.82	15.10	15.43	1.60	1.57	14.27	14.47
93110821	3.06	3.22	1.83	1.85	16.67	16.23	1.66	1.59	16.01	15.52
93110822	3.32	3.32	1.99	2.01	17.80	17.80	1.60	1.68	16.44	16.08
93110823	3.04	3.26	1.95	1.89	17.21	16.55	1.86	1.60	14.28	13.93
93110824	3.00	3.27	1.64	1.71	18.20	17.22	1.62	1.48	15.57	15.16
93110825	2.70	2.66	1.81	1.70	13.93	14.02	1.49	1.52	14.17	14.20
93110826	2.15	2.52	1.68	1.76	15.74	14.56	1.54	1.55	12.75	12.73
93110827	2.62	2.77	2.02	1.86	14.06	13.73	1.72	1.60	15.28	15.22
93110828	2.77	2.91	1.95	1.89	14.39	14.08	1.67	1.59	16.43	15.89
93110830	2.19	2.31	1.73	1.57	12.33	12.07	1.67	1.44	12.74	12.58

Average	3.10	3.20	1.88	1.78	17.61	17.26	1.63	1.53	15.61	15.51
Maximum	3.81	3.80	2.41	2.18	22.19	21.62	2.44	1.75	18.94	18.54
Minimum	2.15	2.31	1.46	1.52	12.33	12.07	1.07	1.25	12.74	12.58
Range	1.66	1.49	0.95	0.66	9.86	9.55	1.37	0.50	6.20	5.96
Std.Deviation	0.36	0.34	0.19	0.16	2.29	2.29	0.22	0.12	1.23	1.19
# of Points	29	29	29	29	29	29	29	29	29	29

Upper Freeport Seam
Long Duration Tests

Test Number	Measured Column Feed Pyritic (%)	Adjusted Column Feed Pyritic (%)	Measured Column Product Pyritic (%)	Adjusted Column Product Pyritic (%)	Measured Column Reject Pyritic (%)	Adjusted Column Reject Pyritic (%)	Measured Thickener Feed Pyritic (%)	Adju Thicl Fe Py (%
93110801	1.46	1.25	1.03	0.96	2.45	2.36	3.53	
93110802	1.94	1.41	0.96	1.11	2.56	2.71	3.30	
93110803	1.39	1.32	0.61	0.64	3.46	3.51	3.91	
93110804	1.43	1.33	0.79	0.85	2.97	3.21	4.10	
93110805	1.69	1.75	1.22	1.29	3.36	3.61	4.70	
93110806	1.20	1.40	0.95	0.93	3.85	3.50	4.50	
93110807	1.43	1.52	0.95	0.98	3.67	3.70	3.96	
93110808	1.66	1.62	1.02	0.97	4.25	4.09	4.74	
93110809	1.43	1.52	1.15	1.17	3.21	3.23	4.39	
93110810	1.01	1.33	1.04	0.94	3.61	3.20	4.68	
93110811	1.88	1.69	1.04	1.12	3.59	3.75	5.25	
93110812	1.59	1.64	1.17	1.21	3.74	3.75	4.96	
93110813	1.56	1.51	0.71	0.78	4.05	4.28	4.11	
93110814	2.00	1.62	0.93	1.00	3.67	3.96	4.81	
93110815	1.43	1.57	1.09	1.08	4.16	4.03	5.37	
93110816	1.51	1.57	1.14	1.14	3.64	3.59	4.75	
93110817	1.69	1.59	1.15	1.22	3.30	3.36	4.29	
93110818	1.47	1.53	1.17	1.13	3.63	3.63	5.02	
93110819	1.72	1.70	1.24	1.25	3.75	3.85	5.41	
93110820	1.36	1.57	1.01	0.94	4.11	3.93	5.07	
93110821	1.69	1.59	1.02	1.05	4.16	4.03	4.78	
93110822	1.92	1.68	1.12	1.15	3.95	3.89	4.96	
93110823	1.55	1.60	1.14	1.19	3.38	3.34	4.27	
93110824	1.51	1.48	1.02	1.03	3.34	3.27	4.04	
93110825	1.64	1.52	1.05	1.11	3.12	3.20	3.87	
93110826	2.03	1.55	1.02	1.03	3.03	3.26	4.43	
93110827	1.64	1.60	1.02	1.08	3.19	3.29	4.06	
93110828	1.71	1.59	1.08	1.14	3.21	3.15	3.93	
93110830	1.40	1.44	1.08	1.16	2.69	2.65	2.98	
Average	1.58	1.53	1.03	1.06	3.49	3.49	4.42	
Maximum	2.03	1.75	1.24	1.29	4.25	4.28	5.41	
Minimum	1.01	1.25	0.61	0.64	2.45	2.36	2.98	
Range	1.02	0.50	0.63	0.65	1.80	1.92	2.43	
Std.Deviation	0.23	0.12	0.14	0.14	0.47	0.44	0.59	
# of Points	29	29	29	29	29	29	29	

Upper Freeport Seam
Long Duration Tests

Test Number	Measured Plant Feed Btu/lb	Adjusted Plant Feed Btu/lb	Measured Deslime U/F Btu/lb	Adjusted Deslime U/F Btu/lb	Measured HMC Reject Btu/lb	Adjusted HMC Reject Btu/lb	Measured WOC O/F Btu/lb	Adjusted WOC O/F Btu/lb	Measured WOC U/F Btu/lb	Adjusted WOC U/F Btu/lb
93110801	10790	10750	11850	11760	2470	2470	11830	11870	6040	6060
93110802	11020	10740	11990	11840	2930	2930	12210	11910	5730	5780
93110803	11190	10920	11980	11960	2730	2730	12080	12060	6510	6530
93110804	11090	11120	12150	11890	3840	3840	11990	11980	6410	6430
93110805	11230	11060	11590	11630	3480	3480	11500	11710	6250	6270
93110806	10920	11060	11720	11830	4780	4770	12020	11980	5210	5240
93110807	11240	11150	11740	11920	3910	3920	12030	11950	6360	6380
93110808	11250	11210	12020	11980	3900	3900	12030	12040	6150	6170
93110809	11210	11190	12040	11910	3420	3430	11980	12020	6370	6420
93110810	11240	11200	11620	11930	3440	3450	12090	12100	6240	6300
93110811	11090	11050	11730	11770	3380	3380	12110	11950	5700	5730
93110812	11210	11210	11970	11880	3000	3000	12030	12000	5780	5840
93110813	11200	11120	11890	11980	3110	3110	12030	12010	5510	5530
93110814	11110	10930	11920	11800	3200	3200	11850	11900	5660	5680
93110815	11230	11250	11930	11980	3210	3210	12200	12120	6090	6130
93110816	10900	10980	11910	11970	3080	3080	12100	12080	6030	6070
93110817	11170	11050	11970	12000	3350	3360	12100	12090	6160	6210
93110818	11080	11100	11840	12000	3320	3320	12270	12110	5820	5870
93110819	11150	11300	11870	11860	3060	3060	12200	11990	6000	6080
93110820	11260	11200	11990	11850	3210	3210	11950	11950	6440	6540
93110821	11270	11240	12080	12020	3780	3780	12190	12130	6110	6180
93110822	11190	11180	11820	11860	3650	3650	12200	12000	6010	6110
93110823	10820	10900	11750	11670	3330	3330	11770	11790	6660	6760
93110824	11050	10930	11840	11790	3260	3260	11910	11880	6010	6080
93110825	11110	11040	11860	11710	3050	3050	11790	11790	6190	6250
93110826	10950	11000	11760	11510	3010	3010	11870	11600	6570	6680
93110827	10840	10750	11450	11390	3050	3050	11430	11490	6020	6090
93110828	10900	10700	11350	11400	2960	2960	11540	11520	5970	6040
93110830	11050	11070	11580	11630	3620	3620	11780	11690	6020	6070

Average	11,095	11,048	11,835	11,818	3,329	3,330	11,968	11,921	6,070	6,121
Maximum	11,270	11,300	12,150	12,020	4,780	4,770	12,270	12,130	6,660	6,760
Minimum	10,790	10,700	11,350	11,390	2,470	2,470	11,430	11,490	5,210	5,240
Range	480	600	800	630	2,310	2,300	840	640	1,450	1,520
Std.Deviation	143	163	183	170	434	433	212	173	320	330
# of Points	29	29	29	29	29	29	29	29	29	29

Upper Freeport Seam
Long Duration Tests

Test Number	Measured Column Feed Btu/lb	Adjusted Column Feed Btu/lb	Measured Column Product Btu/lb	Adjusted Column Product Btu/lb	Measured Column Reject Btu/lb	Adjusted Column Reject Btu/lb	Measured Thickener Feed Btu/lb	Adju Thick Fe Btu
93110801	11900	11870	13320	13440	5640	5780	5970	
93110802	11440	11910	13200	13390	4910	5480	6570	
93110803	11940	12060	13620	13820	6190	6360	6560	
93110804	11950	11980	13350	13550	5590	5760	6010	
93110805	11650	11710	13230	13080	5870	6080	6380	
93110806	12140	11980	13460	13400	5410	5670	5990	
93110807	11980	11950	13480	13510	5280	5690	6300	
93110808	11950	12040	13630	13610	5680	6020	6490	
93110809	11850	12020	13380	13330	5390	5670	6140	
93110810	12350	12100	13480	13430	5370	5640	6150	
93110811	11830	11950	13490	13540	5950	6210	6500	
93110812	11870	12000	13390	13360	5090	5460	6090	
93110813	12070	12010	13670	13750	4920	5420	6260	
93110814	11710	11900	13520	13590	5260	5560	5980	
93110815	12160	12120	13450	13500	5150	5350	5730	
93110816	12070	12080	13490	13360	5620	6020	6650	
93110817	12050	12090	13350	13420	5150	5540	6220	
93110818	12020	12110	13440	13300	5400	5810	6490	
93110819	11920	11990	13320	13290	5290	5790	6740	
93110820	11920	11950	13400	13560	5230	5920	7540	
93110821	12030	12130	13460	13520	5340	5800	6590	
93110822	11800	12000	13500	13470	5160	5760	7080	
93110823	11750	11790	13390	13310	4960	5430	6480	
93110824	11750	11880	13390	13470	5060	5580	6560	
93110825	11650	11790	13360	13440	4610	5080	6010	
93110826	11320	11600	13370	13540	4660	5330	7070	
93110827	11520	11490	13350	13490	4530	5030	6060	
93110828	11440	11520	13410	13500	4280	4650	5410	
93110830	11680	11690	13240	13250	4540	5020	5940	

Average	11,852	11,921	13,419	13,456	5,225	5,618	6,343	
Maximum	12,350	12,130	13,670	13,820	6,190	6,360	7,540	
Minimum	11,320	11,490	13,200	13,080	4,280	4,650	5,410	
Range	1,030	640	470	740	1,910	1,710	2,130	
Std.Deviation	232	173	109	145	437	368	428	
# of Points	29	29	29	29	29	29	29	

Upper Freeport Seam
Long Duration Tests

Test Number	Plant Product Yield (%)	Plant Reject Yield (%)	Plant Energy Recovery (%)	Plant Ash Rejection (%)	Plant Sulfur Rejection (%)	Plant Pyritic Rejection (%)	Plant Separation Efficiency (%)
93110801	69.52	30.48	86.92	72.70	65.24	78.40	65.32
93110802	70.41	29.59	87.78	67.94	63.23	76.81	64.59
93110803	66.58	33.42	84.26	78.53	73.28	88.00	72.26
93110804	71.07	28.93	86.60	70.68	64.47	80.76	67.36
93110805	73.73	26.27	87.20	62.77	59.30	70.91	58.11
93110806	71.05	28.95	86.08	69.86	68.77	82.61	68.69
93110807	71.98	28.02	87.22	68.48	66.29	80.02	67.23
93110808	71.05	28.95	86.26	72.61	67.54	80.37	66.63
93110809	74.39	25.61	88.62	65.43	61.34	72.37	60.99
93110810	73.49	26.51	88.12	67.35	65.20	78.74	66.87
93110811	69.59	30.41	85.27	71.57	65.55	78.82	64.09
93110812	75.01	24.99	89.40	65.11	58.27	71.00	60.40
93110813	71.07	28.93	87.88	72.75	63.36	81.76	69.64
93110814	69.78	30.22	86.76	72.26	63.49	79.36	66.12
93110815	74.41	25.59	89.29	67.41	61.62	75.79	65.09
93110816	72.04	27.96	87.66	69.56	65.41	77.98	65.64
93110817	72.89	27.11	88.52	67.79	63.64	73.38	61.90
93110818	74.13	25.87	88.82	66.93	62.45	75.29	64.11
93110819	75.67	24.33	89.00	62.67	54.82	67.94	56.93
93110820	71.58	28.42	86.66	68.81	62.97	76.31	62.97
93110821	72.79	27.21	87.56	68.46	63.52	76.26	63.82
93110822	72.51	27.49	87.36	67.86	62.59	74.88	62.25
93110823	71.46	28.54	87.26	69.35	62.19	73.91	61.17
93110824	70.68	29.32	87.11	70.29	64.12	77.74	64.84
93110825	73.01	26.99	88.88	68.13	54.04	69.53	58.42
93110826	70.50	29.50	86.78	70.67	56.07	71.18	57.96
93110827	69.18	30.82	86.81	72.88	58.76	73.03	59.84
93110828	69.67	30.33	87.90	72.60	59.53	72.71	60.61
93110830	74.50	25.50	89.17	65.03	48.69	62.59	51.76

Average	71.9	28.1	87.5	69.2	62.3	75.8	63.3
Maximum	75.7	33.4	89.4	78.5	73.3	88.0	72.3
Minimum	66.6	24.3	84.3	62.7	48.7	62.6	51.8
Range	9.1	9.1	5.1	15.9	24.6	25.4	20.5
Std.Deviation	2.1	2.1	1.2	3.3	4.7	5.0	4.3
# of Points	29	29	29	29	29	29	29

Upper Freeport Seam
Long Duration Tests

Test Number	HMC Product Yield (%)	HMC Reject Yield (%)	HMC Energy Recovery (%)	HMC Ash Rejection (%)	HMC Sulfur Rejection (%)	HMC Pyritic Rejection (%)	HM Separ. Efficie (%
93110801	89.16	10.84	97.54	2.49	45.30	56.06	
93110802	87.61	12.39	96.58	3.38	48.86	59.05	
93110803	88.71	11.29	97.16	2.82	49.35	61.28	
93110804	90.52	9.48	96.79	3.27	42.48	55.43	
93110805	92.97	7.03	97.76	2.21	35.59	44.93	
93110806	89.10	10.90	95.30	4.70	47.82	59.43	
93110807	90.40	9.60	96.64	3.38	47.18	58.80	
93110808	90.46	9.54	96.67	3.32	43.94	54.60	
93110809	91.41	8.59	97.29	2.63	40.17	48.54	4
93110810	91.40	8.60	97.36	2.65	41.10	51.18	4
93110811	91.43	8.57	97.39	2.62	36.07	46.02	4
93110812	92.43	7.57	97.95	2.03	33.86	42.71	4
93110813	90.28	9.72	97.26	2.72	40.67	53.08	5
93110814	89.84	10.16	96.99	2.97	39.83	50.89	4
93110815	91.65	8.35	97.60	2.38	36.88	47.11	4
93110816	88.93	11.07	96.95	3.11	46.28	56.30	5
93110817	89.07	10.93	96.73	3.32	43.65	51.97	4
93110818	89.66	10.34	96.93	3.09	43.17	53.07	5
93110819	93.67	6.33	98.31	1.71	28.74	36.16	3
93110820	92.53	7.47	97.90	2.14	33.59	40.59	3
93110821	90.51	9.49	96.79	3.19	39.79	47.83	4
93110822	91.69	8.31	97.27	2.71	35.23	44.55	4
93110823	90.68	9.32	97.09	2.85	38.60	47.31	4
93110824	89.98	10.02	97.06	2.99	42.54	52.77	4
93110825	92.27	7.73	97.87	2.14	30.34	40.74	3
93110826	94.05	5.95	98.41	1.63	26.35	34.38	3
93110827	92.33	7.67	97.83	2.18	30.35	38.02	3
93110828	91.66	8.34	97.66	2.31	31.97	40.35	3
93110830	92.95	7.05	97.65	2.31	28.28	36.84	3

Average	90.9	9.1	97.3	2.7	38.9	48.6	4
Maximum	94.1	12.4	98.4	4.7	49.4	61.3	5
Minimum	87.6	6.0	95.3	1.6	26.3	34.4	3
Range	6.4	6.4	3.1	3.1	23.0	26.9	2
Std.Deviation	1.6	1.6	0.6	0.6	6.5	7.5	
# of Points	29	29	29	29	29	29	

Upper Freeport Seam
Long Duration Tests

Test Number	WOC Product Yield (%)	WOC Reject Yield (%)	WOC Energy Recovery (%)	WOC Ash Rejection (%)	WOC Sulfur Rejection (%)	WOC Pyritic Rejection (%)	WOC Separation Efficiency (%)
93110801	98.10	1.90	99.02	5.04	12.88	19.61	18.63
93110802	98.86	1.14	99.44	3.18	6.44	11.49	10.93
93110803	98.33	1.67	99.15	4.51	10.28	16.01	15.16
93110804	98.39	1.61	99.13	4.25	9.11	15.39	14.52
93110805	98.59	1.41	99.27	3.59	8.31	11.42	10.69
93110806	97.73	2.27	98.97	6.75	13.69	21.12	20.09
93110807	99.46	0.54	99.71	1.45	3.69	5.67	5.38
93110808	99.08	0.92	99.58	2.52	6.39	8.88	8.46
93110809	98.15	1.85	99.06	4.80	11.12	15.91	14.97
93110810	97.09	2.91	98.47	7.87	17.32	25.57	24.04
93110811	97.13	2.87	98.62	7.73	17.76	24.37	22.99
93110812	98.01	1.99	99.00	5.49	12.14	16.84	15.84
93110813	99.51	0.49	99.76	1.39	3.37	4.93	4.69
93110814	98.42	1.58	99.25	4.16	9.39	13.50	12.76
93110815	97.68	2.32	98.82	6.66	13.41	19.71	18.53
93110816	98.20	1.80	99.10	5.21	11.33	16.23	15.33
93110817	98.47	1.53	99.21	4.22	10.04	13.18	12.39
93110818	98.22	1.78	99.12	5.13	11.30	15.71	14.83
93110819	97.75	2.25	98.82	6.15	13.38	17.26	16.08
93110820	98.05	1.95	98.88	5.04	11.76	15.47	14.35
93110821	98.12	1.88	99.02	5.29	12.53	15.85	14.87
93110822	97.70	2.30	98.85	6.18	14.83	18.50	17.35
93110823	97.63	2.37	98.63	5.73	13.83	17.47	16.11
93110824	98.31	1.69	99.06	4.46	9.51	14.98	14.04
93110825	98.55	1.45	99.22	3.73	7.43	12.13	11.35
93110826	98.16	1.84	98.93	4.27	9.83	13.30	12.23
93110827	98.08	1.92	98.94	4.65	11.38	15.60	14.54
93110828	97.89	2.11	98.92	5.08	13.07	17.79	16.72
93110830	98.89	1.11	99.40	2.79	5.66	8.79	8.19

Average	98.2	1.8	99.1	4.7	10.7	15.3	14.3
Maximum	99.5	2.9	99.8	7.9	17.8	25.6	24.0
Minimum	97.1	0.5	98.5	1.4	3.4	4.9	4.7
Range	2.4	2.4	1.3	6.5	14.4	20.6	19.4
Std.Deviation	0.6	0.6	0.3	1.6	3.5	4.6	4.4
# of Points	29	29	29	29	29	29	29

Upper Freeport Seam
Long Duration Tests

Test Number	Column Product Yield (%)	Column Reject Yield (%)	Column Energy Recovery (%)	Column Ash Rejection (%)	Column Sulfur Rejection (%)	Column Pyritic Rejection (%)	Colu Separ Efficie (%)
93110801	79.48	20.52	89.99	58.51	27.07	38.74	2
93110802	81.30	18.70	91.40	53.23	23.28	35.95	2
93110803	76.33	23.67	87.47	67.93	41.26	62.95	5
93110804	79.80	20.20	90.26	59.03	31.89	48.75	3
93110805	80.44	19.56	89.85	52.67	49.18	40.35	3
93110806	81.59	18.41	91.26	54.61	30.73	46.02	3
93110807	80.06	19.94	90.51	57.50	33.93	48.54	3
93110808	79.27	20.73	89.61	61.05	38.10	52.34	4
93110809	82.91	17.09	91.95	51.93	27.30	36.31	2
93110810	82.81	17.19	91.92	53.04	28.67	41.32	3
93110811	78.36	21.64	88.78	59.68	34.42	48.02	3
93110812	82.80	17.20	92.19	53.57	28.30	39.33	3
93110813	79.11	20.89	90.57	62.45	36.25	59.22	4
93110814	78.92	21.08	90.13	60.51	33.11	51.56	4
93110815	83.12	16.88	92.59	53.19	29.63	43.30	3
93110816	82.49	17.51	91.23	52.44	27.32	40.01	3
93110817	83.10	16.90	92.25	52.50	28.16	35.71	2
93110818	84.18	15.82	92.45	49.69	25.33	37.53	2
93110819	82.65	17.35	91.61	50.27	26.93	39.28	3
93110820	78.89	21.11	89.52	57.66	36.77	52.81	4
93110821	81.96	18.04	91.35	54.95	30.97	45.72	3
93110822	80.94	19.06	90.86	55.09	32.47	44.12	3
93110823	80.72	19.28	91.12	55.55	28.53	40.25	31
93110824	79.90	20.10	90.59	57.47	30.78	44.41	3
93110825	80.29	19.71	91.53	57.83	28.80	41.49	3
93110826	76.36	23.64	89.14	62.11	33.91	49.73	38
93110827	76.39	23.61	89.69	64.17	33.09	48.55	38
93110828	77.64	22.36	90.99	63.39	31.56	44.29	35
93110830	81.05	18.95	91.86	55.91	24.18	34.88	26

Average	80.4	19.6	90.8	56.8	31.4	44.5	3
Maximum	84.2	23.7	92.6	67.9	49.2	62.9	5
Minimum	76.3	15.8	87.5	49.7	23.3	34.9	2
Range	7.9	7.9	5.1	18.2	25.9	28.1	2
Std.Deviation	2.1	2.1	1.2	4.4	5.3	6.8	
# of Points	29	29	29	29	29	29	

Upper Freeport Seam
Long Duration Tests

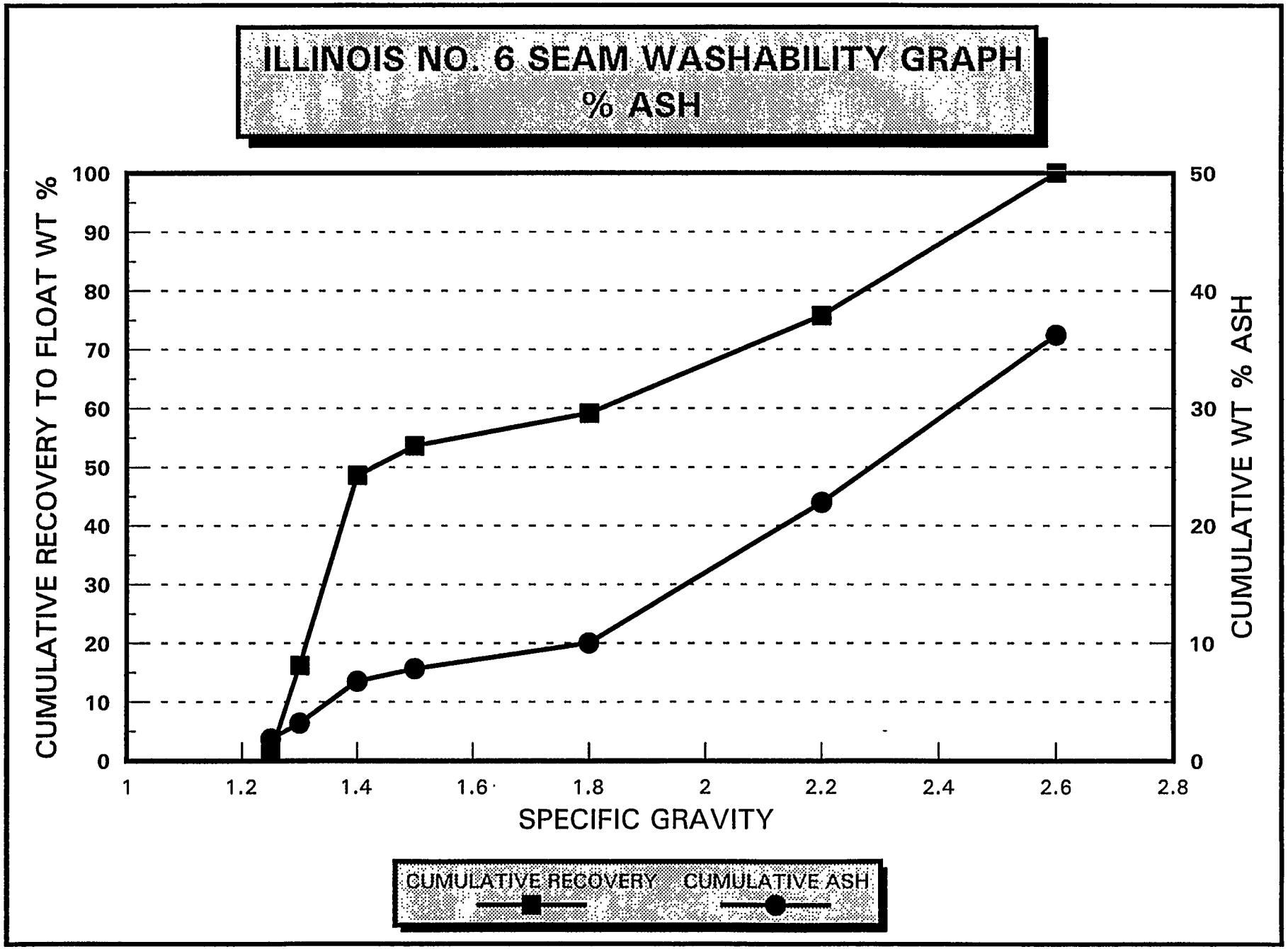
Test Number	% (abs.) of Raw Coal's Energy to: HMC Reject	WOC Reject	Column Reject	% (abs.) of Raw Coal's Pyrite to: HMC Reject	WOC Reject	Column Reject
93110801	2.5	0.9	9.7	56.1	8.5	13.8
93110802	3.4	0.5	8.3	59.2	4.6	13.0
93110803	2.8	0.9	12.0	61.3	6.3	20.4
93110804	3.2	0.8	9.3	55.6	6.7	18.5
93110805	2.2	0.7	9.8	44.8	6.1	20.0
93110806	4.7	1.0	8.3	59.2	8.7	14.7
93110807	3.4	0.3	9.1	58.8	2.5	18.7
93110808	3.3	0.5	10.0	54.6	4.0	21.7
93110809	2.7	1.0	7.7	48.3	8.4	15.7
93110810	2.6	1.5	7.7	51.3	12.3	15.1
93110811	2.6	1.4	10.8	45.8	13.4	19.6
93110812	2.0	1.0	7.6	42.7	9.8	18.5
93110813	2.7	0.2	9.2	53.1	2.3	26.4
93110814	3.0	0.7	9.5	51.1	6.5	21.7
93110815	2.4	1.2	7.1	47.3	10.4	18.1
93110816	3.1	0.9	8.4	56.1	7.1	14.7
93110817	3.3	0.8	7.4	50.9	7.3	15.1
93110818	3.1	0.8	7.3	52.9	7.3	15.0
93110819	1.7	1.1	8.2	36.2	11.1	20.7
93110820	2.1	1.1	10.2	40.7	9.1	26.5
93110821	3.2	0.9	8.3	48.0	8.1	20.1
93110822	2.7	1.2	8.7	44.5	10.2	20.2
93110823	2.9	1.3	8.5	47.4	9.1	17.4
93110824	2.9	0.8	9.1	52.9	7.0	17.8
93110825	2.1	0.8	8.2	41.0	7.0	21.5
93110826	1.6	1.1	10.6	34.3	8.9	28.0
93110827	2.2	1.0	10.0	38.0	9.7	25.3
93110828	2.3	1.1	8.7	40.5	10.5	21.7
93110830	2.3	0.6	7.9	36.8	5.9	19.9

Average	2.7	0.9	8.9	48.6	7.9	19.3
Maximum	4.7	1.5	12.0	61.3	13.4	28.0
Minimum	1.6	0.2	7.1	34.3	2.3	13.0
Range	3.1	1.3	4.9	27.0	11.1	14.9
Std.Deviation	0.6	0.3	1.1	7.5	2.6	3.8
# of Points	29	29	29	29	29	29

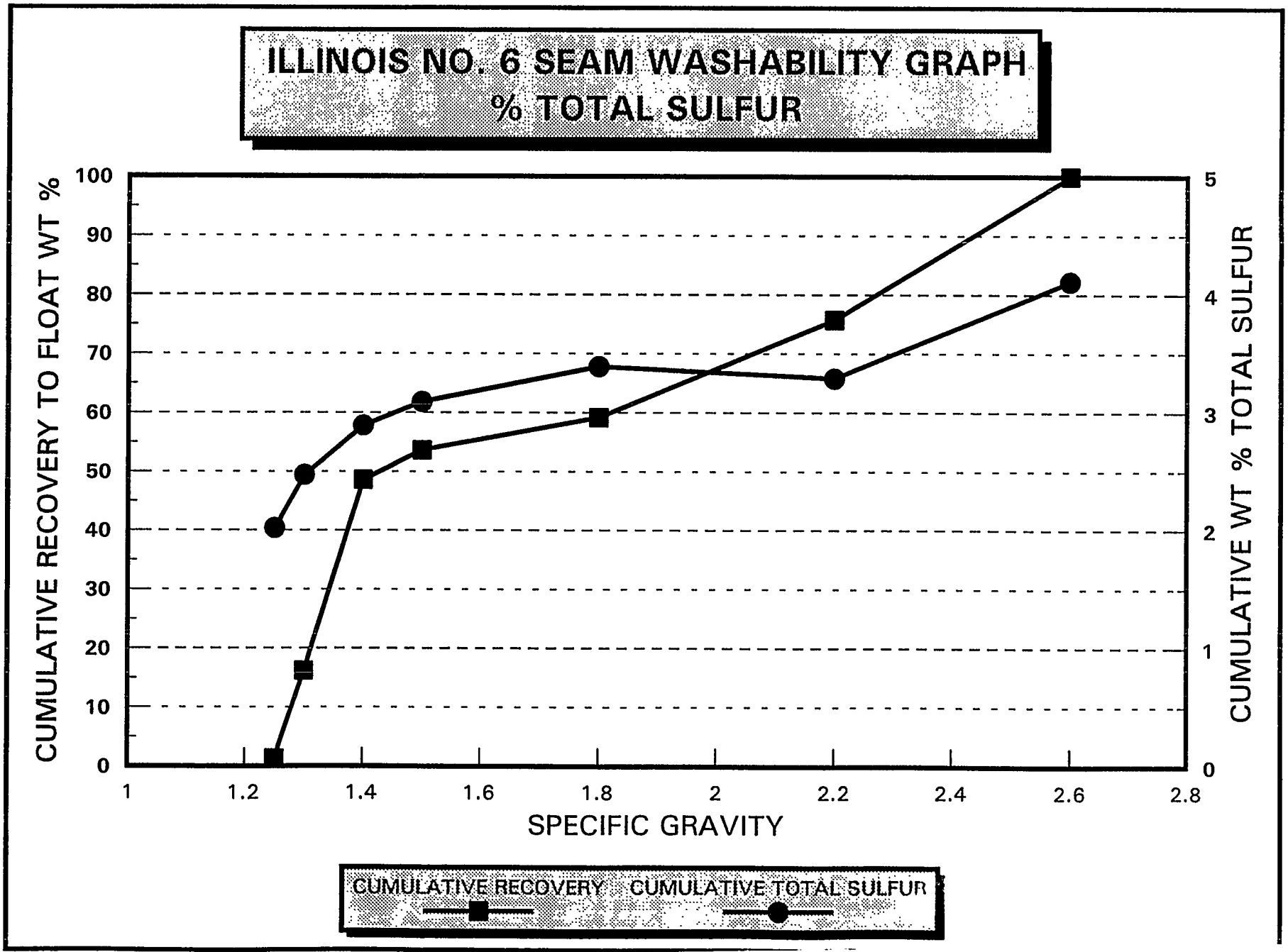
Upper Freeport Seam
Long Duration Tests

Test Number	% of Total Energy Losses			% of Total Pyrite Rejection		
	HMC Reject	WOC Reject	Column Reject	HMC Reject	WOC Reject	Colu Rej
93110801	18.8	7.2	73.9	71.6	10.8	
93110802	28.0	4.4	67.6	77.1	6.0	
93110803	18.1	5.6	76.3	69.6	7.2	
93110804	24.0	6.3	69.7	68.9	8.3	
93110805	17.5	5.8	76.7	63.2	8.6	
93110806	33.7	6.9	59.3	71.7	10.6	
93110807	26.3	2.2	71.5	73.4	3.1	
93110808	24.2	3.3	72.5	68.0	5.0	
93110809	23.8	8.5	67.7	66.8	11.6	
93110810	22.2	12.6	65.2	65.2	15.7	
93110811	17.7	9.2	73.0	58.2	17.0	
93110812	19.3	9.1	71.6	60.2	13.8	
93110813	22.6	1.8	75.6	64.9	2.8	
93110814	22.7	5.6	71.7	64.4	8.2	
93110815	22.4	10.8	66.7	62.4	13.7	
93110816	24.7	7.2	68.1	72.0	9.1	
93110817	28.5	6.7	64.8	69.4	10.0	
93110818	27.5	7.5	65.0	70.3	9.7	
93110819	15.3	10.3	74.3	53.3	16.3	
93110820	15.7	7.9	76.4	53.3	12.0	
93110821	25.8	7.6	66.7	62.9	10.7	
93110822	21.6	9.2	69.2	59.4	13.6	
93110823	22.9	10.5	66.7	64.2	12.3	
93110824	22.8	6.6	70.6	68.1	9.0	
93110825	19.2	6.8	74.0	59.0	10.1	
93110826	12.0	7.9	80.0	48.2	12.5	
93110827	16.5	7.6	76.0	52.0	13.3	
93110828	19.4	9.1	71.6	55.7	14.4	
93110830	21.7	5.2	73.2	58.8	9.4	
Average	21.9	7.2	70.9	63.9	10.5	
Maximum	33.7	12.6	80.0	77.1	17.0	
Minimum	12.0	1.8	59.3	48.2	2.8	
Range	21.7	10.8	20.7	28.9	14.2	
Std.Deviation	4.5	2.4	4.5	7.0	3.5	
# of Points	29	29	29	29	29	

ILLINOIS NO. 6 SEAM WASHABILITY


ILLINOIS NO. 6 SEAM WASHABILITY GRAPH
% ASH
CUMULATIVE RECOVERY TO FLOAT WT %
CUMULATIVE WT % ASH
SPECIFIC GRAVITY
0
10
20
30
40
50
60
70
80
90
100
1
1.2
1.4
1.6
1.8
2
2.2
2.4
2.6
2.8
CUMULATIVE RECOVERY
CUMULATIVE ASH

ILL3.DRW



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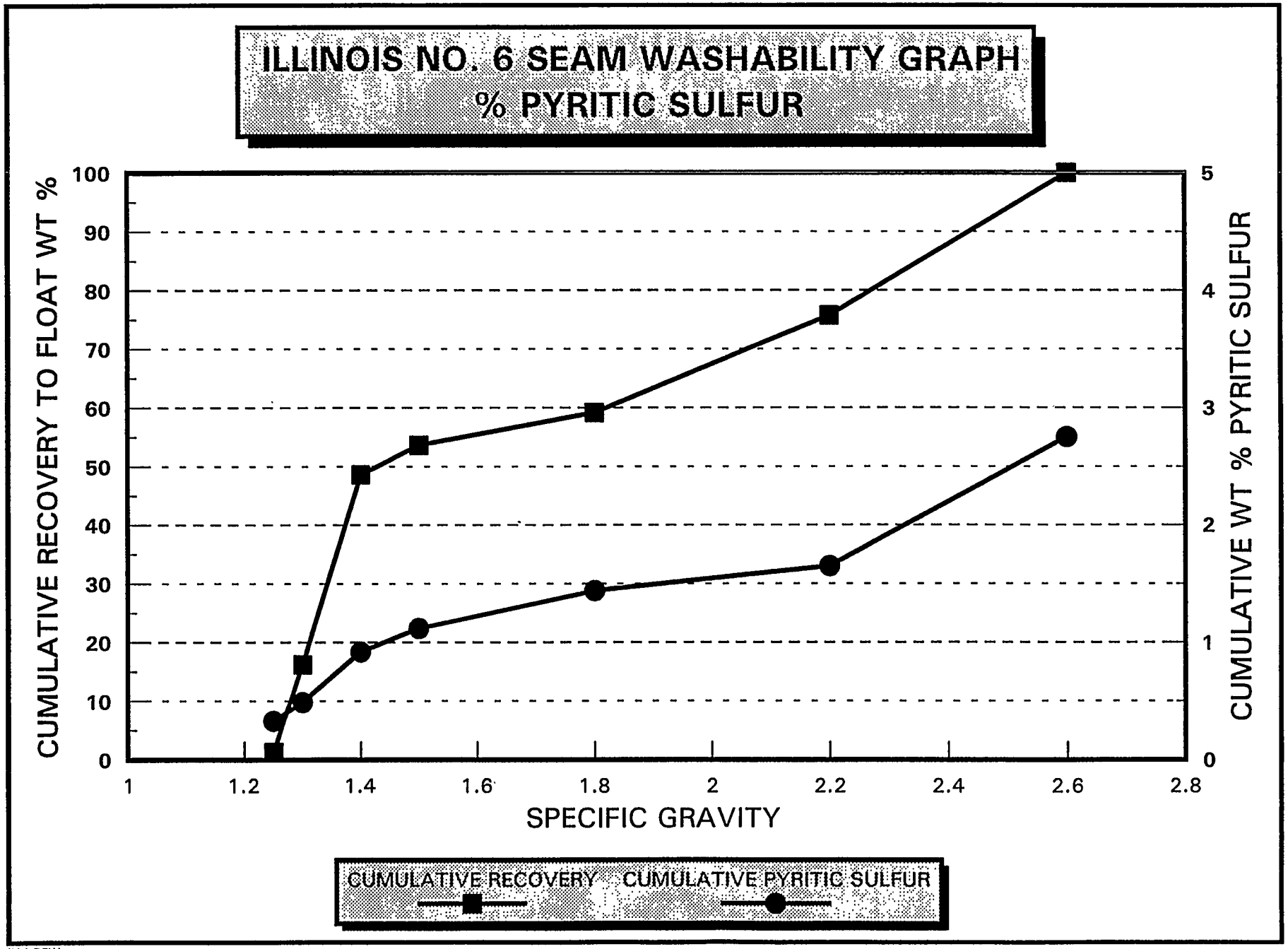
III2 DRW


ILLINOIS NO. 6 SEAM WASHABILITY GRAPH
% PYRITIC SULFUR
CUMULATIVE RECOVERY TO FLOAT WT %
CUMULATIVE WT % PYRITIC SULFUR
SPECIFIC GRAVITY
0
10
20
30
40
50
60
70
80
90
100
0
1
2
3
4
5
1
1.2
1.4
1.6
1.8
2
2.2
2.4
2.6
2.8
CUMULATIVE RECOVERY
CUMULATIVE PYRITIC SULFUR

ILL1.DRW

STANDARD LABORATORIES, INC.

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Telephone: (304) 744-5472 • Fax# (304) 744-4319

ICF-KAISER ENGINEERS

WASHABILITY TEST
LAB NO. 31220927
JANUARY 20, 1994

STANDARD LABORATORIES, INC.

47 Eleventh Avenue, South Charleston, WV 25303
Telephone: (304) 744-5472 • Fax# (304) 744-4319

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LAB NO. 31220927

ILLINOIS NO. 6
RUN # 94010401

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SIZE CONSIST	2
CALCULATED COMPOSITE	3
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DESCRIPTION OF TEST

THE FOLLOWING TEST PROGRAM WAS PERFORMED FOR ICF-KAISER ENGINEERS IN ACCORDANCE WITH THE WRITTEN INSTRUCTIONS ENCLOSED WITH THE SAMPLE. THE RAW COAL SAMPLE DESCRIBED IN THIS REPORT (LAB NO. 31220927) WAS PICKED UP BY STANDARD LABORATORIES, INC. ON DECEMBER 20, 1993.

TESTS PERFORMED ON THE SAMPLE WERE AS FOLLOWS:

1. THE SAMPLE WAS SCREENED AT SIZES OF +1/4" RD, 1/4" RD X 48 MESH, 48 MESH X 200 MESH AND 200 MESH X 0 AND PERCENT WEIGHT WAS DETERMINED.

2. EACH SIZE FRACTION FROM ITEM #1 WAS FLOATED IN ORGANIC LIQUIDS AT SPECIFC GRAVITIES OF 1.25, 1.30, 1.40, 1.50, 1.80 AND 2.20. PERCENT RECOVERY WAS DETERMINED AND EACH FLOAT AND THE 2.20 SINK FRACTION WAS ANALYZED FOR BTU PER POUND, PERCENT ASH, SULFUR AND PYRITIC SULFUR.

3. A CALCULATED COMPOSITE OF THE +1/4" RD X 200 MESH MATERIAL WAS PREPARED AND IS INCLUDED IN THIS REPORT. THE 200 MESH X 0 MATERIAL WAS NOT INCLUDED IN THIS CALCULATED COMPOSITE, DUE TO LACK OF MATERIAL RECOVERY ON NUMEROUS GRAVITIES.

RESPECTFULLY SUBMITTED,

Sharon Blankenship

SHARON BLANKENSHIP
ASSISTANT MANAGER

STANDARD LABORATORIES, INC.

147 Eleventh Avenue, South Charleston, WV 25303
Telephone: (304) 744-5472 • Fax# (304) 744-4319

FOR: ICF-KAISER ENGINEERS
P.O. BOX 1488
BEVERLY, OHIO 45715

LAB NO: 31220927

SAMPLE ID: ILLINOIS NO. 6 SEAM
AS RECEIVED RAW COAL
RUN # 94010401
SAMPLE WEIGHT: 684.3 LBS

SAMPLED BY: ICF-KE

SIZE CONSIST

SIZE	ELEMENTARY % WEIGHT	CUMULATIVE % WEIGHT
+ 1/4" RD	61.65	61.65
1/4" RD X 48 MESH	23.78	85.43
48 MESH X 200 MESH	4.50	89.93
200 MESH X 0	10.07	100.00

STANDARD LABORATORIES,INC.
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FOR: ICF KAISER ENGINEERS
P.O. BOX 1488
BEVERLY, OH 45715

+1/4" RD = 61.65% OF TOTAL SAMPLE

SAMPLE ID:
ILLINOIS NO. 6 SEAM
AS RECEIVED RAW COAL
RUN # 94010401

LAB NO.: 31220927

SAMPLED BY: ICF

SPECIFIC GRAVITY		ELEMENTARY DRY BASIS				CUMULATIVE RETAINED DRY BASIS				CUMULATIVE REJECT DRY BASIS			
SINK	FLOAT	% WT.	% ASH	% SUL.	BTU	% WT.	% ASH	% SUL.	BTU	% WT.	% ASH	% SUL.	BTU
	1.25	0.00				0.00				100.00			
1.25	1.30	12.44	3.82	2.59	14188	12.44	3.82	2.59	14188	100.00	35.33	4.74	8941
1.30	1.40	38.19	9.07	3.15	13270	50.63	7.78	3.01	13496	87.56	39.81	5.05	8196
1.40	1.50	5.70	19.22	5.48	11612	56.33	8.94	3.26	13305	49.37	63.59	6.52	4270
1.50	1.80	6.38	33.33	6.96	9010	62.71	11.42	3.64	12868	43.67	69.38	6.66	3312
1.80	2.20	9.44	64.61	4.73	4642	72.15	18.38	3.78	11792	37.29	75.55	6.60	2337
2.20		27.85	79.26	7.24	1556	100.00	35.33	4.74	8941	27.85	79.26	7.24	1556

		%Pyrite, Dry Basis	%Pyrite, Dry Basis	%Pyrite, Dry Basis
	1.25	0.00		0.00
1.25	1.30	0.54	0.00	3.27
1.30	1.40	1.18	0.54	3.66
1.40	1.50	3.39	1.02	5.58
1.50	1.80	5.23	1.26	5.87
1.80	2.20	3.88	1.67	5.98
2.20		6.69	1.96	6.69
			3.27	

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FOR: ICF KAISER ENGINEERS
P.O. BOX 1488
BEVERLY, OH 45715

1/4" RD X 48 MESH = 23.78% OF TOTAL SAMPLE

SAMPLE ID:
ILLINOIS NO. 6 SEAM
AS RECEIVED RAW COAL
RUN # 94010401

LAB NO.: 31220927

SAMPLED BY: ICF

SPECIFIC GRAVITY		ELEMENTARY DRY BASIS				CUMULATIVE RETAINED DRY BASIS				CUMULATIVE REJECT DRY BASIS			
SINK	FLOAT	% WT.	% ASH	% SUL.	BTU	% WT.	% ASH	% SUL.	BTU	% WT.	% ASH	% SUL.	BTU
										100.00	26.25	3.64	10489
	1.25	3.70	1.93	2.08	14437	3.70	1.93	2.08	14437	96.30	27.18	3.70	10337
1.25	1.30	26.50	2.85	2.47	14264	30.20	2.74	2.42	14285	69.80	36.42	4.16	8847
1.30	1.40	33.99	7.24	2.98	13607	64.19	5.12	2.72	13926	35.81	64.12	5.29	4328
1.40	1.50	4.95	17.16	4.23	11889	69.14	5.98	2.83	13780	30.86	71.65	5.46	3115
1.50	1.80	4.80	26.16	5.64	10399	73.94	7.29	3.01	13561	26.06	80.03	5.42	1774
1.80	2.20	3.73	54.73	5.93	5830	77.67	9.57	3.15	13189	22.33	84.26	5.34	1096
2.20		22.33	84.26	5.34	1096	100.00	26.25	3.64	10489				

		%Pyrite, Dry Basis	%Pyrite, Dry Basis	%Pyrite, Dry Basis
				2.10
	1.25	0.37	0.37	2.17
1.25	1.30	0.48	0.47	2.81
1.30	1.40	1.05	0.78	4.47
1.40	1.50	2.74	0.92	4.75
1.50	1.80	3.83	1.11	4.92
1.80	2.20	4.70	1.28	4.96
2.20		4.96	2.10	

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FORM # 15

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FOR: ICF KAISER ENGINEERS
P.O. BOX 1488
BEVERLY, OH 45715

48 MESH X 200 MESH = 4.50% OF TOTAL SAMPLE

SAMPLE ID:
ILLINOIS NO. 6 SEAM
AS RECEIVED RAW COAL
RUN # 94010401

LAB NO.: 31220927

SAMPLED BY: ICF

SPECIFIC GRAVITY		ELEMENTARY DRY BASIS				CUMULATIVE RETAINED DRY BASIS				CUMULATIVE REJECT DRY BASIS			
SINK	FLOAT	% WT.	% ASH	% SUL.	BTU	% WT.	% ASH	% SUL.	BTU	% WT.	% ASH	% SUL.	BTU
										100.00	37.07	3.61	8716
	1.25	9.78	1.76	1.90	14453	9.78	1.76	1.90	14453	90.22	40.90	3.80	8094
1.25	1.30	20.34	2.57	2.16	14266	30.12	2.31	2.08	14327	69.88	52.05	4.27	6298
1.30	1.40	16.40	5.75	2.67	13750	46.52	3.52	2.29	14123	53.48	66.25	4.76	4012
1.40	1.50	7.15	10.76	2.81	12846	53.67	4.49	2.36	13953	46.33	74.82	5.06	2649
1.50	1.80	5.86	23.45	3.32	10931	59.53	6.35	2.45	13656	40.47	82.25	5.32	1450
1.80	2.20	2.80	48.52	4.73	7006	62.33	8.25	2.55	13357	37.67	84.76	5.36	1037
2.20		37.67	84.76	5.36	1037	100.00	37.07	3.61	8716				

		%Pyrite, Dry Basis	%Pyrite, Dry Basis	%Pyrite, Dry Basis
				2.36
	1.25	0.25	0.25	2.58
1.25	1.30	0.37	0.33	3.23
1.30	1.40	0.71	0.46	4.00
1.40	1.50	1.21	0.56	4.43
1.50	1.80	2.15	0.72	4.76
1.80	2.20	3.85	0.86	4.83
2.20		4.83	2.36	

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FOR: ICF KAISER ENGINEERS
P.O. BOX 1488
BEVERLY, OH 45715

200 MESH X 0 = 10.07% OF TOTAL SAMPLE

SAMPLE ID:
ILLINOIS NO. 6 SEAM
AS RECEIVED RAW COAL
RUN # 94010401

LAB NO.: 31220927

SAMPLED BY: ICF

SPECIFIC GRAVITY		ELEMENTARY DRY BASIS				CUMULATIVE RETAINED DRY BASIS				CUMULATIVE REJECT DRY BASIS			
SINK	FLOAT	% WT.	% ASH	% SUL.	BTU	% WT.	% ASH	% SUL.	BTU	% WT.	% ASH	% SUL.	BTU
										100.00			
	1.25	0.04	*	*	*	0.04				99.96			
1.25	1.30	0.06	*	*	*	0.10				99.90			
1.30	1.40	0.02	*	*	*	0.12				99.88			
1.40	1.50	0.09	*	*	*	0.21				99.79	64.96	1.67	4650
1.50	1.80	2.18	23.39	1.76	11091	2.39	21.33	1.61	10116	97.61	65.89	1.67	4507
1.80	2.20	96.87	65.85	1.63	4518	99.26	64.78	1.63	4653	0.74	70.99	7.31	3010
2.20		0.74	70.99	7.31	3010	100.00	64.82	1.67	4641				

		%Pyrite, Dry Basis	%Pyrite, Dry Basis	%Pyrite, Dry Basis
	1.25			
1.25	1.30			
1.30	1.40			
1.40	1.50			1.31
1.50	1.80	0.47	0.43	1.33
1.80	2.20	1.29	1.27	6.50
2.20		6.50 **	1.31	

*INSUFFICIENT MATERIAL TO DETERMINE ANALYSIS
**ESTIMATED VALUE

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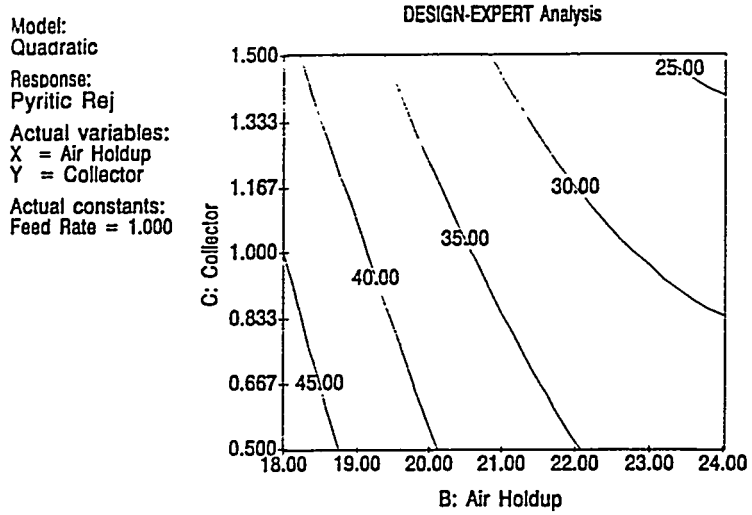
B141

FORM # 15

ILLINOIS NO. 6 SEAM
COLUMN FLOTATION
BOX-BEHNKEN TEST MATRIX RESULTS

a)



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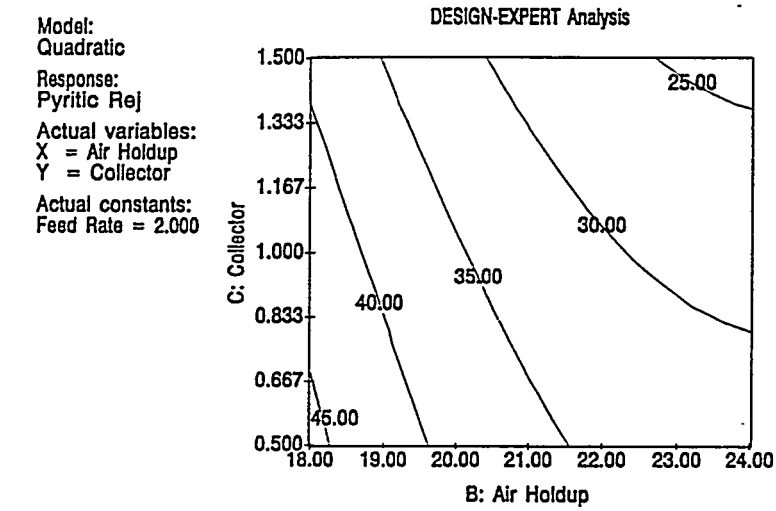


c)

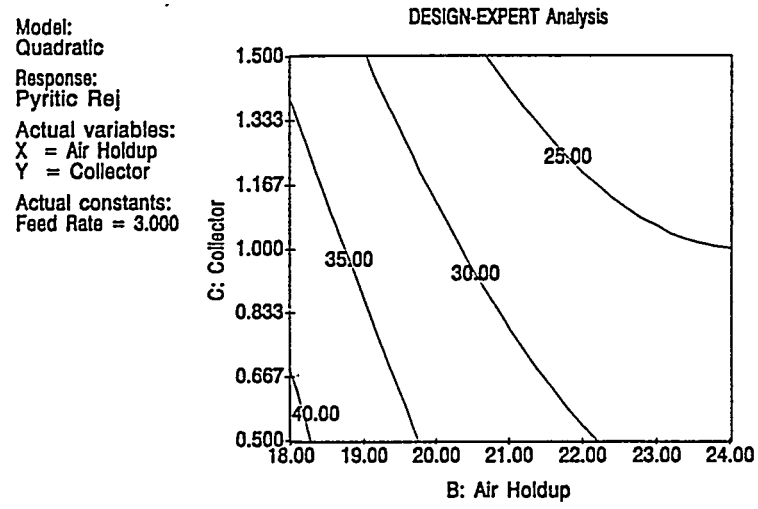
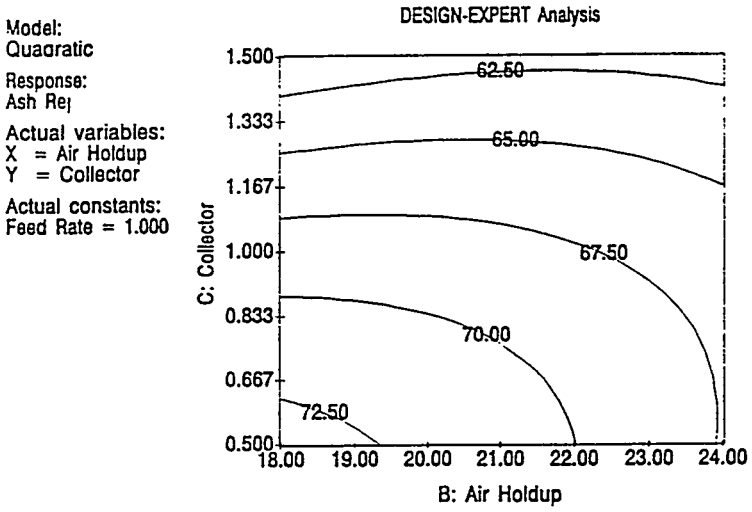


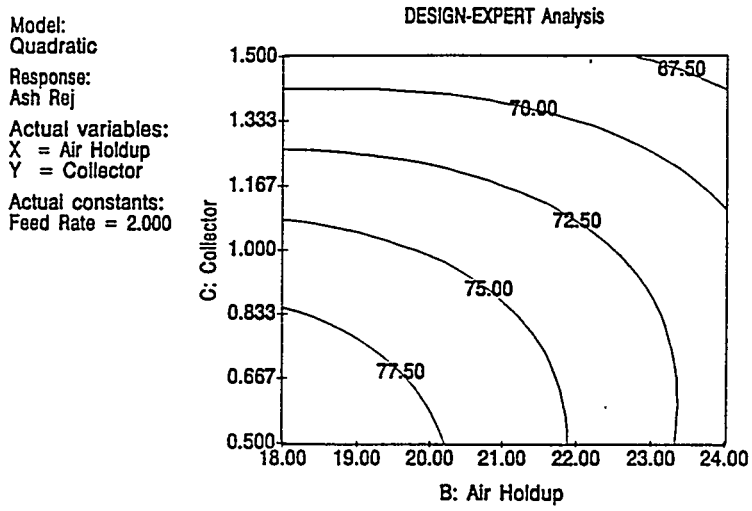
Figure 4.6

Effects of Collector Dosage and Air Holdup on Pyritic Sulfur Rejection for the Illinois No. 6 Coal at Feed Rates of (a) 1.0, (b) 2.0, and (c) 3.0 tph

a)



b)



c)

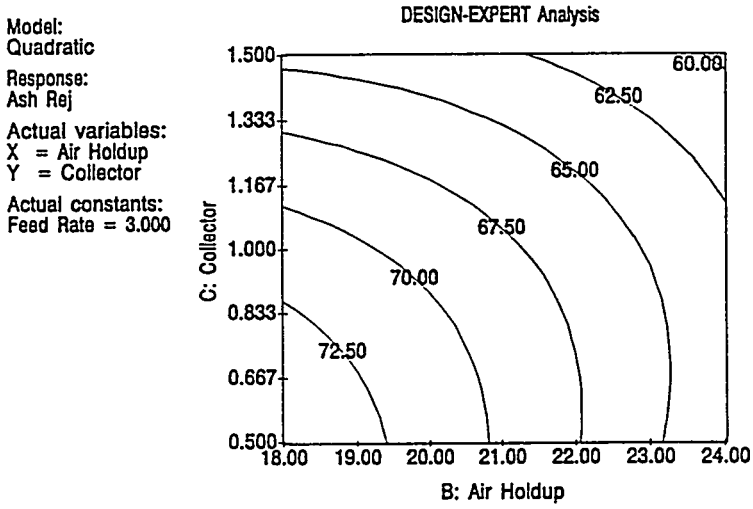
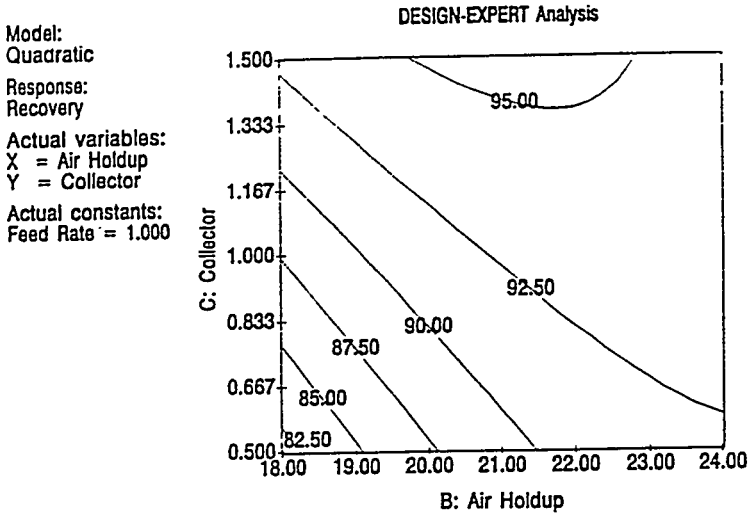


Figure 4.5

Effects of Collector Dosage and Air Holdup on Ash Rejection for the Illinois No. 6 Coal at Feed Rates of (a) 1.0, (b) 2.0, and (C) 3.0 tph

a)



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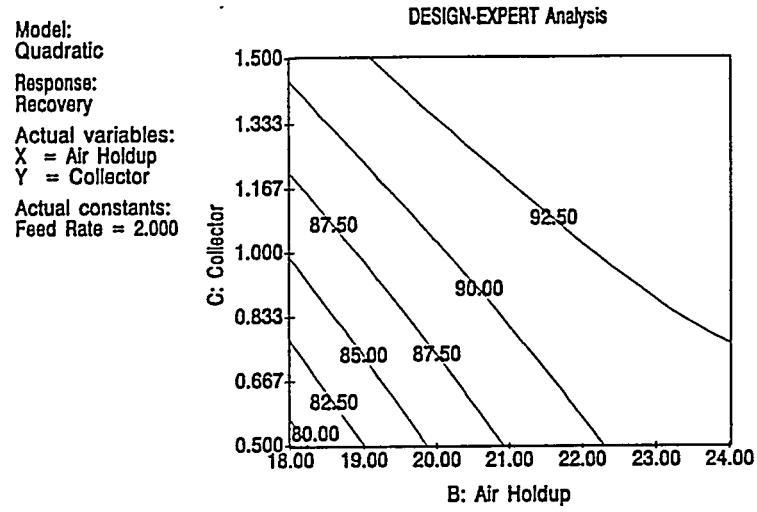

c)

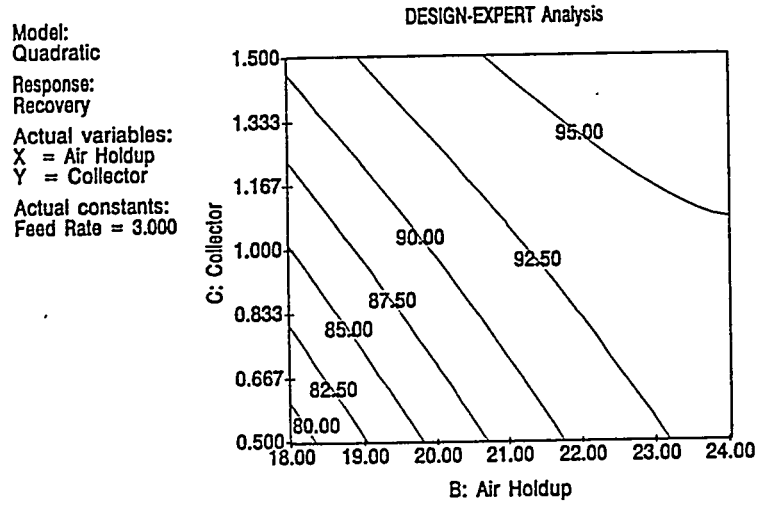

Figure 4.4

Effects of Collector Dosage and Air Holdup on Energy Recovery
For the Illinois No. 6 Coal at Feed Rates of (a) 1.0, (b) 2.0, and (c) 3.0 tph

Illinois No. 6 Seam					
Box-Behnken Tests					
Test	Design	Goodness-of-Fit			Material
Number	Number	Ash	Other	Total	Balance
93120301	12	2.19	5.02	7.21	Good
93120302	0	1.32	3.05	4.37	Good
93120303	9	17.70	3.03	20.73	Poor
93120304	12	10.91	18.67	29.58	Poor
93120305	9	52.85	10.36	63.21	Poor
93120306	3	6.69	22.11	28.80	Poor
93120307	4	7.76	1.43	9.19	Good
93120308	8	11.14	21.19	32.33	Poor
93120309	0	6.05	4.18	10.23	Fair
93120310	10	23.52	19.12	42.64	Poor
93120311	2	3.91	2.95	6.86	Good
93120312	5	4.67	4.06	8.73	Good
93120313	6	4.99	13.52	18.51	Fair
93120314	11	1.85	19.83	21.68	Poor
93120315	0	6.77	11.09	17.86	Fair
93120316	7	3.11	19.88	22.99	Poor
93120317	1	11.83	7.67	19.50	Fair
93120318	11	30.11	9.00	39.11	Poor
93120319	10	2.72	6.26	8.98	Good
Average		11.06	10.65	21.71	

Illinois No. 6 Seam										
Box-Behnken Tests										
	Planned	Planned	Planned	Planned	Planned	Planned	Planned	Planned	Planned	Planned
	Plant	Column	Column	Column	Column	Column	Column	Column	Column	Column
	Feed	Feed	Aeration	Wash	Air	Frother	Frother	Collector	Frother	Collector
Test	Rate	Rate	Rate	Rate	Holdup	Type	Dosage	Dosage	Dosage	Dosage
Number	(tph)	(tph)	(scfm)	(gpm)	(%)	(*)	(lb/ton)	(lb/ton)	(ml/min)	(ml/min)
93120301	2.60	2.00	140	100	24	MIBC	N/A	1.50	N/A	28.40
93120302	2.60	2.00	140	100	21	MIBC	N/A	1.00	N/A	18.90
93120303	2.60	2.00	140	100	18	MIBC	N/A	0.50	N/A	9.50
93120304	2.60	2.00	140	100	24	MIBC	N/A	1.50	N/A	28.40
93120305	2.60	2.00	140	100	18	MIBC	N/A	0.50	N/A	9.50
93120306	1.30	1.00	140	100	24	MIBC	N/A	1.00	N/A	9.50
93120307	3.90	3.00	140	100	24	MIBC	N/A	1.00	N/A	28.40
93120308	3.90	3.00	140	100	21	MIBC	N/A	1.50	N/A	42.60
93120309	2.60	2.00	140	100	21	MIBC	N/A	1.00	N/A	18.90
93120310	2.60	2.00	140	100	24	MIBC	N/A	0.50	N/A	9.50
93120311	3.90	3.00	140	100	18	MIBC	N/A	1.00	N/A	28.40
93120312	1.30	1.00	140	100	21	MIBC	N/A	0.50	N/A	4.70
93120313	3.90	3.00	140	100	21	MIBC	N/A	0.50	N/A	14.20
93120314	2.60	2.00	140	100	18	MIBC	N/A	1.50	N/A	28.40
93120315	2.60	2.00	140	100	21	MIBC	N/A	1.00	N/A	18.90
93120316	1.30	1.00	140	100	21	MIBC	N/A	1.50	N/A	14.20
93120317	1.30	1.00	140	100	18	MIBC	N/A	1.00	N/A	9.50
93120318	2.60	2.00	140	100	18	MIBC	N/A	1.50	N/A	28.40
93120319	2.60	2.00	140	100	24	MIBC	N/A	0.50	N/A	9.50
Average	2.60	2.00	140	100	21	MIBC	N/A	1.00	N/A	18.94

Illinois No. 6 Seam									
Box-Behnken Tests									
	Relative	Relative	Relative	Relative	Relative	Relative	Relative	Relative	Relative
	Plant	Deslime	HMC	WOC	WOC	Column	Column	Column	Thickener
Test	Feed	U/F	Reject	O/F	U/F	Feed	Product	Reject	Feed
Number	(%)	(%)	(%)	(%)	(%)	(%)	(%)	(%)	(%)
93120301	100.00	75.43	24.57	69.53	5.90	69.53	55.95	13.58	17.71
93120302	100.00	75.46	24.54	72.25	3.21	72.25	55.17	17.07	20.28
93120303	100.00	73.48	26.52	68.11	5.37	68.11	44.85	23.26	28.63
93120304	100.00	73.29	26.71	69.76	3.54	69.76	54.53	15.23	18.76
93120305	100.00	78.17	21.83	71.41	6.76	71.41	48.80	22.61	29.37
93120306	100.00	79.77	20.23	76.53	3.24	76.53	61.51	15.02	18.26
93120307	100.00	75.16	24.84	73.26	1.90	73.26	60.93	12.33	14.23
93120308	100.00	75.99	24.01	74.30	1.69	74.30	60.83	13.48	15.17
93120309	100.00	80.90	19.10	77.35	3.55	77.35	59.26	18.09	21.64
93120310	100.00	82.94	17.06	74.87	8.07	74.87	55.47	19.40	27.47
93120311	100.00	72.60	27.40	69.80	2.81	69.80	49.87	19.92	22.73
93120312	100.00	72.35	27.65	70.24	2.11	70.24	54.28	15.96	18.07
93120313	100.00	67.07	32.93	65.16	1.91	65.16	50.25	14.91	16.83
93120314	100.00	69.76	30.24	66.46	3.33	66.46	54.10	12.36	15.66
93120315									
93120316	100.00	79.46	20.50	77.90	1.55	77.90	63.92	13.98	15.54
93120317	100.00	77.84	22.16	75.24	2.60	75.24	54.74	20.50	23.10
93120318									
93120319	100.00	80.57	19.43	78.33	2.24	78.33	60.06	18.27	20.51
Average	100.00	75.90	24.10	72.38	3.52	72.38	55.56	16.82	20.23

Illinois No. 6 Seam									
Box-Behnken Tests									
	Relative	Relative	Relative	Relative	Relative	Relative	Relative	Relative	Relative
	Plant	Deslime	HMC	WOC	WOC	Column	Column	Column	Thickener
Test	Feed	U/F	Reject	O/F	U/F	Feed	Product	Reject	Feed
Number	(tph)	(tph)	(tph)	(tph)	(tph)	(tph)	(tph)	(tph)	(tph)
93120301	2.60	1.96	0.64	1.81	0.15	1.81	1.45	0.35	0.46
93120302	2.60	1.96	0.64	1.88	0.08	1.88	1.43	0.44	0.53
93120303	2.60	1.91	0.69	1.77	0.14	1.77	1.17	0.60	0.74
93120304	2.60	1.91	0.69	1.81	0.09	1.81	1.42	0.40	0.49
93120305	2.60	2.03	0.57	1.86	0.18	1.86	1.27	0.59	0.76
93120306	1.30	1.04	0.26	0.99	0.04	0.99	0.80	0.20	0.24
93120307	3.90	2.93	0.97	2.86	0.07	2.86	2.38	0.48	0.55
93120308	3.90	2.96	0.94	2.90	0.07	2.90	2.37	0.53	0.59
93120309	2.60	2.10	0.50	2.01	0.09	2.01	1.54	0.47	0.56
93120310	2.60	2.16	0.44	1.95	0.21	1.95	1.44	0.50	0.71
93120311	3.90	2.83	1.07	2.72	0.11	2.72	1.94	0.78	0.89
93120312	1.30	0.94	0.36	0.91	0.03	0.91	0.71	0.21	0.23
93120313	3.90	2.62	1.28	2.54	0.07	2.54	1.96	0.58	0.66
93120314	2.60	1.81	0.79	1.73	0.09	1.73	1.41	0.32	0.41
93120315									
93120316	1.30	1.03	0.27	1.01	0.02	1.01	0.83	0.18	0.20
93120317	1.30	1.01	0.29	0.98	0.03	0.98	0.71	0.27	0.30
93120318									
93120319	2.60	2.09	0.51	2.04	0.06	2.04	1.56	0.48	0.53
Average	2.60	1.96	0.64	1.87	0.09	1.87	1.43	0.43	0.52

Illinois No. 6 Seam										
Box-Behnken Tests										
	Measured Plant Feed	Adjusted Plant Feed	Measured Deslime U/F	Adjusted Deslime U/F	Measured HMC Reject	Adjusted HMC Reject	Measured WOC O/F	Adjusted WOC O/F	Measured WOC U/F	Adjusted WOC U/F
Test Number	Ash (%)	Ash (%)	Ash (%)	Ash (%)	Ash (%)	Ash (%)	Ash (%)	Ash (%)	Ash (%)	Ash (%)
93120301	35.52	35.28	21.84	21.31	77.55	77.83	19.63	20.21	51.43	51.28
93120302	37.03	36.17	21.45	21.95	78.89	79.85	20.19	20.56	53.49	53.28
93120303	36.60	36.68	21.41	22.01	77.40	77.31	18.28	19.71	52.81	51.28
93120304	40.66	38.22	21.47	23.34	76.73	79.05	21.93	21.70	56.89	55.69
93120305	34.32	33.13	23.47	20.16	78.23	78.58	13.66	16.96	55.29	53.97
93120306	34.68	33.83	23.22	22.37	78.16	79.03	20.43	21.31	47.71	47.38
93120307	35.98	35.71	19.67	21.70	77.77	78.09	22.45	21.00	48.96	48.52
93120308	36.80	34.33	18.78	19.39	78.87	81.60	18.42	18.62	53.83	53.26
93120309	34.96	34.05	24.97	23.46	78.01	78.88	20.33	22.16	51.63	51.80
93120310	35.76	33.83	22.53	24.29	78.66	80.25	22.75	21.66	51.75	48.66
93120311	38.68	37.79	21.30	21.36	80.50	81.30	20.38	20.05	54.58	54.12
93120312	37.83	37.17	19.91	21.14	78.34	79.12	20.98	20.37	47.18	46.76
93120313	37.64	39.17	19.42	20.41	79.64	77.38	19.98	19.48	52.46	51.91
93120314	37.11	37.32	20.14	19.45	78.83	78.55	17.81	17.84	51.98	51.88
93120315										
93120316	34.82	32.06	20.70	20.26	78.05	80.34	19.04	19.85	40.74	40.77
93120317	36.17	33.93	21.26	21.39	75.77	77.95	18.44	20.47	48.03	48.02
93120318										
93120319	36.30	34.26	22.04	22.95	79.25	81.14	22.49	22.06	54.36	54.20
Average	36.52	35.47	21.39	21.58	78.27	79.19	19.83	20.24	51.36	50.75

Illinois No. 6 Seam								
Box-Behnken Tests								
	Measured	Adjusted	Measured	Adjusted	Measured	Adjusted	Measured	Adjusted
	Column	Column	Column	Column	Column	Column	Thickener	Thickener
	Feed	Feed	Product	Product	Reject	Reject	Feed	Feed
Test	Ash	Ash	Ash	Ash	Ash	Ash	Ash	Ash
Number	(%)	(%)	(%)	(%)	(%)	(%)	(%)	(%)
93120301	20.23	20.21	7.61	7.60	71.78	68.51	63.19	65.91
93120302	21.27	20.56	6.96	6.96	65.55	64.51	61.59	62.74
93120303	22.61	19.71	6.01	6.01	51.08	46.11	42.69	47.08
93120304	23.46	21.70	8.34	8.38	73.72	69.41	62.19	66.83
93120305	21.92	16.96	5.67	5.65	41.85	41.38	44.51	44.28
93120306	21.30	21.31	9.81	9.80	74.50	68.45	60.00	64.71
93120307	22.25	21.00	9.91	9.94	77.34	75.66	70.30	72.03
93120308	19.05	18.62	8.55	8.56	71.48	64.02	57.26	62.82
93120309	22.81	22.16	7.56	7.55	75.25	70.03	65.23	67.04
93120310	22.42	21.66	7.63	7.70	70.81	61.59	49.85	57.79
93120311	19.66	20.05	7.20	7.20	55.75	52.20	49.22	52.44
93120312	21.09	20.37	7.49	7.50	67.50	64.14	58.94	62.12
93120313	20.29	19.48	7.75	7.75	62.19	59.03	55.42	58.22
93120314	17.24	17.84	7.50	7.47	65.44	63.19	58.95	60.80
93120315								
93120316	19.92	19.85	9.14	9.16	69.72	68.72	64.68	65.93
93120317	22.96	22.47	6.21	6.20	59.97	58.57	56.22	57.38
93120318								
93120319	21.96	22.06	8.23	8.23	68.94	67.50	64.59	66.05
Average	21.20	20.35	7.74	7.74	66.05	62.53	57.93	60.83

Illinois No. 6 Seam										
Box-Behnken Tests										
	Measured Plant Feed	Adjusted Plant Feed	Measured Deslime U/F	Adjusted Deslime U/F	Measured HMC Reject	Adjusted HMC Reject	Measured WOC O/F	Adjusted WOC O/F	Measured WOC U/F	Adjusted WOC U/F
Test Number	Sulfur (%)	Sulfur (%)	Sulfur (%)	Sulfur (%)	Sulfur (%)	Sulfur (%)	Sulfur (%)	Sulfur (%)	Sulfur (%)	Sulfur (%)
93120301	4.10	4.29	3.37	3.27	7.58	7.42	3.14	2.98	11.49	11.12
93120302	4.18	4.62	3.27	3.19	9.57	9.01	2.95	2.86	10.59	10.57
93120303	4.77	4.68	3.60	3.49	7.89	7.96	3.06	3.00	9.44	9.72
93120304	3.77	4.68	3.56	3.56	9.22	7.76	3.12	3.09	13.02	12.88
93120305	3.81	4.34	3.19	3.40	8.23	7.69	3.23	2.84	10.60	9.32
93120306	3.85	4.19	3.07	3.27	8.11	7.81	2.97	3.04	9.20	9.65
93120307	4.29	4.40	3.34	3.34	7.73	7.64	3.14	3.15	10.40	10.42
93120308	3.33	4.21	3.32	3.18	9.07	7.50	3.09	3.02	10.07	9.90
93120309	3.63	3.99	3.16	3.09	8.18	7.83	2.89	2.83	9.10	8.76
93120310	3.53	4.20	3.19	3.43	8.65	7.96	2.96	2.76	9.80	9.62
93120311	4.44	4.86	3.19	3.27	9.64	9.09	3.08	2.97	10.68	10.68
93120312	4.16	4.45	3.31	3.19	8.04	7.74	2.94	2.99	9.86	9.82
93120313	6.78	5.26	3.68	3.30	8.47	9.25	3.03	3.11	9.61	9.67
93120314	5.73	5.44	3.84	3.29	10.11	10.39	3.21	2.95	10.57	10.14
93120315										
93120316	3.28	4.02	3.23	3.12	8.57	7.53	3.08	3.01	8.51	8.35
93120317	3.84	4.53	3.29	3.08	10.82	9.61	3.06	2.86	9.64	9.51
93120318										
93120319	3.96	4.60	3.45	3.24	11.20	10.21	3.11	3.04	10.39	10.36
Average	4.20	4.52	3.36	3.28	8.89	8.38	3.06	2.97	10.17	10.03

Illinois No. 6 Seam								
Box-Behnken Tests								
	Measured Column Feed Sulfur (%)	Adjusted Column Feed Sulfur (%)	Measured Column Product Sulfur (%)	Adjusted Column Product Sulfur (%)	Measured Column Reject Sulfur (%)	Adjusted Column Reject Sulfur (%)	Measured Thickener Feed Sulfur (%)	Adjusted Thickener Feed Sulfur (%)
Test Number								
93120301	2.89	2.98	3.08	3.12	2.52	2.43	3.51	3.74
93120302	2.97	2.86	3.02	3.11	2.03	2.05	3.42	3.40
93120303	2.86	3.00	3.04	3.04	2.85	2.93	4.45	4.20
93120304	3.35	3.09	3.37	3.21	2.62	2.64	4.74	4.57
93120305	2.83	2.84	3.01	2.96	2.78	2.57	3.70	4.13
93120306	2.90	3.04	4.08	3.24	2.45	2.24	3.11	3.38
93120307	3.17	3.15	3.38	3.35	2.19	2.20	3.32	3.30
93120308	3.17	3.02	3.38	3.14	2.55	2.49	3.26	3.32
93120309	2.86	2.83	3.07	3.05	2.17	2.08	2.99	3.18
93120310	2.79	2.76	3.18	2.93	2.26	2.27	4.80	4.43
93120311	3.06	2.97	3.08	3.08	2.64	2.69	3.78	3.67
93120312	2.89	2.99	3.21	3.05	2.84	2.78	3.57	3.61
93120313	2.86	3.11	3.16	3.23	2.72	2.69	3.41	3.49
93120314	2.48	2.95	3.11	3.04	2.74	2.56	3.76	4.16
93120315								
93120316	2.84	3.01	3.67	3.03	3.16	2.94	3.33	3.48
93120317	2.85	2.86	2.93	2.95	2.67	2.63	3.32	3.40
93120318								
93120319	2.93	3.04	3.38	3.21	2.49	2.47	3.35	3.33
Average	2.92	2.97	3.24	3.10	2.57	2.51	3.64	3.69

Illinois No. 6 Seam										
Box-Behnken Tests										
	Measured Plant Feed	Adjusted Plant Feed	Measured Deslime U/F	Adjusted Deslime U/F	Measured HMC Reject	Adjusted HMC Reject	Measured WOC O/F	Adjusted WOC O/F	Measured WOC U/F	Adjusted WOC U/F
Test Number	Pyritic (%)	Pyritic (%)	Pyritic (%)	Pyritic (%)	Pyritic (%)	Pyritic (%)	Pyritic (%)	Pyritic (%)	Pyritic (%)	Pyritic (%)
93120301	2.47	2.46	1.67	1.45	5.49	5.51	1.35	1.19	8.60	8.50
93120302	2.66	2.73	1.50	1.39	6.97	6.85	1.29	1.12	7.51	7.52
93120303	3.37	3.23	1.85	1.85	6.87	7.03	1.34	1.37	7.76	7.97
93120304	2.45	3.02	1.83	1.83	7.89	6.30	1.34	1.39	10.17	10.41
93120305	2.37	2.73	1.56	1.63	7.45	6.67	1.24	1.11	8.31	7.15
93120306	2.25	2.52	1.44	1.48	7.22	6.65	1.17	1.25	7.54	6.77
93120307	2.61	2.74	1.33	1.48	6.75	6.54	1.33	1.30	8.47	8.47
93120308	2.10	2.60	1.51	1.44	8.03	6.27	1.21	1.28	8.61	8.48
93120309	2.26	2.45	1.47	1.37	7.38	7.00	1.11	1.10	7.56	7.33
93120310	2.14	2.57	1.47	1.70	7.75	6.79	1.21	1.10	7.87	7.32
93120311	3.08	3.30	1.42	1.43	8.73	8.25	1.18	1.13	8.78	8.81
93120312	2.83	2.97	1.46	1.45	7.17	6.93	1.19	1.25	8.10	8.05
93120313	5.09	3.83	1.91	1.50	7.67	8.61	1.35	1.29	8.05	8.17
93120314	3.87	3.86	1.78	1.32	9.73	9.74	1.30	0.95	8.64	8.75
93120315										
93120316	1.69	2.13	1.26	1.25	7.10	5.52	1.08	1.15	6.27	6.17
93120317	2.30	2.64	1.36	1.17	8.96	7.81	1.07	0.96	7.21	7.32
93120318										
93120319	2.34	2.72	1.57	1.46	8.99	7.91	1.41	1.28	7.85	7.87
Average	2.70	2.85	1.55	1.48	7.66	7.08	1.25	1.19	8.08	7.94

Illinois No. 6 Seam								
Box-Behnken Tests								
	Measured Column Feed	Adjusted Column Feed	Measured Column Product	Adjusted Column Product	Measured Column Reject	Adjusted Column Reject	Measured Thickener Feed	Adjusted Thickener Feed
Test Number	Pyritic (%)	Pyritic (%)	Pyritic (%)	Pyritic (%)	Pyritic (%)	Pyritic (%)	Pyritic (%)	Pyritic (%)
93120301	1.15	1.19	0.96	1.05	1.72	1.73	2.57	2.75
93120302	1.02	1.12	0.94	0.97	1.61	1.61	2.49	2.55
93120303	1.35	1.37	1.10	1.08	1.90	1.92	3.21	3.05
93120304	1.67	1.39	1.38	1.39	1.36	1.41	3.46	3.10
93120305	1.13	1.11	0.94	0.95	1.51	1.45	2.50	2.76
93120306	1.10	1.25	1.86	1.18	1.91	1.55	2.18	2.48
93120307	1.33	1.30	1.33	1.24	1.58	1.59	2.64	2.51
93120308	1.32	1.28	1.27	1.16	1.88	1.81	2.53	2.56
93120309	1.16	1.10	0.93	0.98	1.49	1.47	2.28	2.43
93120310	1.02	1.10	1.09	0.95	1.58	1.53	3.64	3.23
93120311	1.18	1.13	0.89	0.92	1.61	1.67	2.62	2.55
93120312	1.16	1.25	1.17	1.04	2.13	1.98	2.66	2.69
93120313	1.15	1.29	1.10	1.16	1.74	1.73	2.35	2.46
93120314	0.66	0.95	1.08	0.78	2.03	1.70	2.96	3.19
93120315								
93120316	1.02	1.15	1.62	0.97	2.26	1.97	2.37	2.39
93120317	0.95	0.96	0.62	0.66	1.63	1.74	2.39	2.37
93120318								
93120319	1.19	1.28	1.11	1.10	1.86	1.87	2.56	2.52
Average	1.15	1.19	1.14	1.03	1.75	1.69	2.67	2.68

Illinois No. 6 Seam										
Box-Behnken Tests										
	Measured Plant Feed	Adjusted Plant Feed	Measured Deslime U/F	Adjusted Deslime U/F	Measured HMC Reject	Adjusted HMC Reject	Measured WOC O/F	Adjusted WOC O/F	Measured WOC U/F	Adjusted WOC U/F
Test Number	Energy (Btu/lb)	Energy (Btu/lb)	Energy (Btu/lb)	Energy (Btu/lb)	Energy (Btu/lb)	Energy (Btu/lb)	Energy (Btu/lb)	Energy (Btu/lb)	Energy (Btu/lb)	Energy (Btu/lb)
93120301	9000	9015	11270	11281	2110	2110	11440	11454	6410	6581
93120302	8830	8947	11130	11159	2150	2148	11460	11379	6160	6210
93120303	8950	8760	11240	11213	1960	1962	11850	11618	5970	6066
93120304	8260	8649	11310	10902	2470	2461	11290	11168	5430	5663
93120305	9360	9331	11020	11330	2170	2170	12490	11820	6200	6158
93120306	9230	9357	11190	11168	2220	2219	11490	11342	6690	7058
93120307	8950	8973	11600	11245	2100	2098	11210	11357	6790	6901
93120308	9060	9287	11770	11644	1830	1828	12000	11770	5930	6086
93120309	9060	9206	10800	10909	1990	1989	11320	11123	6120	6253
93120310	9000	9240	11100	10743	1930	1928	11190	11180	6240	6693
93120311	8520	8676	11380	11294	1740	1738	11490	11522	5580	5621
93120312	8880	8820	11720	11426	2000	2000	11420	11556	6970	7093
93120313	8590	8307	11600	11529	1740	1744	11580	11687	6070	6148
93120314	8860	8624	11440	11546	1880	1883	11640	11808	6210	6279
93120315										
93120316	9190	9444	11450	11385	1940	1938	11670	11450	8000	8111
93120317	8990	9028	11410	11218	2150	2147	11700	11380	6510	6526
93120318										
93120319	8950	9240	11220	10975	2050	2047	11080	11124	5700	5739
Average	8922	8994	11332	11233	2025	2024	11548	11455	6293	6423

Illinois No. 6 Seam								
Box-Behnken Tests								
	Measured	Adjusted	Measured	Adjusted	Measured	Adjusted	Measured	Adjusted
	Column	Column	Column	Column	Column	Column	Thickener	Thickener
	Feed	Feed	Product	Product	Reject	Reject	Feed	Feed
Test	Energy	Energy	Energy	Energy	Energy	Energy	Energy	Energy
Number	(Btu/lb)	(Btu/lb)	(Btu/lb)	(Btu/lb)	(Btu/lb)	(Btu/lb)	(Btu/lb)	(Btu/lb)
93120301	11500	11454	13470	13475	3440	3718	4780	4149
93120302	11320	11379	13620	13457	4520	4665	5140	4909
93120303	11230	11618	13800	13849	6800	7317	7940	7083
93120304	11130	11168	13360	13322	3120	3453	4870	3869
93120305	11310	11820	13930	13694	8000	7773	7200	7401
93120306	11380	11342	13210	13270	3080	3444	5490	4086
93120307	11170	11357	13140	13096	2660	2767	3540	3320
93120308	11740	11770	13420	13452	3690	4175	5680	4388
93120309	11090	11123	13550	13409	3420	3635	4520	4065
93120310	11230	11180	13450	13576	3900	4327	6900	5022
93120311	11700	11522	13550	13575	6030	6834	6800	6290
93120312	11450	11556	13500	13607	4240	4577	5510	4871
93120313	11570	11687	13410	13595	4880	5261	6000	5362
93120314	11840	11808	13470	13501	4280	4399	5000	4795
93120315								
93120316	11420	11450	13210	13142	3520	3717	4520	4157
93120317	11120	11380	13590	13541	5520	5610	5830	5713
93120318								
93120319	11270	11125	13250	13227	4050	4214	4620	4380
Average	11381	11455	13466	13458	4421	4699	5549	4933

Illinois No. 6 Seam							
Box-Behnken Tests							
	Plant	Plant	Plant	Plant	Plant	Plant	Plant
	Product	Reject	Energy	Ash	Sulfur	Pyritic	Separate
Test	Yield	Yield	Recovery	Rejection	Rejection	Rejection	Efficiency
Number	(%)	(%)	(%)	(%)	(%)	(%)	(%)
93120301	55.95	44.05	83.63	87.95	59.31	76.12	59.75
93120302	55.17	44.83	82.98	89.38	62.86	80.40	63.38
93120303	44.85	55.15	70.90	92.65	70.87	85.00	55.91
93120304	54.53	45.47	83.99	88.04	62.60	74.90	58.89
93120305	48.80	51.20	71.62	91.68	66.72	83.02	54.64
93120306	61.51	38.49	87.23	82.18	52.44	71.20	58.43
93120307	60.93	39.07	88.93	83.04	53.61	72.43	61.35
93120308	60.83	39.17	88.11	84.83	54.63	72.86	60.97
93120309	59.26	40.74	86.32	86.86	54.70	76.30	62.61
93120310	55.47	44.53	81.50	87.37	61.30	79.50	61.00
93120311	49.87	50.13	78.03	90.50	68.40	86.10	64.13
93120312	54.28	45.72	83.74	89.05	62.80	80.99	64.73
93120313	50.25	49.75	82.24	90.06	69.14	84.78	67.02
93120314	54.10	45.90	84.69	89.17	69.77	89.07	73.76
93120315							
93120316	63.92	36.08	88.95	81.74	51.82	70.89	59.84
93120317	54.74	45.26	82.10	90.00	64.35	86.32	68.42
93120318							
93120319	60.06	39.94	85.97	85.57	58.09	75.71	61.68
Average	55.56	44.44	83.00	87.65	61.38	79.15	62.15

Illinois No. 6 Seam							
Box-Behnken Tests							
	HMC	HMC	HMC	HMC	HMC	HMC	HMC
	Product	Reject	Energy	Ash	Sulfur	Pyritic	Separate
Test	Yield	Yield	Recovery	Rejection	Rejection	Rejection	Efficiency
Number	(%)	(%)	(%)	(%)	(%)	(%)	(%)
93120301	75.43	24.57	94.39	54.01	43.41	55.03	49.42
93120302	75.46	24.54	94.12	53.52	50.83	61.57	55.69
93120303	73.48	26.52	94.06	55.96	44.71	57.72	51.78
93120304	73.29	26.71	92.38	53.62	52.62	55.72	48.10
93120305	78.17	21.83	94.92	51.55	41.40	53.34	48.25
93120306	79.77	20.23	95.21	46.74	39.16	53.38	48.59
93120307	75.16	24.84	94.19	54.10	43.64	59.29	53.48
93120308	75.99	24.01	95.28	55.16	51.73	57.90	53.18
93120309	80.90	19.10	95.87	43.76	39.16	54.57	50.44
93120310	82.94	17.06	96.43	39.67	35.14	45.07	41.50
93120311	72.60	27.40	94.51	58.37	54.35	68.50	63.01
93120312	72.35	27.65	93.73	58.28	49.96	64.52	58.24
93120313	67.07	32.93	93.08	66.95	53.03	74.03	67.11
93120314	69.76	30.24	93.40	63.88	56.20	76.31	69.70
93120315							
93120316	79.46	20.54	95.79	50.00	43.79	53.23	49.02
93120317	77.84	22.16	96.72	49.49	52.93	65.56	62.28
93120318							
93120319	80.57	19.43	95.69	44.95	47.31	56.50	52.20
Average	75.90	24.10	94.69	52.94	47.02	59.54	54.24

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Illinois No. 6 Seam							
Box-Behnken Tests							
	WOC	WOC	WOC	WOC	WOC	WOC	WOC
	Product	Reject	Energy	Ash	Sulfur	Pyritic	Separate
Test	Yield	Yield	Recovery	Rejection	Rejection	Rejection	Efficiency
Number	(%)	(%)	(%)	(%)	(%)	(%)	(%)
93120301	92.18	7.82	93.59	18.82	26.60	45.85	39.44
93120302	95.75	4.25	97.63	10.33	14.10	23.01	20.65
93120303	92.69	7.31	96.04	17.03	20.35	31.48	27.52
93120304	95.18	4.82	97.51	11.49	17.43	27.40	24.90
93120305	91.35	8.65	95.30	23.15	23.71	37.93	33.24
93120306	95.94	4.06	97.43	8.60	11.99	18.58	16.01
93120307	97.47	2.53	98.44	5.65	7.89	14.47	12.91
93120308	97.78	2.22	98.83	6.11	6.92	13.10	11.93
93120309	95.61	4.39	97.49	9.69	12.44	23.48	20.97
93120310	90.27	9.73	93.94	19.49	27.29	41.90	35.84
93120311	96.14	3.86	98.08	9.77	12.60	23.76	21.84
93120312	97.08	2.92	98.19	6.45	8.98	16.19	14.38
93120313	97.15	2.85	98.48	7.24	8.34	15.51	13.99
93120314	95.27	4.73	97.43	12.62	14.58	31.36	28.79
93120315							
93120316	98.04	1.96	98.60	3.95	5.25	9.69	8.29
93120317	96.66	3.34	98.06	7.50	10.31	20.90	18.95
93120318							
93120319	97.22	2.78	98.54	6.57	8.89	14.99	13.53
Average	95.40	4.60	97.27	10.85	13.98	24.09	21.36

Illinois No. 6 Seam							
Box-Behnken Tests							
	Column	Column	Column	Column	Column	Column	Column
	Product	Reject	Energy	Ash	Sulfur	Pyritic	Separate
Test	Yield	Yield	Recovery	Rejection	Rejection	Rejection	Efficiency
Number	(%)	(%)	(%)	(%)	(%)	(%)	(%)
93120301	80.47	19.53	94.67	66.21	15.93	28.39	23.06
93120302	76.36	23.64	90.30	74.17	16.94	33.98	24.29
93120303	65.85	34.15	78.49	79.89	33.35	47.86	26.36
93120304	78.17	21.83	93.24	69.83	18.65	22.15	15.39
93120305	68.34	31.66	79.17	77.25	28.65	41.36	20.53
93120306	80.37	19.63	94.04	63.04	14.46	24.34	18.37
93120307	83.17	16.83	95.90	60.64	11.75	20.58	16.49
93120308	81.87	18.13	93.57	62.33	14.95	25.64	19.21
93120309	76.61	23.39	92.36	73.91	17.19	31.25	23.61
93120310	74.09	25.91	89.97	73.68	21.31	36.04	26.01
93120311	71.45	28.55	84.18	74.34	25.86	42.20	26.38
93120312	77.28	22.72	90.99	71.55	21.13	35.99	26.99
93120313	77.12	22.88	89.71	69.34	19.79	30.69	20.39
93120314	81.40	18.60	93.07	65.87	16.14	33.28	26.35
93120315							
93120316	82.05	17.95	94.18	62.13	17.53	30.74	24.92
93120317	72.75	27.25	86.57	71.02	25.06	49.38	35.95
93120318							
93120319	76.68	23.32	91.16	71.37	18.95	34.08	25.24
Average	76.71	23.29	90.09	69.80	19.86	33.41	23.50

ILLINOIS NO. 6 SEAM 24-HOUR GRIND RESULTS

ILLINOIS NO. 6 SEAM 24–HOUR RUN DATA: MICROTRAC OF MILL CIRCUIT FEED

Shift >	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
Microns																	
296.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0		100.0	100.0	100.0			80.5
209.3	76.2	82.4	81.1	76.1	76.3	75.9	78.8	82.9	81.0	83.6		79.0	84.3	76.6			66.2
148.0	54.7	65.3	63.6	52.5	55.3	55.5	59.9	66.4	63.2	66.6		60.9	65.3	57.7			53.7
104.7	38.3	51.7	50.1	35.3	39.8	40.8	45.8	53.2	49.3	53.0		48.7	50.6	44.1			43.4
74.0	26.8	41.3	39.6	23.6	28.8	30.1	35.4	42.9	38.3	42.6		39.7	40.1	34.2			35.4
52.3	17.8	33.7	31.6	15.6	20.3	22.2	27.4	34.5	29.6	33.7		32.3	31.1	26.9			29.3
37.0	11.1	27.8	25.7	10.4	14.5	16.6	21.3	27.8	23.2	26.6		26.8	24.5	21.4			24.2
26.2	8.0	23.2	21.2	7.1	11.0	12.5	16.8	22.5	18.9	21.1		22.1	19.3	17.2			19.9
18.5	6.1	19.1	17.2	4.8	8.4	9.7	13.4	17.9	15.2	16.4		17.4	14.7	14.1			15.8
13.1	3.8	14.5	13.0	3.0	6.1	7.2	9.9	13.1	11.6	11.8		12.8	10.1	11.0			11.2
9.3	2.3	10.6	9.4	1.8	4.3	5.2	7.0	9.0	8.8	8.2		8.9	6.5	8.4			7.7
6.5	1.6	7.7	6.9	1.3	3.1	3.8	4.9	6.2	6.5	5.7		6.2	4.3	6.5			5.2
4.6	0.7	4.8	4.3	0.6	1.8	2.2	2.7	3.6	4.1	3.4		3.5	2.1	4.4			2.8
3.3	0.1	2.6	2.3	0.1	0.9	1.0	1.2	1.7	2.2	1.6		1.6	0.6	2.6			1.3
dv	0.117	0.102	0.105	0.126	0.132	0.119	0.139	0.123	0.111	0.123		0.125	0.100	0.113			0.118
05%	15.9	4.7	5.0	19.0	10.9	8.9	6.6	5.5	5.2	5.8		5.6	7.4	5.1			6.3
50%	135.7	99.6	104.4	141.9	133.5	131.9	117.9	94.4	106.9	95.3		109.7	102.7	123.4			131.6
95%	275.2	267.0	269.4	273.5	275.3	276.0	273.1	266.5	269.2	264.5		272.5	260.3	275.6			472.6
mv	139.5	112.1	116.3	143.1	136.6	135.3	125.0	110.3	118.2	110.5		119.6	113.1	128.7			169.1

ILLINOIS NO. 6 SEAM 24–HOUR RUN DATA: MICROTRAC OF MILL CIRCUIT FEED

Shift >	18	19	20	21	22	23	24	25	26	27	28	29	30	avg	max	min	std
Microns																	
296.0	83.8	84.9	84.2	80.2	86.3	84.0	80.6		79.8	79.9	82.9		82	91.6	100.0	79.8	8.9
209.3	69.4	72.5	70.6	65.3	73.9	69.7	64.4		65.0	64.4	67.9		64.2	73.9	84.3	64.2	6.7
148.0	56.8	58.7	55.8	52.3	61.5	56.1	49.6		52.0	50.8	53.4		46.3	57.3	66.6	46.3	5.5
104.7	46.7	47.6	44.1	42.0	50.9	44.1	39.2		41.7	40.4	42.8		32	44.6	53.2	32.0	5.5
74.0	37.9	39.5	34.8	33.7	41.8	34.7	31.5		33.6	32.6	34.9		21.6	35.0	42.9	21.6	5.6
52.3	31.0	31.7	26.5	27.0	33.1	29.2	24.3		27.4	26.4	28.0		15	27.4	34.5	15.0	5.4
37.0	25.7	25.7	20.2	21.5	26.1	24.1	19.5		22.4	21.8	22.9		10.3	21.7	27.8	10.3	5.2
26.2	21.5	21.8	15.8	17.5	21.3	20.0	16.7		18.5	17.9	19.2		6.99	17.5	23.2	7.0	4.7
18.5	17.6	18.2	12.0	14.1	17.2	16.9	14.0		15.1	14.1	15.6		4.92	14.0	19.1	4.8	4.1
13.1	13.5	14.2	8.3	10.5	13.1	13.5	11.1		11.4	10.2	11.9		3.19	10.4	14.5	3.0	3.3
9.3	10.1	11.0	5.3	7.6	10.0	10.6	8.7		8.6	7.1	8.7		2.05	7.5	11.0	1.8	2.6
6.5	7.4	8.5	3.4	5.4	7.6	8.2	6.7		6.5	5.0	6.4		1.42	5.5	8.5	1.3	2.0
4.6	4.6	5.6	1.8	3.2	5.1	5.4	4.4		4.2	3.0	3.9		0.7	3.3	5.6	0.6	1.4
3.3	2.6	3.3	0.7	1.7	3.1	3.2	2.6		2.4	1.5	2.1		0.2	1.7	3.3	0.1	1.0
dv	0.109	0.091	0.130	0.118	0.097	0.095	0.103		0.1	0.11	0.1		0.16	0.115	0.158	0.091	0.015
05%	4.8	4.4	8.8	6.2	4.6	4.4	5.0		5.2	6.51	5.34		18.8	7.4	19.0	4.4	4.2
50%	117.6	114.6	126.8	137.9	101.1	123.9	149.7		139	145	135		160	123.2	160.1	94.4	17.8
95%	433.1	408.9	448.1	497.3	402.1	433.2	447.4		462	437	453		439	354.1	497.3	260.3	88.6
mv	154.9	145.6	160.3	174.9	140.2	157.2	174.0		172	171	164		184	143.0	183.9	110.3	23.3

ILLINOIS NO. 6 SEAM 24–HOUR RUN DATA: MICROTRAC OF COLUMN FLOTATION FEED

Shift >	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
Microns																	
296.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	99.8		99.7
209.3	98.9	98.3	98.8	99.4	98.6	99.6	98.9	99.6	98.1	99.3	97.9	98.2	99.3	98.4	98.1		98.3
148.0	96.4	95.2	96.2	97.7	95.6	97.9	96.3	98.2	94.9	97.3	94.7	95.4	97.3	95.4	95.4		97.1
104.7	92.5	90.8	92.4	94.3	91.2	94.5	92.3	95.1	90.7	93.8	90.1	91.7	93.7	91.1	91.7		95.5
74.0	85.1	83.4	85.6	87.1	83.4	87.5	84.7	88.2	83.0	86.5	82.3	84.8	86.3	83.4	84.9		91.2
52.3	73.9	72.4	74.8	76.0	71.9	76.5	73.1	76.9	71.3	75.3	71.2	74.2	75.3	72.2	74.5		83.9
37.0	61.1	59.4	62.1	62.8	58.5	63.6	59.8	63.5	57.6	62.1	58.3	61.8	52.5	59.4	62.0		73.8
26.2	49.2	47.4	50.2	50.8	46.5	51.7	47.9	51.4	44.9	49.6	46.4	50.3	50.7	48.0	50.4		62.9
18.5	38.5	36.8	39.8	40.0	36.3	41.1	37.4	40.7	33.5	38.2	35.7	40.2	40.2	38.4	40.0		51.6
13.1	28.5	26.5	29.5	29.6	26.4	30.9	27.1	30.2	22.6	27.1	24.9	30.2	29.8	29.1	29.8		40.0
9.3	20.6	18.4	21.1	21.3	18.7	22.6	19.1	21.9	14.6	18.5	16.7	21.9	21.4	21.7	21.5		30.4
6.5	14.9	13.0	15.2	15.3	13.3	16.6	13.5	16.0	9.6	12.8	11.4	15.8	15.4	16.3	15.6		23.1
4.6	10.0	8.3	10.1	10.0	8.5	11.1	8.6	10.8	5.6	8.0	6.8	10.3	10.1	11.3	10.3		16.1
3.3	6.3	5.0	6.2	6.1	5.1	7.0	5.1	6.9	3.0	4.6	3.7	6.2	7.7	7.4	6.4		10.6
dv	0.145	0.210	0.158	0.177	0.162	0.179	0.157	0.183	0.190	0.218	0.159	0.174	0.177	0.182	0.178		0.137
05%	2.7	3.3	2.8	2.8	3.2	2.6	3.2	2.6	4.4	3.5	3.9	2.8	2.8	2.4	2.7		2.0
50%	26.9	28.5	26.0	25.5	29.2	24.8	28.0	25.0	30.4	26.5	29.4	25.9	25.6	28.0	25.8		17.6
95%	128.3	145.4	131.1	109.9	139.1	108.8	129.8	103.8	150.1	114.8	153.5	141.1	115.8	141.8	141.7		98.9
mv	40.4	43.6	39.9	37.2	43.2	36.3	41.4	35.8	45.4	38.6	45.5	41.3	38.1	42.8	41.5		31.3

ILLINOIS NO. 6 SEAM 24–HOUR RUN DATA: MICROTRAC OF COLUMN FLOTATION FEED

Shift >	18	19	20	21	22	23	24	25	26	27	28	29	30	avg	max	min	std
Microns																	
296.0	100.0	100.0	99.7	100.0	99.7	100.0	99.9	100.0	98.7	100.0	99.8	99.9	99.8	99.9	100.0	98.7	0.2
209.3	99.4	99.3	97.6	99.1	97.9	99.2	97.8	98.9	94.9	98.9	97.7	98.5	98.7	98.5	99.6	94.9	0.9
148.0	97.7	97.7	94.2	96.5	95.0	96.1	93.5	96.0	90.1	96.2	93.7	94.9	96.2	95.8	98.2	90.1	1.6
104.7	94.8	95.0	90.0	93.3	90.6	90.6	88.7	91.1	84.6	91.3	87.4	88.5	91.2	91.7	95.5	84.6	2.4
74.0	88.8	88.9	82.8	86.9	82.0	81.0	81.4	82.1	76.3	81.1	76.8	77.5	81.9	83.9	91.2	76.3	3.5
52.3	78.6	78.5	71.7	75.8	69.4	67.5	70.0	69.4	64.9	67.2	63.4	63.8	69.5	72.5	83.9	63.4	4.6
37.0	66.0	65.5	58.9	63.0	56.4	53.1	57.7	55.9	52.8	53.3	50.4	50.3	56.3	59.2	73.8	50.3	5.1
26.2	54.3	53.2	47.4	51.6	45.2	41.6	47.3	44.7	42.5	41.9	39.6	39.4	44.9	48.0	62.9	39.4	4.8
18.5	43.5	42.2	37.2	40.7	35.5	32.4	33.8	35.3	33.2	32.7	30.7	30.6	35.4	37.6	51.6	30.6	4.3
13.1	32.9	31.3	27.4	29.8	26.3	23.5	28.3	26.3	24.3	24.0	22.4	22.5	26.5	27.8	40.0	22.4	3.6
9.3	24.6	22.9	19.7	21.3	19.1	16.6	20.8	19.3	17.4	17.4	16.0	16.4	19.6	20.1	30.4	14.6	3.0
6.5	18.5	16.9	14.3	15.2	14.0	11.8	15.3	14.3	12.7	12.9	11.7	12.2	14.7	14.6	23.1	9.6	2.5
4.6	12.8	11.6	9.5	9.8	9.5	7.6	10.3	9.8	8.4	8.7	7.7	8.3	10.1	9.7	16.1	5.6	1.9
3.3	8.4	7.5	5.9	6.0	6.1	4.5	6.5	6.3	5.2	5.5	4.8	5.2	6.58	6.1	10.6	3.0	1.4
dv	0.183	0.185	0.174	0.164	0.192	0.208	0.181	0.15	0.16	0.17	0.16	0.15	0.15	0.173	0.218	0.137	0.019
05%	2.2	2.4	2.9	2.9	2.8	3.5	2.7	2.72	3.17	3.03	3.38	3.15	2.61	2.9	4.4	2.0	0.5
50%	22.7	23.6	28.5	24.9	30.7	34.1	28.9	31.3	34	33.9	36.6	36.7	31	28.3	36.7	17.6	4.2
95%	106.5	104.5	160.2	124.5	148.7	135.6	165.7	135	211	132	164	149	133	135.3	210.8	98.9	23.3
mv	34.8	35.3	45.3	38.4	45.8	45.8	46.5	44.1	57	45.6	52	50.1	44.2	42.3	57.0	31.3	5.4

ILLINOIS NO. 6 SEAM
24-HOUR DEMONSTRATION RUN RESULTS

Illinois No. 6 Seam
Long Duration Tests

Test Number	Goodness–of–Fit		
	Ash	Other	Total
94010301	15.70	11.07	26.77
94010302	6.98	20.96	27.94
94010303	3.98	5.96	9.94
94010304	3.16	6.23	9.39
94010305	8.84	12.02	20.86
94010307	5.53	10.78	16.31
94010308	4.32	9.33	13.65
94010309	6.05	10.33	16.38
94010310	2.45	4.08	6.53
94010313	5.29	9.39	14.68
94010315	5.41	5.61	11.02
94010317	5.54	17.85	23.39
94010318	5.76	15.84	21.60
94010320	5.57	21.79	27.36
94010322	11.81	18.65	30.46
94010323	8.06	22.74	30.80
94010325	2.23	8.01	10.24
94010326	13.13	11.73	24.86
94010327	4.77	18.74	23.51
94010328	3.55	5.08	8.63
94010329	4.52	8.10	12.62
Average	6.3	12.1	18.4

Illinois No. 6 Seam
Long Duration Tests

Test Number	Relative Plant Feed (%)	Relative Deslime U/F (%)	Relative HMC Reject (%)	Relative WOC O/F (%)	Relative WOC U/F (%)	Relative Column Feed (%)	Relative Column Product (%)	Relative Column Reject (%)	Re Thi F
94010301	100.00	75.57	24.43	73.11	2.46	73.11	56.86	16.25	
94010302	100.00	72.74	27.26	70.47	2.27	70.47	53.46	17.02	
94010303	100.00	77.56	22.44	74.98	2.59	74.98	57.45	17.53	
94010304	100.00	76.82	23.18	73.44	3.38	73.44	56.48	16.96	
94010305	100.00	80.53	19.47	77.19	3.34	77.19	60.49	16.70	
94010307	100.00	80.59	19.41	77.83	2.75	77.83	58.84	18.99	
94010308	100.00	82.65	17.35	79.28	3.37	79.28	60.86	18.42	
94010309	100.00	82.62	17.38	81.03	1.59	81.03	61.90	19.14	
94010310	100.00	86.31	13.69	81.91	4.40	81.91	62.19	19.72	
94010313	100.00	87.26	12.74	84.12	3.14	84.12	64.22	19.90	
94010315	100.00	82.70	17.30	76.73	5.96	76.73	56.47	20.27	
94010317	100.00	82.12	17.88	79.80	2.32	79.80	58.22	21.58	
94010318	100.00	81.51	18.49	77.16	4.35	77.16	56.02	21.14	
94010320	100.00	72.26	27.74	70.95	1.31	70.95	58.04	12.91	
94010322	100.00	85.17	14.83	82.00	3.17	82.00	61.12	20.87	
94010323	100.00	78.03	21.97	76.04	1.99	76.04	56.31	19.73	
94010325	100.00	79.10	20.90	73.60	5.50	73.60	56.37	17.23	
94010326	100.00	81.77	18.23	75.93	5.84	75.93	54.53	21.40	
94010327	100.00	74.12	25.88	71.34	2.78	71.34	54.81	16.52	
94010328	100.00	80.55	19.45	76.02	4.52	76.02	56.99	19.03	
94010329	100.00	73.38	26.62	71.65	1.73	71.65	55.06	16.59	
Average	100.0	79.7	20.3	76.4	3.3	76.4	57.9	18.5	
Maximum	100.0	87.3	27.7	84.1	6.0	84.1	64.2	21.6	
Minimum	100.0	72.3	12.7	70.5	1.3	70.5	53.5	12.9	
Range	0.0	15.0	15.0	13.7	4.7	13.7	10.8	8.7	
Std.Deviation	0.0	4.3	4.3	3.8	1.3	3.8	2.8	2.1	
# of Points	21	21	21	21	21	21	21	21	

Illinois No. 6 Seam
Long Duration Tests

Test Number	Measured Plant Feed Ash (%)	Adjusted Plant Feed Ash (%)	Measured Deslime U/F Ash (%)	Adjusted Deslime U/F Ash (%)	Measured HMC Reject Ash (%)	Adjusted HMC Reject Ash (%)	Measured WOC O/F Ash (%)	Adjusted WOC O/F Ash (%)	Measured WOC U/F Ash (%)	Adjusted WOC U/F Ash (%)
94010301	36.79	35.33	24.09	21.47	76.65	78.20	18.00	20.40	53.04	53.22
94010302	34.95	37.21	24.10	22.90	78.48	75.38	20.29	21.88	54.54	54.67
94010303	36.02	35.41	23.42	23.10	77.32	77.95	20.90	22.01	54.93	54.72
94010304	34.33	35.15	23.08	22.92	76.63	75.68	21.25	21.52	53.67	53.20
94010305	33.82	32.73	22.36	21.65	77.43	78.54	18.60	20.39	51.09	50.92
94010307	35.12	33.69	22.86	22.92	77.10	78.43	20.65	21.80	54.88	54.61
94010308	34.17	32.40	23.30	22.96	75.88	77.39	20.57	21.73	51.82	51.73
94010309	33.34	31.47	21.84	21.50	78.01	78.89	19.73	20.84	22.19	55.02
94010310	31.47	31.37	24.20	24.12	77.05	77.13	21.80	22.47	55.20	54.82
94010313	31.84	29.12	22.88	22.93	69.81	71.48	21.68	21.85	52.10	52.03
94010315	36.36	34.34	26.24	25.69	74.23	75.69	22.48	23.61	52.68	52.46
94010317	34.47	34.90	27.27	25.17	80.02	79.60	23.14	24.40	51.99	51.97
94010318	33.09	34.28	25.27	24.79	77.29	76.09	22.83	23.08	55.78	55.11
94010320	39.35	36.64	20.48	19.69	77.85	80.79	17.83	19.08	52.60	52.67
94010322	36.76	32.74	24.98	24.55	77.13	79.76	21.45	23.42	53.80	53.80
94010323	39.63	36.40	23.70	23.95	77.89	80.63	22.06	23.10	56.85	56.64
94010325	37.53	35.99	24.70	24.34	78.66	80.08	21.20	22.18	53.21	53.26
94010326	36.07	34.74	26.13	25.03	77.16	78.27	23.90	22.89	53.53	52.90
94010327	41.39	37.98	23.21	23.24	77.15	80.21	21.36	21.79	60.42	60.29
94010328	35.32	35.72	26.95	25.24	79.50	79.11	22.67	23.25	58.60	58.61
94010329	37.60	36.78	21.49	21.54	77.85	78.79	19.84	20.74	54.71	54.47

Average	35.69	34.49	23.93	23.32	77.10	78.00	21.06	22.02	52.74	54.15
Maximum	41.39	37.98	27.27	25.69	80.02	80.79	23.90	24.40	60.42	60.29
Minimum	31.47	29.12	20.48	19.69	69.81	71.48	17.83	19.08	22.19	50.92
Range	9.92	8.86	6.79	6.00	10.21	9.31	6.07	5.32	38.23	9.37
Std.Deviation	2.46	2.16	1.73	1.51	2.01	2.16	1.58	1.24	7.18	2.20
# of Points	21	21	21	21	21	21	21	21	21	21

Illinois No. 6 Seam
Long Duration Tests

Test Number	Measured Column Feed Ash (%)	Adjusted Column Feed Ash (%)	Measured Column Product Ash (%)	Adjusted Column Product Ash (%)	Measured Column Reject Ash (%)	Adjusted Column Reject Ash (%)	Measured Thickener Feed Ash (%)	Adj Thic F A (
94010301	21.22	20.40	7.13	7.11	71.04	66.88	61.86	
94010302	23.13	21.88	7.09	7.06	68.65	68.44	67.61	
94010303	22.84	22.01	7.45	7.45	73.54	69.75	64.52	
94010304	21.97	21.52	7.14	7.14	73.43	69.39	63.00	
94010305	21.54	20.39	7.31	7.29	72.65	67.83	61.46	
94010307	22.76	21.80	6.97	6.97	72.03	67.74	62.42	
94010308	22.18	21.73	7.34	7.34	72.45	69.29	63.72	
94010309	21.36	20.84	7.00	6.99	71.11	65.64	60.82	
94010310	23.20	22.47	7.02	7.03	74.29	71.16	65.03	
94010313	21.11	21.85	8.53	8.54	67.70	64.79	60.23	
94010315	23.84	23.61	6.99	6.99	74.00	69.89	62.05	
94010317	24.49	24.40	7.83	7.84	72.45	69.05	64.12	
94010318	23.22	23.08	6.21	6.20	73.84	67.81	61.10	
94010320	19.43	19.08	8.16	8.16	69.65	68.14	65.19	
94010322	24.17	23.42	7.54	7.54	74.12	69.90	64.01	
94010323	23.61	23.10	7.12	7.12	73.98	68.68	63.39	
94010325	22.49	22.18	6.54	6.53	75.08	73.35	66.97	
94010326	21.13	22.89	6.77	6.77	71.08	63.94	55.84	
94010327	21.65	21.79	7.02	7.02	73.51	70.78	66.50	
94010328	22.66	23.25	7.21	7.20	74.42	71.31	66.22	
94010329	21.77	20.74	6.81	6.82	70.92	66.96	62.23	
Average	22.37	22.02	7.20	7.20	72.38	68.61	63.25	(
Maximum	24.49	24.40	8.53	8.54	75.08	73.35	67.61	(
Minimum	19.43	19.08	6.21	6.20	67.70	63.94	55.84	(
Range	5.06	5.32	2.32	2.34	7.38	9.41	11.77	
Std.Deviation	1.19	1.24	0.50	0.50	1.95	2.18	2.63	
# of Points	21	21	21	21	21	21	21	

Illinois No. 6 Seam
Long Duration Tests

Test Number	Measured Plant Feed Sulfur (%)	Adjusted Plant Feed Sulfur (%)	Measured Deslime U/F Sulfur (%)	Adjusted Deslime U/F Sulfur (%)	Measured HMC Reject Sulfur (%)	Adjusted HMC Reject Sulfur (%)	Measured WOC O/F Sulfur (%)	Adjusted WOC O/F Sulfur (%)	Measured WOC U/F Sulfur (%)	Adjusted WOC U/F Sulfur (%)
94010301	3.81	4.45	3.10	3.24	9.05	8.17	3.31	3.03	10.30	9.74
94010302	7.57	4.97	3.12	3.08	9.00	10.00	2.80	2.80	11.95	11.81
94010303	3.63	3.85	3.14	2.99	7.00	6.82	2.82	2.77	9.34	9.21
94010304	5.88	5.56	3.09	3.13	13.21	13.59	2.77	2.75	11.79	11.43
94010305	3.90	4.35	3.34	3.21	9.59	9.06	2.92	2.85	12.25	11.48
94010307	3.45	3.96	3.23	3.11	8.01	7.48	3.04	2.89	9.67	9.43
94010308	3.61	4.12	3.26	3.19	9.16	8.59	2.96	2.84	11.87	11.44
94010309	3.68	4.10	3.42	3.11	9.28	8.81	3.06	2.96	10.91	10.80
94010310	3.90	3.90	3.11	3.24	8.07	8.07	2.99	2.85	10.74	10.55
94010313	3.53	4.12	3.35	3.25	10.80	10.09	3.00	2.92	12.53	12.24
94010315	3.79	4.47	3.41	3.44	10.22	9.37	2.97	2.81	12.14	11.54
94010317	4.00	3.85	2.83	3.09	7.24	7.33	3.04	2.86	11.22	10.96
94010318	5.29	4.22	2.95	3.30	7.81	8.24	3.10	2.87	11.48	11.05
94010320	3.32	4.26	3.26	3.15	9.09	7.14	3.35	3.00	11.62	11.40
94010322	3.27	4.16	3.27	3.23	11.01	9.51	3.17	2.97	10.24	10.06
94010323	3.20	4.10	3.40	3.12	9.22	7.58	3.14	2.85	13.44	13.21
94010325	3.90	4.47	3.01	3.13	10.42	9.56	3.04	2.74	8.80	8.35
94010326	3.65	4.17	3.00	3.16	9.32	8.70	2.97	2.73	9.36	8.76
94010327	3.56	4.50	3.20	3.17	10.33	8.29	3.06	2.87	11.06	10.82
94010328	4.38	4.10	3.15	3.29	7.32	7.47	2.88	2.92	9.97	9.48
94010329	3.74	4.08	3.00	3.06	7.22	6.89	2.89	2.88	10.53	10.39

Average	4.05	4.27	3.17	3.18	9.16	8.61	3.01	2.86	11.01	10.67
Maximum	7.57	5.56	3.42	3.44	13.21	13.59	3.35	3.03	13.44	13.21
Minimum	3.20	3.85	2.83	2.99	7.00	6.82	2.77	2.73	8.80	8.35
Range	4.37	1.71	0.59	0.45	6.21	6.77	0.58	0.30	4.64	4.86
Std.Deviation	1.00	0.38	0.16	0.10	1.49	1.48	0.15	0.08	1.17	1.18
# of Points	21	21	21	21	21	21	21	21	21	21

Illinois No. 6 Seam
Long Duration Tests

Test Number	Measured Column Feed Sulfur (%)	Adjusted Column Feed Sulfur (%)	Measured Column Product Sulfur (%)	Adjusted Column Product Sulfur (%)	Measured Column Reject Sulfur (%)	Adjusted Column Reject Sulfur (%)	Measured Thickener Feed Sulfur (%)	Adj Thic F Su
94010301	3.22	3.03	3.27	3.25	2.37	2.23	2.97	
94010302	2.87	2.80	2.66	2.90	2.50	2.50	3.45	
94010303	2.65	2.77	2.97	2.91	2.39	2.32	3.09	
94010304	2.63	2.75	2.97	2.89	2.40	2.31	3.61	
94010305	2.89	2.85	2.97	2.97	2.58	2.43	3.58	
94010307	2.99	2.89	2.99	3.02	2.55	2.48	3.22	
94010308	2.76	2.84	3.15	2.99	2.40	2.31	3.56	
94010309	2.96	2.96	2.99	3.07	2.66	2.60	3.11	
94010310	2.84	2.85	2.97	2.97	2.49	2.46	3.86	
94010313	2.93	2.92	3.16	3.00	2.71	2.64	3.88	
94010315	2.88	2.81	3.03	2.94	2.49	2.45	4.42	
94010317	2.55	2.86	3.34	2.92	2.92	2.69	3.34	
94010318	2.93	2.87	2.92	3.06	2.38	2.34	3.61	
94010320	3.02	3.00	3.18	3.03	2.94	2.86	3.55	
94010322	3.25	2.97	3.30	3.15	2.42	2.42	3.50	
94010323	3.00	2.85	2.97	2.99	2.46	2.46	3.42	
94010325	2.91	2.74	2.86	2.94	2.13	2.10	3.47	
94010326	2.81	2.73	2.90	2.85	2.51	2.42	3.58	
94010327	3.03	2.87	3.06	2.97	2.55	2.53	3.73	
94010328	3.04	2.92	3.03	3.06	2.64	2.51	3.54	
94010329	3.02	2.88	3.06	3.02	2.47	2.42	3.10	
Average	2.91	2.86	3.04	3.00	2.52	2.45	3.50	
Maximum	3.25	3.03	3.34	3.25	2.94	2.86	4.42	
Minimum	2.55	2.73	2.66	2.85	2.13	2.10	2.97	
Range	0.70	0.30	0.68	0.40	0.81	0.76	1.45	
Std.Deviation	0.17	0.08	0.15	0.09	0.18	0.16	0.32	
# of Points	21	21	21	21	21	21	21	

Illinois No. 6 Seam
Long Duration Tests

Test Number	Measured Plant Feed Pyritic (%)	Adjusted Plant Feed Pyritic (%)	Measured Deslime U/F Pyritic (%)	Adjusted Deslime U/F Pyritic (%)	Measured HMC Reject Pyritic (%)	Adjusted HMC Reject Pyritic (%)	Measured WOC O/F Pyritic (%)	Adjusted WOC O/F Pyritic (%)	Measured WOC U/F Pyritic (%)	Adjusted WOC U/F Pyritic (%)
94010301	2.37	2.60	1.48	1.24	7.35	6.80	1.12	1.03	7.73	7.66
94010302	4.02	2.57	1.44	1.14	5.63	6.40	0.98	0.90	8.74	8.59
94010303	2.02	2.23	1.40	1.28	5.87	5.48	1.05	1.06	8.15	7.71
94010304	3.45	3.54	1.60	1.45	10.70	10.49	0.97	1.09	8.97	9.07
94010305	2.09	2.28	1.72	1.26	6.92	6.51	1.21	1.12	4.30	4.43
94010307	2.15	2.47	1.56	1.47	7.31	6.60	1.32	1.23	8.67	8.34
94010308	2.11	2.51	1.63	1.47	8.61	7.46	1.27	1.19	8.17	8.10
94010309	2.09	2.18	1.66	1.22	6.90	6.73	1.29	1.07	9.07	8.81
94010310	2.12	2.16	1.36	1.46	6.59	6.54	1.20	1.07	9.14	8.77
94010313	1.54	2.00	1.56	1.41	7.38	6.04	1.19	1.14	8.61	8.53
94010315	2.27	2.45	1.71	1.58	6.89	6.60	1.16	1.07	8.25	8.16
94010317	2.15	1.99	1.12	1.28	5.13	5.29	1.17	1.08	7.92	7.84
94010318	2.82	2.36	1.58	1.37	6.29	6.71	1.16	1.00	8.02	8.02
94010320	1.74	2.24	1.53	1.29	6.82	4.70	1.24	1.16	8.45	4.49
94010322	1.51	1.96	1.34	1.38	6.59	5.32	1.27	1.17	7.63	6.69
94010323	1.93	2.29	1.48	1.31	6.80	5.81	1.26	1.12	8.44	8.34
94010325	2.82	2.86	1.38	1.33	8.76	8.68	1.21	0.95	6.48	6.37
94010326	2.38	2.51	1.28	1.36	7.95	7.68	0.97	0.97	6.99	6.42
94010327	2.12	2.60	1.26	1.36	7.86	6.16	1.26	1.09	8.26	8.17
94010328	2.61	2.45	1.44	1.50	6.18	6.36	1.17	1.11	8.13	8.04
94010329	2.00	2.27	1.13	1.17	5.92	5.30	1.04	1.02	7.21	7.18
Average	2.30	2.41	1.46	1.35	7.07	6.56	1.17	1.08	7.97	7.61
Maximum	4.02	3.54	1.72	1.58	10.70	10.49	1.32	1.23	9.14	9.07
Minimum	1.51	1.96	1.12	1.14	5.13	4.70	0.97	0.90	4.30	4.43
Range	2.51	1.58	0.60	0.44	5.57	5.79	0.35	0.33	4.84	4.64
Std.Deviation	0.58	0.34	0.17	0.11	1.21	1.24	0.11	0.08	1.05	1.25
# of Points	21	21	21	21	21	21	21	21	21	21

Illinois No. 6 Seam
Long Duration Tests

Test Number	Measured Column Feed Pyritic (%)	Adjusted Column Feed Pyritic (%)	Measured Column Product Pyritic (%)	Adjusted Column Product Pyritic (%)	Measured Column Reject Pyritic (%)	Adjusted Column Reject Pyritic (%)	Measured Thickener Feed Pyritic (%)	Adj Thic F Py (
94010301	0.96	1.03	0.84	0.88	1.57	1.55	2.22	
94010302	1.00	0.90	0.52	0.60	1.74	1.83	2.26	
94010303	1.00	1.06	0.93	0.89	1.82	1.61	2.14	
94010304	1.03	1.09	1.01	0.90	1.87	1.74	2.90	
94010305	1.22	1.12	0.71	0.80	2.03	2.28	2.73	
94010307	1.32	1.23	0.93	0.99	2.00	1.98	2.59	
94010308	1.07	1.19	1.10	1.04	1.74	1.69	2.66	
94010309	1.04	1.07	0.78	0.89	1.70	1.66	1.92	
94010310	1.05	1.07	0.81	0.82	1.89	1.88	3.07	
94010313	1.13	1.14	1.04	0.98	1.67	1.67	2.76	
94010315	1.00	1.07	0.87	0.88	1.62	1.61	3.00	
94010317	0.84	1.08	1.88	0.91	1.88	1.57	2.25	
94010318	1.01	1.00	0.63	0.70	1.69	1.79	2.58	
94010320	0.99	1.16	1.13	0.99	1.99	1.93	2.60	
94010322	1.37	1.17	1.01	1.00	1.91	1.68	2.05	
94010323	1.29	1.12	0.76	0.84	1.80	1.91	2.41	
94010325	1.00	0.95	0.68	0.77	1.44	1.54	2.59	
94010326	0.96	0.97	0.74	0.71	1.80	1.65	2.48	
94010327	1.15	1.09	0.84	0.85	1.80	1.89	3.04	
94010328	1.19	1.11	0.81	0.86	1.81	1.87	3.02	
94010329	0.95	1.02	0.88	0.80	1.81	1.75	2.34	
Average	1.07	1.08	0.90	0.86	1.79	1.77	2.55	
Maximum	1.37	1.23	1.88	1.04	2.03	2.28	3.07	
Minimum	0.84	0.90	0.52	0.60	1.44	1.54	1.92	
Range	0.53	0.33	1.36	0.44	0.59	0.74	1.15	
Std.Deviation	0.13	0.08	0.27	0.11	0.14	0.17	0.33	
# of Points	21	21	21	21	21	21	21	

Illinois No. 6 Seam
Long Duration Tests

Test Number	Measured Plant Feed Btu/lb	Adjusted Plant Feed Btu/lb	Measured Deslime U/F Btu/lb	Adjusted Deslime U/F Btu/lb	Measured HMC Reject Btu/lb	Adjusted HMC Reject Btu/lb	Measured WOC O/F Btu/lb	Adjusted WOC O/F Btu/lb	Measured WOC U/F Btu/lb	Adjusted WOC U/F Btu/lb
94010301	8700	8920	10840	11160	1990	1980	11800	11320	6110	6250
94010302	9030	8640	10950	11170	1860	1870	11450	11350	5650	5650
94010303	8970	9080	11080	11080	2190	2190	11410	11260	5660	5800
94010304	9170	9020	10980	11100	2120	2120	11380	11330	5870	6060
94010305	9340	9470	11110	11250	2110	2100	11850	11460	5990	6220
94010307	9050	9240	10990	10970	2060	2060	11450	11140	5830	6010
94010308	9310	9470	10890	10980	2240	2240	11430	11190	5910	6090
94010309	9520	9690	11220	11290	2060	2060	11670	11390	5890	5970
94010310	9780	9680	10860	10900	1930	1930	11360	11190	5360	5540
94010313	9710	10050	11160	11050	3260	3260	11440	11230	5870	5970
94010315	9050	9210	10800	10630	2440	2440	11140	10980	5950	6030
94010317	9090	9120	10480	10710	1830	1830	11200	10850	5920	6010
94010318	9310	9210	10720	10820	2110	2110	11120	11100	5600	5830
94010320	8490	8880	11630	11520	2030	2020	11760	11620	5810	5860
94010322	8810	9360	10800	10660	1910	1900	11200	10830	6040	6180
94010323	8620	8890	11070	10860	1890	1890	11120	10990	5450	5570
94010325	8820	8900	10660	10750	1910	1910	11190	11070	6200	6390
94010326	8800	9100	10680	10670	2070	2070	11000	11010	5880	6160
94010327	8270	8660	10960	11000	1990	1990	11360	11230	4850	4960
94010328	9240	9020	10350	10730	1920	1920	11080	11070	4970	5120
94010329	8580	8800	11340	11270	2010	2010	11570	11400	5530	5640

Average	9,031	9,162	10,932	10,980	2,092	2,090	11,380	11,191	5,730	5,872
Maximum	9,780	10,050	11,630	11,520	3,260	3,260	11,850	11,620	6,200	6,390
Minimum	8,270	8,640	10,350	10,630	1,830	1,830	11,000	10,830	4,850	4,960
Range	1,510	1,410	1,280	890	1,430	1,430	850	790	1,350	1,430
Std.Deviation	383	349	280	239	296	296	240	197	337	351
# of Points	21	21	21	21	21	21	21	21	21	21

Illinois No. 6 Seam
Long Duration Tests

Test Number	Measured Column Feed Btu/lb	Adjusted Column Feed Btu/lb	Measured Column Product Btu/lb	Adjusted Column Product Btu/lb	Measured Column Reject Btu/lb	Adjusted Column Reject Btu/lb	Measured Thickener Feed Btu/lb	Adj Thic F Bt
94010301	11370	11320	13560	13410	3680	4010	5020	
94010302	11140	11350	13600	13690	4010	4020	4230	
94010303	11290	11260	13540	13600	3270	3580	4560	
94010304	11330	11330	13520	13610	3420	3750	4940	
94010305	11370	11460	13640	13610	3320	3670	5090	
94010307	11150	11140	13460	13570	3220	3610	4940	
94010308	11140	11190	13570	13460	3370	3700	4860	
94010309	11410	11390	13600	13620	3790	4200	5180	
94010310	11010	11190	13630	13690	3070	3330	4380	
94010313	11330	11230	13300	13320	4180	4500	5300	
94010315	10970	10980	13600	13740	3230	3310	4090	
94010317	10860	10850	13400	13480	3450	3730	4480	
94010318	11040	11100	13970	13940	3210	3580	5060	
94010320	11730	11620	13470	13280	3940	4180	4710	
94010322	10960	10830	13470	13390	3090	3330	4240	
94010323	11040	10990	13530	13570	3220	3650	4920	
94010325	10940	11070	13720	13480	3040	3190	4380	
94010326	11370	11010	13790	13750	3640	4040	5780	
94010327	11400	11230	13870	13550	3230	3540	4450	
94010328	11250	11070	13620	13660	3060	3300	4190	
94010329	11340	11400	13730	13630	3580	4020	5200	

Average	11,211	11,191	13,600	13,574	3,430	3,726	4,762	
Maximum	11,730	11,620	13,970	13,940	4,180	4,500	5,780	
Minimum	10,860	10,830	13,300	13,280	3,040	3,190	4,090	
Range	870	790	670	660	1,140	1,310	1,690	
Std.Deviation	207	197	151	151	324	341	431	
# of Points	21	21	21	21	21	21	21	

Illinois No. 6 Seam
Long Duration Tests

Test Number	Plant Product Yield (%)	Plant Reject Yield (%)	Plant Energy Recovery (%)	Plant Ash Rejection (%)	Plant Sulfur Rejection (%)	Plant Pyritic Rejection (%)	Plant Separate Efficiency (%)
94010301	56.86	43.14	85.48	89.01	58.47	80.76	66.24
94010302	53.46	46.54	84.71	89.20	68.81	87.52	72.23
94010303	57.45	42.55	86.05	88.12	56.58	77.07	63.12
94010304	56.48	43.52	85.22	88.25	70.64	85.64	70.86
94010305	60.49	39.51	86.93	86.96	58.70	78.78	65.71
94010307	58.84	41.16	86.41	88.32	55.13	76.42	62.83
94010308	60.86	39.14	86.50	86.93	55.83	74.78	61.29
94010309	61.90	38.10	87.00	87.02	53.65	74.73	61.73
94010310	62.19	37.81	87.95	86.11	52.64	76.39	64.34
94010313	64.22	35.78	85.12	82.78	53.24	68.53	53.65
94010315	56.47	43.53	84.25	89.14	62.86	79.72	63.96
94010317	58.22	41.78	86.05	86.76	55.84	73.38	59.43
94010318	56.02	43.98	84.79	89.50	59.38	83.38	68.17
94010320	58.04	41.96	86.80	87.96	58.72	74.35	61.15
94010322	61.12	38.88	87.44	87.46	53.72	68.82	56.25
94010323	56.31	43.69	85.95	89.88	58.93	79.34	65.30
94010325	56.37	43.63	85.38	90.19	62.92	84.82	70.20
94010326	54.53	45.47	82.39	89.77	62.73	84.58	66.97
94010327	54.81	45.19	85.76	90.70	63.83	82.08	67.84
94010328	56.99	43.01	86.31	88.38	57.47	80.00	66.30
94010329	55.06	44.94	85.28	90.01	59.24	80.60	65.88

Average	57.9	42.1	85.8	88.2	59.0	78.7	64.4
Maximum	64.2	46.5	88.0	90.7	70.6	87.5	72.2
Minimum	53.5	35.8	82.4	82.8	52.6	68.5	53.6
Range	10.8	10.8	5.6	7.9	18.0	19.0	18.6
Std.Deviation	2.8	2.8	1.2	1.7	4.7	5.0	4.5
# of Points	21	21	21	21	21	21	21

Illinois No. 6 Seam
Long Duration Tests

Test Number	HMC Product Yield (%)	HMC Reject Yield (%)	HMC Energy Recovery (%)	HMC Ash Rejection (%)	HMC Sulfur Rejection (%)	HMC Pyritic Rejection (%)	HI Sep Effici (%
94010301	75.57	24.43	94.55	5.42	44.85	63.89	
94010302	72.74	27.26	94.04	5.90	54.85	67.88	
94010303	77.56	22.44	94.64	5.41	39.75	55.14	
94010304	76.82	23.18	94.53	5.45	56.66	68.69	
94010305	80.53	19.47	95.67	4.32	40.55	55.59	
94010307	80.59	19.41	95.68	4.33	36.66	51.86	
94010308	82.65	17.35	95.83	4.10	36.17	51.57	
94010309	82.62	17.38	96.26	3.69	37.35	53.65	
94010310	86.31	13.69	97.19	2.73	28.33	41.45	
94010313	87.26	12.74	95.94	4.13	31.20	38.47	
94010315	82.70	17.30	95.45	4.58	36.26	46.60	
94010317	82.12	17.88	96.44	3.59	34.04	47.53	
94010318	81.51	18.49	95.76	4.24	36.10	52.57	
94010320	72.26	27.74	93.74	6.31	46.49	58.20	
94010322	85.17	14.83	97.00	3.01	33.90	40.25	
94010323	78.03	21.97	95.32	4.67	40.62	55.74	
94010325	79.10	20.90	95.54	4.49	44.70	63.43	
94010326	81.77	18.23	95.88	4.15	38.03	55.78	
94010327	74.12	25.88	94.15	5.95	47.68	61.32	
94010328	80.55	19.45	95.82	4.14	35.44	50.49	
94010329	73.38	26.62	93.98	6.08	44.95	62.15	
Average	79.7	20.3	95.4	4.6	40.2	54.4	
Maximum	87.3	27.7	97.2	6.3	56.7	68.7	
Minimum	72.3	12.7	93.7	2.7	28.3	38.5	
Range	15.0	15.0	3.4	3.6	28.3	30.2	
Std.Deviation	4.3	4.3	1.0	1.0	7.0	8.3	
# of Points	21	21	21	21	21	21	

Illinois No. 6 Seam
Long Duration Tests

Test Number	WOC Product Yield (%)	WOC Reject Yield (%)	WOC Energy Recovery (%)	WOC Ash Rejection (%)	WOC Sulfur Rejection (%)	WOC Pyritic Rejection (%)	WOC Separate Efficiency (%)
94010301	96.74	3.26	98.13	8.07	9.79	20.11	18.24
94010302	96.88	3.12	98.44	7.45	11.97	23.51	21.96
94010303	96.67	3.33	98.24	7.91	10.29	20.11	18.36
94010304	95.60	4.40	97.58	10.21	16.07	27.52	25.10
94010305	95.85	4.15	97.64	9.75	14.83	14.58	12.22
94010307	96.58	3.42	98.07	8.13	10.35	19.36	17.43
94010308	95.92	4.08	97.76	9.19	14.62	22.47	20.22
94010309	98.08	1.92	98.94	4.92	6.68	13.90	12.84
94010310	94.90	5.10	97.43	11.59	16.60	30.62	28.05
94010313	96.40	3.60	97.97	8.17	13.55	21.77	19.74
94010315	92.78	7.22	95.84	14.72	24.18	37.22	33.06
94010317	97.17	2.83	98.45	5.83	10.02	17.30	15.75
94010318	94.66	5.34	97.11	11.86	17.87	31.24	28.35
94010320	98.19	1.81	99.04	4.85	6.56	6.31	5.35
94010322	96.28	3.72	97.81	8.16	11.59	18.04	15.86
94010323	97.45	2.55	98.62	6.03	10.80	16.24	14.85
94010325	93.05	6.95	95.82	15.21	18.55	33.30	29.12
94010326	92.86	7.14	95.82	15.09	19.80	33.71	29.53
94010327	96.25	3.75	98.26	9.73	12.80	22.53	20.79
94010328	94.38	5.62	97.37	13.03	16.17	30.08	27.44
94010329	97.64	2.36	98.77	5.96	8.01	14.47	13.24
Average	95.9	4.1	97.8	9.3	13.4	22.6	20.4
Maximum	98.2	7.2	99.0	15.2	24.2	37.2	33.1
Minimum	92.8	1.8	95.8	4.8	6.6	6.3	5.3
Range	5.4	5.4	3.2	10.4	17.6	30.9	27.7
Std.Deviation	1.6	1.6	0.9	3.2	4.4	7.7	6.9
# of Points	21	21	21	21	21	21	21

Illinois No. 6 Seam
Long Duration Tests

Test Number	Column Product Yield (%)	Column Reject Yield (%)	Column Energy Recovery (%)	Column Ash Rejection (%)	Column Sulfur Rejection (%)	Column Pyritic Rejection (%)	Colu Sepa Effici (%
94010301	77.77	22.23	92.13	72.87	16.36	33.45	
94010302	75.86	24.14	91.50	75.55	21.56	49.11	
94010303	76.62	23.38	92.54	74.09	19.58	35.51	
94010304	76.91	23.09	92.38	74.46	19.40	36.87	
94010305	78.37	21.63	93.07	71.97	18.45	44.04	
94010307	75.60	24.40	92.09	75.82	20.94	39.28	
94010308	76.77	23.23	92.34	74.09	18.90	33.00	
94010309	76.39	23.61	91.35	74.40	20.75	36.65	
94010310	75.92	24.08	92.89	76.24	20.78	42.30	
94010313	76.34	23.66	90.55	70.15	21.39	34.65	
94010315	73.60	26.40	92.10	78.20	23.03	39.75	
94010317	72.96	27.04	90.64	76.53	25.44	39.31	
94010318	72.60	27.40	91.18	80.50	22.34	49.04	
94010320	81.80	18.20	93.49	64.98	17.35	30.27	
94010322	74.54	25.46	92.16	75.96	20.74	36.55	
94010323	74.05	25.95	91.44	77.14	22.40	44.25	
94010325	76.59	23.41	93.26	77.42	17.94	37.95	
94010326	71.82	28.18	89.69	78.73	24.98	47.94	
94010327	76.83	23.17	92.70	75.22	20.41	40.15	
94010328	74.97	25.03	92.51	76.78	21.52	42.17	
94010329	76.85	23.15	91.88	74.75	19.46	39.73	

Average	75.9	24.1	92.0	75.0	20.7	39.6	
Maximum	81.8	28.2	93.5	80.5	25.4	49.1	
Minimum	71.8	18.2	89.7	65.0	16.4	30.3	
Range	10.0	10.0	3.8	15.5	9.1	18.8	
Std.Deviation	2.2	2.2	0.9	3.2	2.2	5.1	
# of Points	21	21	21	21	21	21	

Illinois No. 6 Seam
Long Duration Tests

Test Number	% (abs.) of Raw Coal's Energy to:			% (abs.) of Raw Coal's Pyrite to:		
	HMC Reject	WOC Reject	Column Reject	HMC Reject	WOC Reject	Column Reject
94010301	5.5	1.7	7.3	64.0	7.1	9.7
94010302	6.0	1.5	7.8	67.7	7.6	12.2
94010303	5.4	1.7	6.9	55.5	8.9	12.7
94010304	5.5	2.3	7.0	68.5	8.9	8.3
94010305	4.3	2.2	6.5	55.5	6.6	16.7
94010307	4.3	1.8	7.5	52.0	9.2	15.2
94010308	4.2	2.2	7.2	51.6	10.8	12.4
94010309	3.7	1.0	8.3	53.8	6.5	14.5
94010310	2.8	2.5	6.7	41.7	17.8	17.0
94010313	4.1	1.9	9.0	38.5	13.6	16.5
94010315	4.5	3.9	7.3	46.7	19.8	13.2
94010317	3.6	1.5	8.9	47.2	9.5	16.7
94010318	4.2	2.8	8.2	52.7	14.6	16.1
94010320	6.3	0.9	6.1	58.4	4.9	11.1
94010322	3.0	2.1	7.5	40.0	11.0	17.8
94010323	4.7	1.2	8.1	55.4	7.4	16.5
94010325	4.5	3.9	6.2	63.2	12.3	9.3
94010326	4.1	4.0	9.5	55.7	15.0	13.9
94010327	5.9	1.6	6.8	61.2	8.9	12.0
94010328	4.2	2.6	6.9	50.7	14.9	14.4
94010329	6.0	1.1	7.6	62.2	5.6	12.8

Average	4.6	2.1	7.5	54.4	10.5	13.8
Maximum	6.3	4.0	9.5	68.5	19.8	17.8
Minimum	2.8	0.9	6.1	38.5	4.9	8.3
Range	3.4	3.1	3.5	30.1	15.0	9.5
Std.Deviation	1.0	0.9	0.9	8.3	4.0	2.7
# of Points	21	21	21	21	21	21

Illinois No. 6 Seam
Long Duration Tests

Test Number	% of Total Energy Losses			% of Total Pyrite Rejectio		
	HMC Reject	WOC Reject	Column Reject	HMC Reject	WOC Reject	Co Re
94010301	37.6	11.9	50.6	79.2	8.8	
94010302	39.0	9.7	51.3	77.4	8.7	
94010303	38.4	11.9	49.7	72.0	11.5	
94010304	37.0	15.4	47.7	80.0	10.3	
94010305	33.2	16.8	50.0	70.4	8.4	
94010307	31.8	13.2	55.0	68.1	12.0	
94010308	30.9	16.1	53.0	69.0	14.5	
94010309	28.8	7.5	63.7	71.9	8.7	
94010310	23.3	20.9	55.8	54.5	23.3	
94010313	27.3	12.5	60.2	56.2	19.8	
94010315	28.9	24.8	46.4	58.5	24.9	
94010317	25.5	11.0	63.5	64.3	13.0	
94010318	27.9	18.1	54.0	63.2	17.5	
94010320	47.4	6.5	46.1	78.5	6.6	
94010322	23.9	16.7	59.5	58.2	16.0	
94010323	33.3	8.9	57.8	69.8	9.4	
94010325	30.5	27.0	42.5	74.5	14.5	
94010326	23.4	22.5	54.1	65.9	17.7	
94010327	41.1	11.2	47.7	74.6	10.8	
94010328	30.5	18.7	50.7	63.4	18.6	
94010329	40.9	7.5	51.5	77.1	7.0	
Average	32.4	14.7	52.9	68.9	13.4	
Maximum	47.4	27.0	63.7	80.0	24.9	
Minimum	23.3	6.5	42.5	54.5	6.6	
Range	24.1	20.5	21.2	25.5	18.3	
Std.Deviation	6.4	5.6	5.6	7.7	5.2	
# of Points	21	21	21	21	21	

APPENDIX C

SEMI–WORKS PLANT COST DATA AND DRAWINGS

PROCESS , SAMPLING , AND LABORATORY EQUIPMENT

FOR 20 TPH SEMI–WORKS PLANT

UNITED STATES DEPARTMENT OF ENGERY

REVISION 0

PROCESS, SAMPLING, AND LABORATORY EQUIPMENT (FACILITY 500)

20 TPH CLEAN COAL SEMI–WORKS CONCEPTUAL DESIGN
ICF KAISER ENGINEERS PROJECT NUMBER 88107–250–00

EQUIPLST.wk3

TASK 15 : 20 TONS PER HOUR, SEMI–WORKS FLOWSHEET

EQUIP. NO.	DESCRIPTION	# OF UNITS	WEIGHT	PRICE	UNIT HP	TOTAL HP	ENCL	VOLTS	RPM	MOTOR SUPPLIED	COMMENTS
100	PLANT FEED CONVEYOR	–	–	by others	–	–	–	–	–	–	BY OTHERS
105	BELT MAGNET	1	1,615	4,934	–	–	–	–	–	–	ERIEZ MODEL SE7235MCI
105.1	BELT MAGNET RECTIFIER	1	210	1,771	–	–	–	–	–	–	ERIEZ MODEL 36C 1800 WATTS
110	RAW COAL CRUSHER	1	12,000	37,100	50.00	50.00	TEFC	480	1800	YES	GUNDLACH 45 DA
111	RAW COAL CRUSHER	1	12,000	79,500	50.00	50.00	TEFC	480	1800	YES	GUNDLACH 45 DA
112	RAW COAL SCREEN	1	5,000	16,960	7.50	7.50	TEFC	480	1800	YES	TABOR 4X12 VIBRAT. INCLINED
113	OVERSIZE BUCKET ELEVATOR	1	15,000	25,355	10.00	10.00	TEFC	480	1800	YES	GOODMAN
120	RAW COAL FEED PUMP	1	5,000	13,627	15.00	15.00	TEFC	480	1800	YES	GOYNE PUMP
135	REFUSE CENTRIFUGE DRIVE	1	5,000	86,920	10.00	10.00	TEFC	480	1800	YES	CMI HVC–20
135.1	REFUSE CENTIFUGE VIBRATOR	1	–	included	7.50	7.50	TEFC	480	1800	YES	CMI HVC–20
135.2	REFUSE CENTIFUGE OIL PUMP	1	–	included	0.50	0.50	TEFC	480	1800	YES	CMI HVC–20
140	DESLIME SIEVE BEND	2	3,360	9,752	–	–	–	–	–	–	3'W,80°R,60,.35 MM,3/32 ISO
145	DESLIME SCREEN	1	9,000	20,670	10.00	10.00	TEFC	480	1800	YES	TABOR 4X12 SD VIB. HORIZONTAL
150	MIDDLINGS CRUSHER DRIVE 1	1	12,000	125,811	100.00	100.00	TEFC	480	1800	YES	GUNDLACH CAGEPACTOR
150.1	MIDDLINGS CRUSHER DRIVE 2	1	–	included	75.00	75.00	TEFC	480	1800	YES	SAME
152	OVERSIZE PROTECTION PUMP	1	5,000	12,912	40.00	40.00	TEFC	480	1800	YES	GOYNE PUMP
153	OVERSIZE PROTECTION SIEVE BEND	2	5,600	10,600	–	–	–	–	–	–	5'W,40°R,60,.35 MM,3/32 ISO
160	FINE HYDRO FEED PUMP	1	5,000	14,578	60.00	60.00	TEFC	480	1800	YES	GOYNE PUMP
165	FINE HYDROCYCLONES	5	15,600	83,475	–	–	–	–	–	–	KREBS 10" DIAMETER W/STAND
205	CLASSIFYING CYCLONE PUMP	1	5,000	30,493	200.00	200.00	TEFC	480	1800	YES	GOYNE PUMP
207	CLASSIFYING CYCLONES	8	17,640	127,624	–	–	–	–	–	–	KREBS 10" DIAMETER W/STAND
208	VARI–SIEVE	2	7,500	103,414	–	–	–	–	–	–	KREBS 5'W VARI–SIEVE
210	BALL MILL	1	186,000	606,320	750.00	750.00	TEFC	4160	900	YES	10' DIA. X 6' CONICAL BALL MILL
220	ADVANCED FLOTATION FEED PUMP	1	5,000	25,803	100.00	100.00	TEFC	480	1800	YES	GOYNE PUMP
230	ADVANCED FLOTATION CELL	4	46,000	466,400	–	–	–	–	–	–	ICF KE MICROCEL™ MODEL 12025
230.1	ADVANCED FLOTATION PUMP	4	5,000	included	75.00	300.00	TEFC	480	1800	YES	GOYNE PUMP
240	COAL STATIC THICKENER DRIVE	1	17,000	68,900	3.00	3.00	TEFC	480	1800	YES	EIMCO 50' DIAMETER HIRATE
240.1	COAL STATIC THICKENER LIFTING DEVICE	1	–	included	1.00	1.00	TEFC	480	900	YES	SAME
247	COAL THICK. CLARIFIED WATER PUMP	1	5,000	30,152	200.00	200.00	TEFC	480	1800	YES	GOYNE PUMP
249	COAL STATIC THICKENER U'FLOW PUMP	1	5,000	12,207	25.00	25.00	TEFC	480	1800	YES	GOYNE PUMP
260	CLEAN COAL FILTER DRIVE	1	122,000	1,228,710	10.00	10.00	TEFC	480	1800	YES	ANDRITZ RUTHNER, INC.
260.1	AGITATOR	3	–	included	1.50	4.50	TEFC	480	1800	YES	SAME
260.2	DISCHARGE GATES	1	–	included	30.00	30.00	TEFC	480	1800	YES	SAME
260.3	AIR COMPRESSOR	1	8,000	52,391	200.00	200.00	TEFC	480	1800	YES	AIRTEC
260.4	FILTRATE PUMP	1	5,000	8,509	5.00	5.00	TEFC	480	1800	YES	GOYNE PUMP

UNITED STATES DEPARTMENT OF ENGERY

REVISION 0

PROCESS, SAMPLING, AND LABORATORY EQUIPMENT (FACILITY 500)

20 TPH CLEAN COAL SEMI-WORKS CONCEPTUAL DESIGN
ICF KAISER ENGINEERS PROJECT NUMBER 88107-250-00

EQUIPLST.wk3

TASK 15 : 20 TONS PER HOUR, SEMI-WORKS FLOWSHEET

EQUIP. NO.	DESCRIPTION	# OF UNITS	WEIGHT	PRICE	UNIT HP	TOTAL HP	ENCL	VOLTS	RPM	MOTOR SUPPLIED	COMMENTS
260.5	LUBRICATOR	1	–	included	1.00	1.00	TEFC	480	1800	YES	ANDRITZ RUTHNER, INC.
260.6	AUXILLARY AIR COMPRESSOR	1	5,000	included	7.50	7.50	TEFC	480	1800	YES	SAME
260.7	INTERNAL CONVEYOR	1	–	included	10.00	10.00	TEFC	480	1800	YES	SAME
265	CLEAN COAL BELT	–	–	by others	–	–	–	–	–	–	BY OTHERS
275	REFUSE STATIC THICKENER DRIVE	1	17,000	74,200	3.00	3.00	TEFC	480	1800	YES	EIMCO 60' DIAMETER HIRATE
275.1	REF. STATIC THICKENER LIFTING DEVICE	1	–	included	1.00	1.00	TEFC	480	900	YES	SAME
290	REF. STATIC THICKENER U'FLOW PUMP	1	5,000	13,928	30.00	30.00	TEFC	480	1800	YES	GOYNE PUMP
315	REFUSE CONVEYOR	–	–	by others	–	–	–	–	–	–	BY OTHERS
325	HEAVY MEDIA CYCLONE PUMP	1	5,000	16,797	75.00	75.00	TEFC	480	1800	YES	GOYNE PUMP
330	HEAVY MEDIA CYCLONE	1	1,350	79,394	–	–	–	–	–	–	KREBS 20" DIAMETER CERAMIC
335	MIDS SIEVE BEND	1	2,200	4,876	–	–	–	–	–	–	3'W,80°R,60,.5 MM,3/32 ISO
340	MIDS DRAIN & RINSE SCREEN	1	18,000	23,320	20.00	20.00	TEFC	480	1800	YES	TABOR 4X16 SD VIB. HORIZONTAL
345	REFUSE SIEVE BEND	1	2,800	2,332	–	–	–	–	–	–	3'W,40°R,60,.5 MM,3/32 ISO
350	REFUSE DRAIN & RINSE SCREEN	1	12,000	23,320	15.00	15.00	TEFC	480	1800	YES	TABOR 4X16 SD VIB. HORIZONTAL
375	DILUTE MEDIA PUMP	1	5,000	11,546	10.00	10.00	TEFC	480	1800	YES	GOYNE PUMP
380	MAGNETIC SEPARATOR	1	4,700	16,960	5.00	5.00	TEFC	480	1800	YES	ERIEZ 36" DIAMETER X 9'W
385.1	MAGNETITE BIN DUST COLLECTOR	1	1,000	7,579	2.00	2.00	TEFC	480	1800	YES	AAF
390	MAGNETITE ROTARY VALVE	1	1,000	2,899	5.00	5.00	TEFC	480	1800	YES	ANDRITZ SPROUT-BAUER
395	INSTRUMENT AIR COMPRESSOR	1	2,000	12,036	25.00	25.00	TEFC	480	1800	YES	AIRTEC
395.1	INSTRUMENT AIR DRYER	1	500	included	–	–	–	–	–	–	SAME
395.2	PREFILTERS	1	500	included	–	–	–	–	–	–	SAME
395.3	AFTER FILTERS	2	750	included	–	–	–	–	–	–	SAME
398	PLANT & COLUMN AIR COMPRESSOR	1	8,000	52,391	200.00	200.00	TEFC	480	1800	YES	AIRTEC
398.1	PREFILTERS	1	500	included	–	–	–	–	–	–	SAME
398.2	AFTER FILTERS	2	750	included	–	–	–	–	–	–	SAME
400	FLOCCULANT SYSTEM	1	–	see below	–	–	–	–	–	–	MINETEC
400.1	ANIONIC FEEDER	1	500	1,272	0.13	0.13	TEFC	110	1800	YES	SAME
400.2	ANIONIC MIXER	1	500	1,590	1.00	1.00	TEFC	480	1800	YES	SAME
400.3	ANIONIC MIX TANK	1	1,000	4,240	–	–	–	–	–	–	SAME
400.4	ANIONIC HOLDING TANK	1	1,000	5,300	–	–	–	–	–	–	SAME
400.5	ANIONIC METERING PUMP	2	450	3,721	0.50	1.50	TEFC	110	1800	YES	SAME
400.6	CATIONIC HOLDING TANK	1	1,000	6,360	–	–	–	–	–	–	SAME
400.7	CATIONIC METERING PUMP	2	200	3,721	0.25	0.50	TEFC	110	1800	YES	SAME
400.8	SETTLING RATE DETECTOR	2	2,000	38,775	–	–	–	110	–	–	SAME
400.9	WATER CLARITY MEASURMENT	2	1,800	8,946	–	–	–	110	–	–	SAME

04

PROCESS, SAMPLING, AND LABORATORY EQUIPMENT (FACILITY 500)

20 TPH CLEAN COAL SEMI-WORKS CONCEPTUAL DESIGN
ICF KAISER ENGINEERS PROJECT NUMBER 88107-250-00

EQUIPLST.wk3

TASK 15 : 20 TONS PER HOUR, SEMI-WORKS FLOWSHEET

EQUIP. NO.	DESCRIPTION	# OF UNITS	WEIGHT	PRICE	UNIT HP	TOTAL HP	ENCL	VOLTS	RPM	MOTOR SUPPLIED	COMMENTS
400.10	pH REAGENT PUMP	1	540	1,860	0.50	0.50	TEFC	110	1800	YES	SAME
405	REAGENT SYSTEM	1	–	see below	–	–	–	–	–	–	SAME
405.1	FROTHER BULK STORAGE	1	5,000	2,385	–	–	–	–	–	–	SAME
405.2	FROTHER TRANSFER PUMP	1	500	3,721	10.00	10.00	TEFC	480	1800	YES	SAME
405.3	FROTHER DAY TANK	1	–	3,180	–	–	–	–	–	–	SAME
405.4	FROTHER REAGENT PUMPS	4	1,400	7,441	0.25	1.00	TEFC	110	1800	YES	SAME
405.5	COLLECTOR BULK STORAGE	1	5,000	2,385	–	–	–	–	–	–	SAME
405.6	COLLECTOR TRANSFER PUMP	1	500	3,721	10.00	10.00	TEFC	480	1800	YES	SAME
405.7	COLLECTOR DAY TANK	1	–	3,180	–	–	–	–	–	–	SAME
405.8	COLLECTOR REAGENT FEEDERS	4	1,400	7,441	0.25	1.00	TEFC	110	1800	YES	SAME
415	OVERDENSE MEDIA PUMP	1	5,000	8,678	10.00	10.00	TEFC	480	1800	YES	GOYNE PUMP
430	BALL MILL OVERHEAD CRANE HOIST	1	5,000	44,520	25.00	25.00	TEFC	480	1800	YES	THERN
430.1	BALL MILL OVERHEAD CRANE TRAM	1	–	8,480	10.00	10.00	TEFC	480	1800	YES	THERN
435	LABORATORY EQUIPMENT			see below	–	–	–	–	–	–	PREISER SCIENTIFIC
435.1	OVEN	1	2,500	7,632	0.25	0.25	TEFC	480	1800	YES	SAME
435.2	OVEN	1	3,000	2,862	0.25	0.25	TEFC	480	1800	YES	SAME
435.3	TABLE	1	150	403	–	–	–	–	–	–	SAME
435.4	DESK	1	125	785	–	–	–	–	–	–	SAME
435.5	EXHAUST HOOD	1	450	2,424	0.75	0.75	TEFC	480	1800	YES	SAME
435.6	CABINETS	1	1,250	1,985	–	–	–	–	–	–	SAME
485	CLEAN-UP PUMP	1	5,000	5,599	7.50	7.50	TEFC	480	1800	YES	GOYNE PUMP
495	GLAND WATER PUMP	1	2,500	3,407	5.00	5.00	TEFC	480	1800	YES	GOYNE PUMP
500.1	SLURRY SAMPLERS	3	7,000	14,930	5.00	15.00	TEFC	480	1800	YES	ESTIMATED
500.2	DRY SAMPLERS	2	5,250	13,483	5.00	10.00	TEFC	480	1800	YES	ESTIMATED
500.13	AUTOMATIC FLOC MIXING SYSTEM	1	2,000	16,483	1.50	1.50	TEFC	480	1800	YES	ESTIMATED
	OTHER MOTORS				38.00	38.00					
	TOTAL VALUES		700,590	3,887,376		2822					HEATING LOAD 715 KW

DETAILED CAPITAL COST ESTIMATE

ICF KE JOB NO: 88107-250-00
DATE: JULY 15, 1994

ESTIMATE CRITERIA
FOR
ENGINEERING DEVELOPMENT OF
ADVANCE PHYSICAL FINE COAL
CLEANING TECHNOLOGIES - FROTH FLOTATION
PREPARED FOR
U.S. DEPARTMENT OF ENERGY
PITTSBURGH ENERGY TECHNOLOGY CENTER
PITTSBURGH, PA.

TYPE 3 PRELIMINARY COST ESTIMATE
PREPARED BY
ICF KAISER ENGINEERS, INTERNATIONAL
PITTSBURGH, PA

SCOPE OF WORK

The Department of Energy has commissioned ICF Kaiser Engineers International to develop generic facility for the cleaning of fine coal using the advance froth floatation technology. The facility is based on processing 41.5 tons of raw coal per hour.

PURPOSE

Provide a preliminary cost estimate for a generic advance froth flotation coal cleaning facility based on the plant being located in the Greater Pittsburgh Area. This plant could be built anywhere within the United States.

DRAWINGS AND SPECIFICATIONS

The specifications and drawings were prepared by ICF KE. The specifications and drawings are based on the test results from the labaratory and proof-of concept plant.

ESTIMATE FORMAT

The estimate utilizes ICF KE's interactive estimating system(IEST) and is formatted to show quantities, manhours, labor cost, construction equipment usage, material and equipment, subcontracts, indirect costs, contractor's overhead and profit, and total dollars for each cost element.

The estimate is an ICF KE Type 3, Preliminary Estimate as defined by the attached estimate type sheets.

QUANTITIES

Quantities for the estimate were developed from the drawings provided and estimators judgement.

MATERIALS

Material pricing is based on vendor quotes or in house information that was used to revise the IES estimating system.

EQUIPMENT

Quotation from vendors were received for all the equipment.

LABOR RATES

The IEST project database was updated using the UMW craft labor rates as quoted by Lincoln Contractin Company to establish a crew rate. Crew rate consist of journeymen, foreman, general foreman for the variou types of erection work elements. These rates include:

- Base Rate
- Fringe Benefits
- Payroll Taxes and Insurance
- Small Tools
- Overhead and Profit

CONSTRUCTION EQUIPMENT USAGE

The cost of construction equipment rental is based on the blue book rental cost and includes fuel an maintenance. Equipment usage is included for each line item in the estimate.

SITE

This is a generic plant and no site has been selected.

SCHEDULE

A construction schedule has not been prepared, however the estimate is based on a twelve(12) month duratio for construction.

PROJECT INDIRECT COSTS

Subcontractor's overhead and profit is included with each line item cost element as follows:

Labor Rates include OH &P
10 % on Equipment Usage
10% on material
10% on construction indirects

PROJECT DISTRIBUTABLE COST

The following distributables are included in this estimate:

Project Management
Construction Management
Allowance for Site Specify Engineering

SALE TAX

Sales tax has been excluded.

COST EXCLUSIONS

Permits and Licenses
Finance Charges
Owner's Cost
Land and Right of Way
Soil Investigation
Environmental Reports
Legal Services
Utilities

CONTINGENCY

The estimate contains contingency at 5% to provide for unforeseen events which statistically are bound to occur during the life of the project.

ESCALATION

Escalation has been excluded.

ESTIMATE DISCUSSION

The project was commissioned by the Department Of Energy to determine the feasibility of cleaning coal by the advance froth flotation process. A preliminary cost estimates was prepared with no specify site selected. Estimate cost were based on the plant being constructed in the Greater Pittsburgh Area.

ICF KAISER ENGINEERS, INC.
DEPARTMENT OF ENERGY
JOB NO. 88107-250-00

ICF KAISER ENGINEERS INTERACTIVE ESTIMATING
20 TPH CLEAN COAL SEMI-WORKS CONCEPTUAL DESIGN
GENERAL ESTIMATE FOR REFERANCE
REPORT S1 - ESTIMATE SUMMARY BY FACILITY

DATE: 07/13/94 14:02
BY

WORK BREAKDWN FACIL.STANDRD	DESCRIPTION	MANHOURS	LABOR	EQUIP USAGE	MATERIAL	SUB-CONTRACT	EQUIP-MENT	S/C OH&P	TOTAL DOLLARS
200	CONCRETE AND FOUNDATIONS	6512	239827	24678	141066	0	0	16578	422149
300	STRUCTURAL STEEL	5236	204788	29719	489556	0	0	51928	775991
400	ARCHITECTURAL WORK	3148	113985	3126	187882	0	0	19103	324096
500	EQUIPMENT INSTALLATION	12080	469655	98705	187620	0	3887376	28632	4671988
600	PIPING	4835	188767	25478	157284	0	0	18286	389815
675	MECHANICAL	1465	57149	5449	14325	0	100759	1981	179663
700	ELECTRICAL AND INSTRUMENTATION	14003	624051	38033	234657	72	687426	27274	1611513
900	INDIRECTS AND DISTRIBUTABLES	960	35860	4205	57452	10000	0	6166	113683
901	ENGINEERING	0	0	0	0	600000	0	0	600000
902	PROJECT/CONSTRUCTION MANAGEMENT	0	0	0	0	600000	0	0	600000
903	FIELD OFFICE EXPENSES	80	2940	372	33496	1000	0	0	37808
904	INSURANCE/TAXES/PERMITS/	0	0	0	173840	0	0	0	173840
REPORT TOTAL		48,319	1,937,022	229,765	1,677,178	1,211,072	4,675,561	169,948	9,900,546
ICFKE PROFIT/FEE @ 5%									495,027
SUBTOTAL									10,395,573
PROJECT CONTINGENCY @ 5%									519,779
GRAND TOTAL									10,915,352

--WORK BREAKDOWN--- FACIL.STANDRD.WKPKG	DESCRIPTION	QUANTITY	MANHOURS	LABOR	EQUIP USAGE	MATERIAL	SUB-CONTRACT	EQUIP-MENT	S/C OH&P	TOTAL DOLLARS
200	CONCRETE AND FOUNDATIONS									
200 .131102 .	EXCAVATION MASS-1.5CY BACKHOE BUILDING FOUNDATION	880 CY	29	1060	339	0	0	0	34	1433
200 .1311021.	EXCAVATION MASS-1.5CY BACKHOE EQUIPMENT FOUNDATIONS	65 CY	2	73	25	0	0	0	3	101
200 .134910 .	DISPOSAL- 10 MI ROUND TRIP 10-12 CY TRUCK BUILDING FOUNDATION	880 CY	80	3106	1741	0	0	0	174	5021
200 .1349101.	DISPOSAL- 10 MI ROUND TRIP 10-12 CY TRUCK EQUIPMENT FOUNDATION	65 CY	6	233	129	0	0	0	13	375
200 .1349102.	DISPOSAL- 10 MI ROUND TRIP 10-12 CY TRUCK 50' CLEAN COAL THICKENER	57 CY	5	194	113	0	0	0	11	318
200 .141100 .	EXCAVATION STRUCT. FOR MAT 50' CLEAN COAL THICKENER	95 CY	4	143	139	0	0	0	14	296
200 .1411001.	EXCAVATION STRUCT. FOR MAT 55' REFUSE THICKENER	114 CY	5	179	167	0	0	0	17	363
200 .142210 .	BACKFILL STRUCTURAL AGGREGATE 50' CLEAN COAL THICKENER	38 CY	8	290	40	367	0	0	41	738
200 .1422101.	BACKFILL STRUCTURAL AGGREGATE EQUIPMENT FOUNDATIONS	13 CY	3	109	14	125	0	0	14	262
200 .1422102.	BACKFILL STRUCTURAL AGGREGATE OFFICE AREA	35 CY	7	253	37	338	0	0	38	666
200 .1422103.	BACKFILL STRUCTURAL AGGREGATE 55' REFUSE THICKENER	46 CY	9	326	48	444	0	0	49	867
200 .142212 .	BACKFILL STRUCTURAL AGGREGATE BUILDING FOUNDATION	228 CY	46	1665	238	2199	0	0	244	4346
200 .211000 .	FORMS - BUILDING FOUNDATION	2500 SF	500	17043	308	1961	0	0	227	19539
200 .212300 .	REBAR-CONTINUOUS FOOTINGS BUILDING FOUNDATION	87500 LB	875	34322	5203	20405	0	0	2561	62491
200 .213000 .	EMBEDDED METALS-BLDG FDNS	1400 LB	85	3025	0	2226	0	0	223	5474
200 .214100 .	CONCRETE-FOOTINGS & PEDESTALS 3000 PSI BUILDING FOUNDATION	700 CY	862	31322	5240	37842	0	0	4308	78712
200 .220000 .	COLUMN CONCRETE OFFICE AREA	22 CY	220	8084	1023	2665	0	0	369	12141
200 .221000 .	FORMS-EQUIP FOUNDATIONS	340 SF	89	3034	55	551	0	0	61	3701
200 .221400 .	FORMS-RING FOUNDATIONS 50' CLEAN COAL THICKENER	4200 SF	788	30250	486	6455	0	0	694	37885
200 .221405 .	FORMS-RING FOUNDATIONS 55' REFUSE THICKENER	4600 SF	863	33129	532	7070	0	0	760	41491
200 .221500 .	FORMS-SMALL PIERS	805 SF	193	6579	119	1152	0	0	127	7977
200 .222000 .	REBAR-EQUIP FOUNDATIONS	6500 LB	55	2229	325	1516	0	0	184	4254

--WORK BREAKDOWN--- FACIL.STANDRD.WKPKG	DESCRIPTION	QUANTITY	MANHOURS	LABOR	EQUIP USAGE	MATERIAL	SUB-CONTRACT	EQUIP-MENT	S/C OH&P	TOTAL DOLLARS
200 .222400 .	REBAR-RING FOUNDATIONS 50' CLEAN COAL THICKENER	7400 LB	71	2785	422	1726	0	0	215	5148
200 .222405 .	REBAR-RING FOUNDATIONS 55' REFUSE THICKENER	7800 LB	75	2942	445	1819	0	0	226	5432
200 .222500 .	REBAR-SMALL PIERS	3125 LB	31	1256	184	729	0	0	91	2260
200 .223000 .	EMBEDDED METALS-EQUIP FDNS	260 LB	13	463	0	413	0	0	41	917
200 .223400 .	EMB METALS-RING FOUNDATIONS 50' CLEAN COAL THICKENER	400 LB	20	786	0	636	0	0	64	1486
200 .223405 .	EMB METALS-RING FOUNDATIONS 55' REFUSE THICKENER	400 LB	20	786	0	636	0	0	64	1486
200 .223500 .	EMBEDDED METALS-SM PIERS	100 LB	5	178	0	159	0	0	16	353
200 .224000 .	CONCRETE-EQUIP FOUNDATIONS 3000 PSI	52 CY	90	2759	550	2811	0	0	336	6456
200 .224403 .	CONCRETE-RING FDNS-PUMPED 3000 PSI 50' CLEAN COAL THICKENER	75 CY	125	4528	692	4055	0	0	475	9750
200 .224404 .	CONCRETE-RING FDNS-PUMPED 3000 PSI 55' REFUSE THICKENER	80 CY	133	4818	738	4325	0	0	506	10387
200 .224500 .	CONCRETE - SMALL PIERS, 3000 PSI	25 CY	45	1380	276	1352	0	0	163	3171
200 .231100 .	FORMS - MAT FOUNDATIONS 50' CLEAN COAL THICKENER	120 SF	20	768	12	93	0	0	11	884
200 .2311001.	FORMS - MAT FOUNDATIONS 55' REFUSE THICKENER	132 SF	22	845	14	102	0	0	12	973
200 .232100 .	REBAR - MAT FOUNDATIONS 50' CLEAN COAL THICKENER	12875 LB	129	5060	766	3002	0	0	377	9205
200 .2321001.	REBAR - MAT FOUNDATIONS 55' REFUSE THICKENER	15000 LB	150	5884	892	3498	0	0	439	10713
200 .233150 .	ANCHOR BOLTS-MAT FOUNDATIONS 50' CLEAN COAL THICKENER	120 LB	5	197	0	191	0	0	19	407
200 .2331501.	ANCHOR BOLTS-MAT FOUNDATIONS 55' REFUSE THICKENER	120 LB	5	197	0	191	0	0	19	407
200 .234103 .	CONCRETE - MAT FDNS PUMPED 3000 PSI 50' CLEAN COAL THICKENER	105 CY	49	1775	269	5676	0	0	595	8315
200 .2341031.	CONCRETE - MAT FDNS PUMPED 3000 PSI 55' REFUSE THICKENER	120 CY	55	1992	307	6487	0	0	679	9465
200 .241300 .	FORMS - SUSPENDED SLAB	1420 SF	241	8262	195	1641	0	0	184	10282
200 .242300 .	REBAR - SUSPENDED SLAB	11400 LB	114	4617	673	2658	0	0	333	8281
200 .244303 .	CONCRETE - SUSPENDED SLAB PUMPED, 3000 PSI	230 CY	347	10455	1922	12434	0	0	1436	26247
200 .431306 .	VAPOR BARRIER-6 MIL POLY OFFICE AREA	1200 SF	3	103	0	22	0	0	2	127

--WORK BREAKDOWN--- FACIL.STANDRD.WKPKG		DESCRIPTION	QUANTITY	MANHOURS	LABOR	EQUIP USAGE	MATERIAL	SUB-CONTRACT	EQUIP-MENT	S/C OH&P	TOTAL DOLLARS
200	.432212 .	F.G.INSULATION RIGID - WALL 2" THICK - R8.3 OFFICE AREA	1200 SF	10	343	0	1094	0	0	109	1546
	TOTAL	CONCRETE AND FOUNDATIONS		6,512		24,678		0		16,578	
					239,827		141,066		0		422,149
300		STRUCTURAL STEEL									
300	.310110 .	STRUCTURAL STEEL - LIGHT UP TO 25LB/LF	49 TON	980	38269	5669	110113	0	0	11578	165629
300	.3101101.	STRUCTURAL STEEL - LIGHT EQUIPMENT FOUNDATIONS	560 LB	8	312	45	712	0	0	76	1145
300	.310120 .	STRUCTURAL STEEL - MEDIUM 25 LB/LF TO 49LB/LF	190 TON	2850	111293	16486	314184	0	0	33067	475030
300	.310130 .	STRUCTURAL STEEL - HEAVY OVER 50 LB/LF	15 TON	180	7029	1041	20352	0	0	2139	30561
300	.321110 .	GRATING -PLATFORMS, GALV.STL	661 SF	99	4072	398	7882	0	0	828	13180
300	.322105 .	1/4" PLATEWORK @ SUMPS	690 LB	8	314	33	775	0	0	81	1203
300	.324000 .	STAIR INCLUDING SUPPORT STEEL & HANDRAIL	101 LF	162	6372	1385	8672	0	0	1006	17435
300	.325100 .	LADDERS WITH CAGE	10 LF	7	277	48	578	0	0	63	966
300	.331200 .	PLATEWORK	6 TON	240	9367	1364	15264	0	0	1663	27658
300	.399110 .		260 TON	702	27483	3250	11024	0	0	1427	43184
	TOTAL	STRUCTURAL STEEL		5,236		29,719		0		51,928	
					204,788		489,556		0		775,991
400		ARCHITECTURAL WORK									
400	.284109 .	10" THICK PRECAST DOOR LINTELS	93 LF	16	622	200	1949	0	0	215	2986
400	.353186 .	METAL STUDS AND JOISTS, GALV. 18 GA., 6"	572 LF	13	510	53	609	0	0	66	1238
400	.415210 .	CMU BLOCK WALLS, 10" EVERY OTHER CELL GROUTED 1 LB REBAR/SF	3871 SF	503	17921	394	12023	0	0	1242	31580
400	.4152101.	CMU BLOCK WALLS, 10" LINTEL BLOCK	437 LF	78	2779	61	5605	0	0	567	9012
400	.415406 .	CMU BLOCK WALLS, 6" LINTEL BLOCK AT TOP OF WALL	126 LF	22	784	17	821	0	0	84	1706
400	.432111 .	INSULATION, 3-1/2" BATT-R11 FOIL FACED	4187 SF	21	819	0	1021	0	0	102	1942
400	.434618 .	SIDING GALV RIBBED STL 18GA	16632 SF	685	23526	615	53189	0	0	5380	82710
400	.434622 .	SIDING GALV RIBBED STL 22GA	7863 SF	331	12191	298	20979	0	0	2128	35596
400	.434624 .	SIDING GALV RIBBED STL 24GA	20924 SF	871	32082	795	52565	0	0	5336	90778
400	.437100 .	FLASHING METAL, AVG.	1025 SF	62	2420	0	2499	0	0	250	5169

--WORK BREAKDOWN--- FACIL.STANDRD.WKPKG	DESCRIPTION	QUANTITY	MANHOURS	LABOR	EQUIP USAGE	MATERIAL	SUB-CONTRACT	EQUIP-MENT	S/C OH&P	TOTAL DOLLARS
400 .441012 .	DOOR HM SINGLE, 20 GA.W/FRAME AND HEAVY HARDWARE AVG.	15 EA	67	2368	0	11852	0	0	1185	15405
400 .441062 .	DOOR,HM,DOUBLE, 18GA.W.FRAME & HEAVY HARDWARE AVG. FIRERATED	1 EA	4	141	0	1311	0	0	131	1583
400 .441065 .	DOUBLE HM DOOR W/HEAVY HARDWARE 4' X 10'	1 EA	8	313	0	1908	0	0	191	2412
400 .441214 .	DOUBLE HM DOOR W/HEAVY HARDWARE 4' X 7'	3 EA	15	586	0	4770	0	0	477	5833
400 .441603 .	TRANSOM REMOVABLE	34 SF	9	352	0	541	0	0	54	947
400 .443200 .	DOOR ROLL-UP (NO OPERATOR)	200 SF	32	1323	0	2258	0	0	226	3807
400 .443280 .	MOTOR OPERATOR AND SAFETY BAR FOR ROLL-UP DOOR	2 EA	8	331	0	2406	0	0	241	2978
400 .445220 .	WINDOW-STL INSULATED GLASS	32 SF	3	118	0	397	0	0	40	555
400 .446113 .	TEMPERED GLASS	13 SF	3	117	0	103	0	0	10	230
400 .454311 .	TERRAZZO CAST-IN-PLACE 1-3/4", GRAY CEMENT	1400 SF	98	3632	182	2834	0	0	302	6950
400 .454326 .	TERRAZZO BASE CAST-IN-PLACE 6"	247 SF	17	630	31	270	0	0	30	961
400 .455100 .	CEILING MINERAL FIBER SUSPEND	1470 SF	34	1329	0	1901	0	0	190	3420
400 .456186 .	FLR BASE VINYL/RUBBER 6"	62 LF	2	78	0	39	0	0	4	121
400 .459111 .	PAINTING - MASONRY BLOCK WALL 2 COATS BRUSHED	15000 SF	150	5265	480	1113	0	0	159	7017
400 .461505 .	WASTE RECEPTACLES W/SWING TOP 13 GAL. CAP. #2250	5 EA	20	782	0	806	0	0	81	1669
400 .461510 .	PAPER TOWEL DISPENSER W/MIRROR AND SOAP DISPENSER SURFACE MOUNTED #B3309	4 EA	16	625	0	1153	0	0	115	1893
400 .461515 .	PAPER TOWEL DISPENSER SURFACE MOUNTED #262	2 EA	4	156	0	87	0	0	9	252
400 .461520 .	SOAP DISPENSER (LIQUID) SURFACE MOUNTED #B150	2 EA	4	156	0	22	0	0	2	180
400 .461525 .	MIRROR (24 X 30) AND SHELF #B292	1 EA	4	156	0	131	0	0	13	300
400 .461530 .	TOILET TISSUE DISPENSER DOUBLE ROLL W/SHELF #B28407	2 EA	4	156	0	242	0	0	24	422
400 .461535 .	SANITARY NAPKIN DISPENSER /SURFACE MOUNTED #B282	1 EA	4	156	0	297	0	0	30	483
400 .461540 .	SANITARY NAPKIN DISPOSAL W/UTILITY SELF-SERVICE MOUNTED #B271	1 EA	4	156	0	38	0	0	4	198

--WORK BREAKDOWN--- FACIL.STANDRD.WKPKG	DESCRIPTION	QUANTITY	MANHOURS	LABOR	EQUIP USAGE	MATERIAL	SUB-CONTRACT	EQUIP-MENT	S/C OH&P	TOTAL DOLLARS
400 .461545 .	COAT HOOK STRIP (3 HOOK) B232X24	3 EA	6	234	0	116	0	0	12	362
400 .461550 .	MOP AND BROOM HOLDER W/SHELF B239X34	1 EA	2	78	0	155	0	0	16	249
400 .461555 .	STAINLESS STEEL SHELF B296X24	1 EA	2	78	0	33	0	0	3	114
400 .461560 .	SHOWER STALL CURTAIN ROD W/VINYL SHOWER CURTAIN AND HOOKS #204-2	3 EA	6	234	0	143	0	0	14	391
400 .461565 .	HEAVY DUTY ROBE HOOK B2116	3 EA	6	234	0	38	0	0	4	276
400 .465100 .	LOCKERS METAL - 60"-72" SINGLE TIER	16 EA	13	508	0	1526	0	0	153	2187
400 .465200 .	LOCKER BENCH WOOD W/ PIPE PEDESTALS	8 LF	1	39	0	132	0	0	13	184
TOTAL	ARCHITECTURAL WORK		3,148		3,126		0		19,103	
500	EQUIPMENT INSTALLATION			113,985		187,882		0		324,096
500 .100000 .	PLANT FEED CONVEYOR BY OTHERS-NOT PART OF THIS PROJECT	1 EA	0	0	0	0	0	0	0	0
500 .100100 .	PLANT FEED CONVEYOR HEAD END DISCHARGE HOPPER WT. 1300#	1 EA	32	1243	274	2120	0	0	239	3876
500 .100200 .	PLANT FEED CONVEYOR DISCHARGE CHUTE FROM HOPPER TO CRUSHER WT. 1100#	1 EA	32	1243	274	1855	0	0	213	3585
500 .105000 .	BELT MAGNET ERIEZ MODEL SE7235MC1	1 EA	24	933	206	0	0	4934	21	6094
500 .105100 .	BELT MAGNET RECTIFIER ERIEZ MODEL 36C-1800WATTS	1 EA	24	940	86	0	0	1771	9	2806
500 .110000 .	RAW COAL CRUSHER #1 GUNDLACH MODEL 45DA	1 EA	160	6217	1371	0	0	37100	137	44825
500 .110100 .	#1 RAW COAL CRUSHER DISCHARGE CHUTE TO RAW COAL CRUSHER #2 WT. 1100#	1 EA	32	1243	274	1855	0	0	213	3585
500 .111000 .	RAW COAL CRUSHER #2 GUNDLACH MODEL 45DA	1 EA	160	6217	1371	0	0	79500	137	87225
500 .111100 .	RAW COAL CRUSHER #2 DISCHARGE CHUTE TO RAW COAL SCREEN WT. 1500#	1 EA	32	1243	274	2385	0	0	266	4168
500 .112000 .	RAW COAL SCREEN TABOR 4' X 12' VIBRATING SCREEN INCLINED	1 EA	400	15543	3429	0	0	16960	343	36275

--WORK BREAKDOWN--- FACIL.STANDRD.WKPKG	DESCRIPTION	QUANTITY	MANHOURS	LABOR	EQUIP USAGE	MATERIAL	SUB-CONTRACT	EQUIP-MENT	S/C OH&P	TOTAL DOLLARS
500 .112100 .	RAW COAL SCREEN UNDER FLOW PAN TO COLLECT FINES WT. 2000#	1 EA	64	2487	549	3180	0	0	373	6589
500 .112200 .	RAW COAL SCREEN OVER FLOW HOPPER AND CHUTE WT. 1400#	1 EA	32	1243	274	2226	0	0	250	3993
500 .113000 .	OVERSIZE BUCKET ELEVATOR GOODMAN	1 EA	400	15543	3429	0	0	25355	343	44670
500 .113200 .	OVERSIZE BUCKET ELEVATOR TOP DISCHARGE CHUTE WT. 600#	1 EA	24	933	206	1060	0	0	127	2326
500 .115000 .	RAW COAL FEED SUMP WT. 3000#	1 EA	120	4663	1029	5300	0	0	633	11625
500 .120000 .	RAW COAL FEED PUMP GOYNE PUMP	1 EA	32	1243	274	0	0	13627	27	15171
500 .135000 .	REFUSE CENTRIFUGE DRIVE MODEL CMI HVC-20	1 EA	32	1243	274	0	0	86920	27	88464
500 .135100 .	REFUSE CENTRIFUGE VIBRATOR MODEL CMI HVC-20	1 EA	24	933	206	0	0	0	21	1160
500 .135200 .	REFUSE CENTRIFUGE OIL PUMP MODEL CMI HVC-20	1 EA	24	933	206	0	0	0	21	1160
500 .135300 .	REFUSE CENTRIFUGE DRIVE DISCHARGECHUTE WT. 2000#	1 EA	48	1865	411	3392	0	0	380	6048
500 .140000 .	DESLIME SIEVE BEND 3'WIDE,80"RAD,60, .35MM, 3/32 ISO	2 EA	96	3730	823	0	0	9752	82	14387
500 .140100 .	DESLIME SIEVE BEND DISCHARGE CHUTE WT. 700#	2 EA	64	2487	549	2332	0	0	288	5656
500 .145000 .	DESLIME SCREEN TABOR 4' X 12'STD. VIBRATING HORIZONTAL	1 EA	160	6217	1371	0	0	20670	137	28395
500 .145100 .	DESLIME SCREEN DISCHARGE CHUTE #1 WT. 600#	1 EA	32	1243	274	954	0	0	123	2594
500 .145200 .	DESLIME SCREEN DISCHARGE CHUTE #2 WT. 1000#	1 EA	32	1243	274	1590	0	0	186	3293
500 .145300 .	DESLIME SCREEN UNDERFLOW PAN WT. 1400#	1 EA	32	1243	274	2226	0	0	250	3993
500 .145400 .	DESLIME AND MIDLS DISCHARGE CHUTE WT. 1500#	1 EA	32	1243	274	2650	0	0	292	4459
500 .150000 .	MIDDLINGS CRUSHER DRIVE #1 GUNDLACH CAGEPACTOR	1 EA	240	9326	2057	0	0	125811	206	137400
500 .150100 .	MIDDLINGS CRUSHER DISCHARGE CHUTE WT. 500#	1 EA	24	933	206	954	0	0	116	2209
500 .150200 .	MIDDLINGS CRUSHER DRIVE #2 GUNDLACH CAGEPACTOR W/500.150000	1 EA	240	9326	2057	0	0	0	206	11589

--WORK BREAKDOWN--- FACIL.STANDRD.WKPKG	DESCRIPTION	QUANTITY	MANHOURS	LABOR	EQUIP USAGE	MATERIAL	SUB-CONTRACT	EQUIP-MENT	S/C OH&P	TOTAL DOLLARS
500 .150300 .	CRUSHER DISCHARGE CHUTE PLATEWORK WT. 1600#	1 EA	32	1243	274	2650	0	0	292	4459
500 .151000 .	OVERSIZE PROTECTION SUMP PLATEWORK WT. 2700#	1 EA	32	1243	274	5300	0	0	557	7374
500 .152000 .	OVERSIZE PROTECTION PUMP GOYNE PUMP	1 EA	32	1249	168	0	0	12912	17	14346
500 .153000 .	OVERSIZE PROTECTION SIEVE BEND 5'WIDE,40"R,60, .35MM, 3/32 ISO	2 EA	96	3730	823	0	0	10600	82	15235
500 .153100 .	OVERSIZE PROTECTION SIEVE BEND DISCHARGE HOPPER WT. 500#	1 EA	32	1243	274	954	0	0	123	2594
500 .153200 .	OVERSIZE PROTECTION SIEVE BEND DISCHARGE CHUTE WT.1100#	1 EA	32	1243	274	1908	0	0	218	3643
500 .155000 .	FINE HYDRO FEED SUMP PLATEWORK WT. 2700#	1 EA	48	1865	411	5300	0	0	571	8147
500 .160000 .	FINE HYDRO FEED PUMP GOYNE PUMP	1 EA	32	1249	168	0	0	14578	17	16012
500 .165000 .	FINE HYDROCLONES KREBS 10" DIAMETER WITH/STAND	5 EA	160	6217	1371	0	0	83475	137	91200
500 .165100 .	FINE CYCLONE HOPPER WT. 1800#	5 EA	120	4663	1029	15900	0	0	1693	23285
500 .202000 .	CLASSIFYING CYCLONE SUMP PLATEWORK WT. 2700#	1 EA	48	1865	411	5300	0	0	571	8147
500 .205000 .	CLASSIFYING CYCLONE PUMP GOYNE PUMP	1 EA	32	1249	168	0	0	30493	17	31927
500 .207000 .	CLASSIFYING CYCLONES KREBS 10" DIAMETER WITH/STAND	8 EA	256	9947	2194	0	0	127624	219	139984
500 .207100 .	CLASSIFYING CYCLONES HOPPER WT. 1800	8 EA	192	7460	1646	25440	0	0	2709	37255
500 .208000 .	VARI-SIEVE KREBS 5'WIDE VARI-SIEVE	2 EA	96	3730	823	0	0	103414	82	108049
500 .208100 .	VARI-SIEVE DISCHARGE CHUTE WT. 1000#	2 EA	48	1865	411	3180	0	0	359	5815
500 .210100 .	10' DIA. X 6' CONICAL BALL MILL	1 EA	800	31085	6857	0	0	606320	686	644948
500 .210200 .	BALL MILL DISCHARGE CHUTE WT. 3000#	1 EA	160	6217	1371	4770	0	0	614	12972
500 .215000 .	ADVANCED FLOTATION FEED SUMP PLATEWORK WT. 2700#	1 EA	32	1243	274	5300	0	0	557	7374
500 .220100 .	ADVANCED FLOTATION FEED PUMP GOYNE PUMP	1 EA	32	1249	168	0	0	25803	17	27237
500 .225000 .	FLOTATION FEED DISTRIBUTER PLATEWORK WT. 2500#	1 EA	32	1243	274	5300	0	0	557	7374
500 .230100 .	ADVANCED FLOTATION CELL ICFKE MICROCEL MODEL 12025	4 EA	1600	62171	13715	0	0	466400	1372	543658

--WORK BREAKDOWN--- FACIL.STANDRD.WKPKG	DESCRIPTION	QUANTITY	MANHOURS	LABOR	EQUIP USAGE	MATERIAL	SUB-CONTRACT	EQUIP-MENT	S/C OH&P	TOTAL DOLLARS
500 .230200 .	ADVANCED FLOTATION PUMP GOYNE PUMP	4 EA	128	4998	674	0	0	0	67	5739
500 .240000 .	COAL STATIC THICKENER DRIVE EIMCO 50' DIAMETER HIRATE	1 EA	400	15543	3429	0	0	68900	343	88215
500 .240100 .	COAL STATIC THICKENER LIFTING DEVICEC, EMICO 50' DIAMETER HIRATE	1 EA	128	4974	1097	0	0	0	110	6181
500 .245000 .	COAL THICKENER CLARIFIED WATER SUMP, PLATEWORK WT. 11000#	1 EA	64	2487	549	18550	0	0	1910	23496
500 .247000 .	COAL THICKENER CLARIFIED WATER PUMP, GOYNE PUMP	1 EA	64	2499	337	0	0	30152	34	33022
500 .249000 .	COAL STATIC THICKENER UNDER-FLOW PUMP, GOYNE PUMP	1 EA	32	1249	168	0	0	12207	17	13641
500 .260000 .	CLEAN COAL FILTER DRIVE, ANDRITZ RUTHNER,INC.	1 EA	400	15543	3429	0	0	1228710	343	1248025
500 .260100 .	AGITATORS ANDRITZ RUTHNER, INC. W/500.260000	3 EA	120	4663	1029	0	0	0	103	5795
500 .260200 .	DISCHARGE GATES, ANDRITZ RUTHNER, INC. W/500.260000	1 EA	64	2487	549	0	0	0	55	3091
500 .260300 .	AIR COMPRESSOR, AIRTEC	1 EA	200	7809	1053	0	0	52391	105	61358
500 .260400 .	FILTRATE PUMP GOYNE PUMP	1 EA	64	2499	337	0	0	8509	34	11379
500 .260500 .	LUBRICATOR, ANDRITZ RUTHNER,INC. W/500.260000	1 EA	32	1243	274	0	0	0	27	1544
500 .260600 .	AUXILLARY AIR COMPRESSOR ANDRITZ RUTHNER, INC. W/500.260000	1 EA	64	2499	337	0	0	0	34	2870
500 .260700 .	INTERNAL CONVEYOR, ANDRITZ RUTHNER,INC. W/500.260000	1 EA	64	2487	549	0	0	0	55	3091
500 .260800 .	CLEAN COAL FILTER DISCHARGE CHUTE, PLATEWORK WT.900#	1 EA	32	1243	274	1590	0	0	186	3293
500 .265000 .	CLEAN COAL BELT CONVEYOR BY OTHERS NOT INCLUDED IN THIS CONTRACT	1 EA	0	0	0	0	0	0	0	0
500 .275000 .	REFUSE STATIC THICKENER DRIVE EMICO 60' DIAMETER HIRATE	1 EA	400	15543	3429	0	0	74200	343	93515
500 .275100 .	REFUSE STATIC THICKENER LIFTING DEVICE, EMICO 60' DIAMETER HIRATE	1 EA	128	4974	1097	0	0	0	110	6181

--WORK BREAKDOWN--- FACIL.STANDRD.WKPKG	DESCRIPTION	QUANTITY	MANHOURS	LABOR	EQUIP USAGE	MATERIAL	SUB-CONTRACT	EQUIP-MENT	S/C OH&P	TOTAL DOLLARS
500 .290000 .	REFUSE STATIC THICKENER UNDERFLOW PUMP GOYNE PUMP	1 EA	64	2499	337	0	0	13928	34	16798
500 .315100 .	REFUSE CONVEYOR BY OTHERS NOT PART OF THIS CONTRACT	1 EA	0	0	0	0	0	0	0	0
500 .320100 .	HEAVY MEDIA CYCLONE SUMP PLATEWORK WT. 2500#	1 EA	32	1243	274	4240	0	0	451	6208
500 .325000 .	HEAVY MEDIA CYCLONE PUMP[GOYNE PUMP	1 EA	32	1249	168	0	0	16797	17	18231
500 .330000 .	HEAVY MEDIA CYCLONE KREBS 20" DIAMETER CERAMIC	1 EA	40	1554	343	0	0	39697	34	41628
500 .330100 .	HEAVY MEDIA CYCLONE OVERFLOW BOX PLATEWORK WT. 2000#	1 EA	32	1243	274	3180	0	39697	345	44739
500 .335000 .	MIDS SIEVE BEND 3'WIDE,80"R,60, .5MM,3/32 ISO	1 EA	48	1865	411	0	0	4876	41	7193
500 .335100 .	MIDS SIEVE BEND DISCHARGE CHUTE P[LATEWORK WT. 1000#	1 EA	24	933	206	1590	0	0	180	2909
500 .340000 .	MIDS DRAIN AND RINSE SCREEN TABOR 4'X16' SD VIBRATING, HORIZONTAL	1 EA	160	6217	1371	0	0	23320	137	31045
500 .340100 .	MIDS DRAIN AND RINSE SCREEN UNDERFLOW PAN PLATEWORK WT. 3500#	1 EA	160	6217	1371	6360	0	0	773	14721
500 .340200 .	MIDS DRAIN AND RINSE SCREEN DISCHARGE CHUTE PLATEWORK WT. 2000#	1 EA	32	1243	274	3180	0	0	345	5042
500 .340300 .	MIDLS DESLIME DISCHARGE CHUTE PLATEWORK WT. 1600#	1 EA	32	1243	274	2650	0	0	292	4459
500 .345000 .	REFUSE SIEVE BEND 3'WIDE,40"R,60, .5MM,3/32 ISO	1 EA	64	2487	549	0	0	2332	55	5423
500 .345100 .	REFUSE SIEVE BEND DISCHARGE CHUTE PLATEWORK WT. 1000#	1 EA	24	933	206	0	0	0	21	1160
500 .350000 .	REFUSE DRAIN AND RINSE SCREEN TABOR 4'X16' SD VIBRATING NORIZONTAL	1 EA	160	6217	1371	0	0	23320	137	31045
500 .350100 .	REFUSE DRAIN AND RINSE SCREEN UNDERFLOW PAN PLATEWORK WT. 2200#	1 EA	160	6217	1371	3710	0	0	508	11806
500 .350200 .	REFUSE DRAIN AND RINSE SCREEN DISCHARGE CHUTE PLATEWORK WT. 1200#	1 EA	24	933	206	2120	0	0	233	3492
500 .350300 .	REFUSE DRAIN AND RINSE SCREEN DISCHARGE CHUTE TO REFUSE CENTRIFUGE DRIVE WT. 300#	1 EA	24	933	206	636	0	0	84	1859

--WORK BREAKDOWN--- FACIL.STANDRD.WKPKG	DESCRIPTION	QUANTITY	MANHOURS	LABOR	EQUIP USAGE	MATERIAL	SUB-CONTRACT	EQUIP-MENT	S/C OH&P	TOTAL DOLLARS
500 .350400 .	REFUSE DRAIN AND RINSE SCREEN DISCHARGE CHUTE TO REFUSE CONVEYOR WT. 1000#	1 EA	24	933	206	1590	0	0	180	2909
500 .360000 .	HEAVY MEDIA CONTROL BOX PLATEWORK WT. 1000#	1 EA	32	1243	274	1855	0	0	213	3585
500 .365000 .	HEAVY MEDIA SENSOR BOX PLATEWORK WT. 400#	1 EA	16	622	137	795	0	0	93	1647
500 .370000 .	DILUTE MEDIA SUMP PLATEWORK WT. 2200#	1 EA	32	1243	274	4240	0	0	451	6208
500 .375100 .	DILUTE MEDIA PUMP GOYNE PUMP	1 EA	64	2499	337	0	0	11546	34	14416
500 .380000 .	MAGNETIC SEPARATOR ERIEZ 36" DIAMETER X 9'WIDE	1 EA	64	2487	549	0	0	16960	55	20051
500 .380100 .	MAGNETIC SEOARATOR TAILINGS CHUTE AND CONCENTRATE CHUTE PLATEWORK WT. 2600#	1 EA	48	1865	411	4240	0	0	465	6981
500 .385000 .	MAGNITITE BIN PLATEWORK WT. 3000#	1 EA	32	1243	274	5300	0	0	557	7374
500 .385100 .	MAGNITITE BIN DUST COLLECTOR AMERICAN AIR FILTER	1 EA	32	1243	274	0	0	7579	27	9123
500 .390000 .	MAGNITITE ROTARY VALVE ANDRITZ SPROUT-BAUER	1 EA	24	933	206	0	0	2899	21	4059
500 .390100 .	MAGNETIC ROTARY VALVE DISCHARGE CHUTE PLATEWORK WT. 60#	1 EA	16	622	137	318	0	0	46	1123
500 .395000 .	INSTRUMENT AIR COMPRESSOR AIRTEC	1 EA	64	2499	337	0	0	12036	34	14906
500 .395100 .	INSTRUMENT AIR COMPRESSOR DRYER AIRTEC EQUIPMENT IN 395000	1 EA	24	937	126	0	0	0	13	1076
500 .395200 .	INSTRUMENT AIR COMPRESSOR PREFILTERS AIRTEC EQUIPMENT IN 395000	1 EA	24	937	126	0	0	0	13	1076
500 .395300 .	INSTRUMENT AIR COMPRESSOR AFTERFILTERS AIRTEC EQUIPMENT IN 395000	2 EA	48	1874	253	0	0	0	25	2152
500 .398000 .	PLANT AND COLUMN AIR COMPRESSOR AIRTEC	1 EA	64	2499	337	0	0	52391	34	55261
500 .398100 .	PLANT AND COLUMN AIR COMPRESSOR-PREFILTERS AIRTEC EQUIPMENT IN 398000	1 EA	24	937	126	0	0	0	13	1076
500 .398200 .	PLANT AND COLUMN AIR COMPRESSOR AFTERFILTERS EQUIPMENT IN 398000	2 EA	48	1874	253	0	0	0	25	2152
500 .400000 .	FLOCCULATION SYSTEM CONSIST OF ITEMS 400100 THRU 401000	1 EA	0	0	0	0	0	0	0	0

--WORK BREAKDOWN--- FACIL.STANDRD.WKPKG	DESCRIPTION	QUANTITY	MANHOURS	LABOR	EQUIP USAGE	MATERIAL	SUB-CONTRACT	EQUIP-MENT	S/C OH&P	TOTAL DOLLARS
500 .400100 .	FLOCCULANT SYSTEM ANIONIC FEEDER MINETEC	1 EA	32	1243	274	0	0	1272	27	2816
500 .400200 .	FLOCCULANT SYSTEM ANIONIC MIXER MINETEC	1 EA	24	933	206	0	0	1590	21	2750
500 .400300 .	FLOCCULANT SYSTEM ANIONIC MIX TANK MINETEC	1 EA	24	933	206	0	0	4240	21	5400
500 .400400 .	FLOCCULANT SYSTEM ANIONIC HOLDING TANK MINETEC	1 EA	32	1243	274	0	0	5300	27	6844
500 .400500 .	FLOCCULANT SYSTEM ANIONIC METERING PUMP MINETEC	2 EA	64	2499	337	0	0	3721	34	6591
500 .400600 .	FLOCCULANT SYSTEM CATIONIC HOLDING TANK MINETEC	1 EA	32	1243	274	0	0	6360	27	7904
500 .400700 .	FLOCCULANT SYSTEM CATIONIC METERING PUMP MINETEC	2 EA	48	1874	253	0	0	3721	25	5873
500 .400800 .	FLOCCULANT SYSTEM SETTLING RATE DETECTOR MINETEC	2 EA	32	1243	274	0	0	38775	27	40319
500 .400900 .	FLOCCULANT SYSTEM WATER CLARITY MEASUREMENT MINETEC	2 EA	32	1243	274	0	0	8946	27	10490
500 .401000 .	FLOCCULANT SYSTEM PH REAGENT PUMP MINETEC	1 EA	24	937	126	0	0	1860	13	2936
500 .405000 .	REAGENT SYSTEM COMPLETE INCLUDING ITEMS 405100 THRU 405800 MINETEC	1 LOT	0	0	0	0	0	0	0	0
500 .405100 .	REAGENT SYSTEM FROTHER BULK STORAGE MINETEC	1 EA	32	1243	274	0	0	2385	27	3929
500 .405200 .	REAGENT SYSTEM FROTHER TRANSFER PUMP MINETEC	1 EA	0	0	0	0	0	3721	0	3721
500 .405300 .	REAGENT SYSTEM FROTHER DAY TANK MINETEC	1 EA	32	1243	274	0	0	3180	27	4724
500 .405400 .	REAGENT SYSTEM FROTHER REAGENT PUMPS MINETEC	4 EA	96	3748	505	0	0	7441	51	11745
500 .405500 .	REAGENT SYSTEM COLLECTOR BULK STORAGE MINETEC	1 EA	32	1243	274	0	0	2385	27	3929
500 .405600 .	REAGENT SYSTEM COLLECTOR TRANSFER PUMPS MINETEC	1 EA	24	937	126	0	0	3721	13	4797
500 .405700 .	REAGENT SYSTEM COLLECTOR DAY TANK MINETEC	1 EA	32	1243	274	0	0	3180	27	4724
500 .405800 .	REAGENT SYSTEM COLLECTION REAGENT FEEDERS MINETEC	4 EA	96	3730	823	0	0	7441	82	12076
500 .410000 .	OVERDENSE MEDIA SUMP PLATEWORK WT. 2000#	1 EA	32	1243	274	3710	0	0	398	5625
500 .415000 .	OVERDENSE MEDIA PUMP GOYNE PUMP	1 EA	32	1249	168	0	0	8678	17	10112
500 .420000 .	OVERDENSE MEDIA CONTROL BOX PLATEWORK WT. 1000#	1 EA	32	1243	274	1590	0	0	186	3293

--WORK BREAKDOWN--- FACIL.STANDRD.WKPKG	DESCRIPTION	QUANTITY	MANHOURS	LABOR	EQUIP USAGE	MATERIAL	SUB-CONTRACT	EQUIP-MENT	S/C OH&P	TOTAL DOLLARS
500 .425000 .	OVERDENSE MEDIA SENSOR BOX PLATEWORK WT. 400#	1 EA	16	622	137	795	0	0	93	1647
500 .430000 .	BALL MILL OVERHEAD CRANE HOIST THERN	1 EA	24	933	206	0	0	44520	21	45680
500 .430100 .	BALL MILL OVERHEAD CRANE TRAM RUNWAY THERN	1 LOT	128	4974	1097	0	0	8480	110	14661
500 .481105 .	LAB EQUIPMENT - OVEN (91-2150-1) PREISER SCIENTIFIC	1 EA	0	0	0	0	0	7632	0	7632
500 .481110 .	LAB EQUIPMENT - OVEN (91-2290-83) PREISER SCIENTIFIC	1 EA	0	0	0	0	0	2862	0	2862
500 .481115 .	LAB EQUIPMENT - TABLE (80-1345-01) PREISER SCIENTIFIC	1 EA	0	0	0	0	0	403	0	403
500 .481120 .	LAB EQUIPMENT - DESK (80-1345-01) PREISER SCIENTIFIC	1 EA	0	0	0	0	0	785	0	785
500 .481125 .	LAB EQUIPMENT - EXHAUST HOOD (80-2200-03) PREISER SCIENTIFIC	1 EA	0	0	0	0	0	2424	0	2424
500 .481130 .	LAB EQUIPMENT - CABINETS PREISER SCIENTIFIC	1 LOT	0	0	0	0	0	1985	0	1985
500 .485000 .	CLEAN UP PUMP 7.5HP/TEFC/480V/1800RPM	1 EA	64	2487	549	0	0	5599	55	8690
500 .495000 .	GLAND WATER PUMP 5HP/TEFC/480V/1800RPM	1 EA	64	2487	549	0	0	3407	55	6498
500 .500100 .	SLURRY SAMPLERS - 5 HP/TEFC/ 480V/1800 RPM	3 EA	120	4663	1029	0	0	14930	103	20725
500 .500200 .	DRY SAMPLERS - 5 HP/TEFC/ 480V/1800 RPM	2 EA	80	3109	686	0	0	13483	69	17347
500 .501300 .	AUTOMATIC FLOC MIXING SYSTEM 1.50HP/TEFC/480V/1800RPM	1 EA	32	1243	274	0	0	16483	27	18027
TOTAL	EQUIPMENT INSTALLATION		12,080	469,655	98,705	187,620	0	3,887,376	28,632	4,671,988
600	PIPING									
600 .601056 .	PIPE BLK PE EW 53 S40 1-1/2"	100 LF	7	273	37	136	0	0	17	463
600 .601060 .	PIPE BLK TC EW 53 S40 1/2"	143 LF	3	117	15	84	0	0	10	226
600 .601062 .	PIPE BLK TC EW 53 S40 3/4"	281 LF	11	429	59	197	0	0	26	711
600 .601064 .	PIPE BLK TC EW 53 S40 1"	440 LF	22	859	116	430	0	0	55	1460
600 .601065 .	PIPE BLK TC EW 53 S80 1"	14 LF	1	39	4	24	0	0	3	70
600 .601069 .	PIPE BLK TC EW 53 S80 1-1/2	7 LF	1	39	3	19	0	0	2	63
600 .601070 .	PIPE BLK TC EW 53 S40 2"	823 LF	82	3202	433	1685	0	0	212	5532

--WORK BREAKDOWN--- FACIL.	STANDRD.	WKPKG	DESCRIPTION	QUANTITY	MANHOURS	LABOR	EQUIP USAGE	MATERIAL	SUB-CONTRACT	EQUIP-MENT	S/C OH&P	TOTAL DOLLARS
600	.601071	.	PIPE BLK TC EW 53 S80 2"	98 LF	12	469	62	375	0	0	44	950
600	.601375	.	90 EL FS SCRD 3000 1/2"	24 EA	3	117	18	102	0	0	12	249
600	.601376	.	90 EL FS SCRD 3000 3/4"	26 EA	5	195	25	142	0	0	17	379
600	.601377	.	90 EL FS SCRD 3000 1"	28 EA	6	234	29	221	0	0	25	509
600	.601379	.	90 EL FS SCRD 3000 1-1/2"	5 EA	2	78	8	100	0	0	11	197
600	.601380	.	90 EL FS SCRD 3000 2"	70 EA	23	898	122	1694	0	0	182	2896
600	.601386	.	45 EL FS SCRD 3000 2"	4 EA	1	39	7	105	0	0	11	162
600	.601388	.	TEE FS SCRD 3000 3/4"	4 EA	1	39	4	34	0	0	4	81
600	.601392	.	TEE FS SCRD 3000 2"	65 EA	26	1015	137	2134	0	0	227	3513
600	.601444	.	UNION FS SCRD 3000 1/2"	20 EA	2	78	13	132	0	0	15	238
600	.601445	.	UNION FS SCRD 3000 3/4"	20 EA	3	117	16	159	0	0	18	310
600	.601446	.	UNION FS SCRD 3000 1"	30 EA	5	195	28	311	0	0	34	568
600	.601449	.	UNION FS SCRD 3000 2"	20 EA	6	234	34	466	0	0	50	784
600	.601551	.	CAP FS SW 3000 1/2"	8 EA	1	39	5	22	0	0	3	69
600	.601554	.	CAP FS SW 6000 3/4"	4 EA	1	39	4	30	0	0	3	76
600	.601561	.	CAP FS SW 3000 2"	4 EA	1	39	6	48	0	0	5	98
600	.601587	.	COUPLING FS SW 3000 1/2"	11 EA	1	39	7	23	0	0	3	72
600	.601589	.	COUPLING FS SW 3000 3/4"	17 EA	2	78	13	48	0	0	6	145
600	.601591	.	COUPLING FS SW 3000 1"	4 EA	1	39	3	12	0	0	2	56
600	.601597	.	COUPLING FS SW 3000 2"	2 EA	1	39	3	21	0	0	2	65
600	.601672	.	THREADOLET FS 3000 1/2"	4 EA	0	0	0	21	0	0	2	23
600	.601673	.	THREADOLET FS 3000 3/4"	5 EA	0	0	0	31	0	0	3	34
600	.601674	.	THREADOLET FS 3000 1"	34 EA	0	0	0	235	0	0	24	259
600	.601677	.	THREADOLET FS 3000 2"	8 EA	0	0	0	98	0	0	10	108
600	.602044	.	PIPE BLK PE EW 53 S40 2-1/2"	16 LF	0	0	0	51	0	0	5	56
600	.602046	.	PIPE BLK PE EW 53 S40 3"	143 LF	0	0	0	586	0	0	59	645
600	.6020461	.	PIPE BLK PE EW 53 XS 3"	191 LF	44	1718	231	1324	0	0	156	3429
600	.602048	.	PIPE BLK PE EW 53 S40 4"	305 LF	0	0	0	1557	0	0	156	1713
600	.6020481	.	PIPE BLK PE EW 53 XS 4"	465 LF	135	5271	710	4057	0	0	477	10515
600	.602052	.	PIPE BLK PE EW 53 S40 6"	80 LF	0	0	0	693	0	0	69	762
600	.6020521	.	PIPE BLK PE EW 53 XS 6"	390 LF	179	6989	944	6528	0	0	747	15208
600	.602056	.	PIPE BLK PE EW 53 S40 8"	110 LF	0	0	0	1430	0	0	143	1573
600	.6020561	.	PIPE BLK PE EW 53 XS 8"	644 LF	399	15578	2102	16220	0	0	1832	35732
600	.602058	.	PIPE BLK PE EW 53 XS 10"	378 LF	0	0	0	17551	0	0	1755	19306
600	.602061	.	PIPE BLK PE EW 53 S40 10"	15 LF	0	0	0	275	0	0	28	303
600	.602062	.	PIPE BLK PE EW 53 S80 10"	28 LF	0	0	0	1778	0	0	178	1956
600	.602064	.	PIPE BLK PE EW 53 XS 12"	40 LF	0	0	0	2192	0	0	219	2411
600	.602067	.	PIPE BLK PE EW 53 S40 12"	25 LF	0	0	0	1121	0	0	112	1233
600	.602068	.	PIPE BLK PE EW 53 S80 12"	4 LF	0	0	0	343	0	0	34	377
600	.602070	.	PIPE BLK PE EW 53 XS 14"	45 LF	0	0	0	2849	0	0	285	3134
600	.602074	.	PIPE BLK PE EW 53 S40 14"	30 LF	0	0	0	1759	0	0	176	1935
600	.602075	.	PIPE BLK PE EW 53 S80 14"	4 LF	0	0	0	465	0	0	47	512
600	.602077	.	PIPE BLK PE EW 53 XS 16"	82 LF	0	0	0	5824	0	0	582	6406
600	.602251	.	LOOSE PIPE CS S40 2-1/2"	16 LF	2	78	10	0	0	0	1	89
600	.602254	.	LOOSE PIPE CS S40 3"	143 LF	21	820	113	0	0	0	11	944
600	.602255	.	LOOSE PIPE CS S80 3"	191 LF	34	1327	181	0	0	0	18	1526

--WORK BREAKDOWN--- FACIL.STANDRD.WKPKG	DESCRIPTION	QUANTITY	MANHOURS	LABOR	EQUIP USAGE	MATERIAL	SUB-CONTRACT	EQUIP-MENT	S/C OH&P	TOTAL DOLLARS
600 .602257 .	LOOSE PIPE CS S40 4"	305 LF	61	2382	321	0	0	0	32	2735
600 .602258 .	LOOSE PIPE CS S80 4"	465 LF	112	4373	587	0	0	0	59	5019
600 .602263 .	LOOSE PIPE CS S40 6"	80 LF	23	898	122	0	0	0	12	1032
600 .602264 .	LOOSE PIPE CS S80 6"	390 LF	144	5622	760	0	0	0	76	6458
600 .602268 .	LOOSE PIPE CS S40 8"	110 LF	43	1679	226	0	0	0	23	1928
600 .602270 .	LOOSE PIPE CS S80 8"	672 LF	329	12845	1733	0	0	0	173	14751
600 .602272 .	LOOSE PIPE CS XS 10"	378 LF	231	9019	1213	0	0	0	121	10353
600 .602275 .	LOOSE PIPE CS S40 10"	15 LF	7	273	39	0	0	0	4	316
600 .602280 .	LOOSE PIPE CS XS 12"	40 LF	29	1132	154	0	0	0	15	1301
600 .602283 .	LOOSE PIPE CS S40 12"	25 LF	16	625	83	0	0	0	8	716
600 .602285 .	LOOSE PIPE CS S80 12"	4 LF	4	156	21	0	0	0	2	179
600 .602288 .	LOOSE PIPE CS XS 14"	45 LF	38	1484	201	0	0	0	20	1705
600 .602292 .	LOOSE PIPE CS S40 14"	30 LF	23	898	123	0	0	0	12	1033
600 .602294 .	LOOSE PIPE CS S80 14"	4 LF	5	195	27	0	0	0	3	225
600 .602296 .	LOOSE PIPE CS XS 16"	82 LF	80	3123	423	0	0	0	42	3588
600 .602408 .	90 LR BUTTW. CS S40 2-1/2"	8 EA	0	0	0	62	0	0	6	68
600 .602411 .	90 LR BUTTW. CS S40 3"	15 EA	0	0	0	115	0	0	12	127
600 .602412 .	90 LR BUTTW. CS S80 3"	12 EA	0	0	0	136	0	0	14	150
600 .602414 .	90 LR BUTTW. CS S40 4"	19 EA	0	0	0	242	0	0	24	266
600 .602415 .	90 LR BUTTW. CS S80 4"	32 EA	0	0	0	598	0	0	60	658
600 .602420 .	90 LR BUTTW. CS S40 6"	12 EA	0	0	0	374	0	0	37	411
600 .602421 .	90 LR BUTTW. CS S80 6"	19 EA	0	0	0	883	0	0	88	971
600 .602424 .	90 LR BUTTW. CS S40 8"	1 EA	0	0	0	58	0	0	6	64
600 .602425 .	90 LR BUTTW. CS S80 8"	52 EA	0	0	0	4508	0	0	451	4959
600 .602427 .	90 LR BUTTW. CS XS 10"	30 EA	0	0	0	4648	0	0	465	5113
600 .602432 .	90 LR BUTTW. CS STD 12"	3 EA	0	0	0	446	0	0	45	491
600 .602433 .	90 LR BUTTW. CS XS 12"	3 EA	0	0	0	655	0	0	66	721
600 .602437 .	90 LR BUTTW. CS STD 14"	1 EA	0	0	0	201	0	0	20	221
600 .602438 .	90 LR BUTTW. CS XS 14"	1 EA	0	0	0	271	0	0	27	298
600 .602442 .	90 LR BUTTW. CS XS 16"	2 EA	0	0	0	725	0	0	73	798
600 .602488 .	45 EL BUTTW. CS S40 3"	5 EA	0	0	0	33	0	0	3	36
600 .602501 .	45 EL BUTTW. CS S40 8"	25 EA	0	0	0	1017	0	0	102	1119
600 .602506 .	45 EL BUTTW. CS S40 10"	5 EA	0	0	0	367	0	0	37	404
600 .602508 .	45 EL BUTTW. CS STD 12"	1 EA	0	0	0	104	0	0	10	114
600 .602512 .	45 EL BUTTW. CS STD 14"	4 EA	0	0	0	563	0	0	56	619
600 .602537 .	TEE BUTTW. CS S40 3"	4 EA	0	0	0	68	0	0	7	75
600 .602538 .	TEE BUTTW. CS S80 3"	1 EA	0	0	0	23	0	0	2	25
600 .602540 .	TEE BUTTW. CS S40 4"	11 EA	0	0	0	259	0	0	26	285
600 .602546 .	TEE BUTTW. CS S40 6"	2 EA	0	0	0	85	0	0	9	94
600 .602547 .	TEE BUTTW. CS S80 6"	3 EA	0	0	0	181	0	0	18	199
600 .602550 .	TEE BUTTW. CS S40 8"	1 EA	0	0	0	79	0	0	8	87
600 .602551 .	TEE BUTTW. CS S80 8"	2 EA	0	0	0	244	0	0	24	268
600 .602553 .	TEE BUTTW. CS XS 10"	1 EA	0	0	0	198	0	0	20	218
600 .602635 .	CON RED BUTTW CS S40 3"	3 EA	0	0	0	21	0	0	2	23
600 .602638 .	CON RED BUTTW CS S40 4"	5 EA	0	0	0	47	0	0	5	52
600 .602644 .	CON RED BUTTW CS S40 6"	1 EA	0	0	0	19	0	0	2	21

--WORK BREAKDOWN--- FACIL.STANDRD.WKPKG	DESCRIPTION	QUANTITY	MANHOURS	LABOR	EQUIP USAGE	MATERIAL	SUB-CONTRACT	EQUIP-MENT	S/C OH&P	TOTAL DOLLARS
600 .602645 .	CON RED BUTTW CS S80 6"	6 EA	0	0	0	144	0	0	14	158
600 .602648 .	CON RED BUTTW CS S40 8"	2 EA	0	0	0	52	0	0	5	57
600 .602649 .	CON RED BUTTW CS S80 8"	10 EA	0	0	0	343	0	0	34	377
600 .602651 .	CON RED BUTTW CS XS 10"	6 EA	0	0	0	286	0	0	29	315
600 .602653 .	CON RED BUTTW CS S40 10"	1 EA	0	0	0	39	0	0	4	43
600 .602656 .	CON RED BUTTW CS STD 12"	1 EA	0	0	0	61	0	0	6	67
600 .602657 .	CON RED BUTTW CS XS 12"	1 EA	0	0	0	71	0	0	7	78
600 .602662 .	CON RED BUTTW CS XS 14"	2 EA	0	0	0	256	0	0	26	282
600 .602743 .	CAP BUTTWELD CS S40 3"	3 EA	0	0	0	12	0	0	1	13
600 .602746 .	CAP BUTTWELD CS S40 4"	5 EA	0	0	0	26	0	0	3	29
600 .602752 .	CAP BUTTWELD CS S40 6"	1 EA	0	0	0	10	0	0	1	11
600 .602761 .	CAP BUTTWELD CS S40 10"	1 EA	0	0	0	23	0	0	2	25
600 .602897 .	WELDOLET CS STD 3"	8 EA	0	0	0	288	0	0	29	317
600 .602992 .	SO FLANGE CS A181 150 2-1/2"	8 EA	0	0	0	84	0	0	8	92
600 .602995 .	SO FLANGE CS A181 150 3"	37 EA	0	0	0	396	0	0	40	436
600 .602998 .	SO FLANGE CS A181 150 4"	37 EA	0	0	0	506	0	0	51	557
600 .603004 .	SO FLANGE CS A181 150 6"	33 EA	0	0	0	737	0	0	74	811
600 .603007 .	SO FLANGE CS A181 150 8"	37 EA	0	0	0	1256	0	0	126	1382
600 .603010 .	SO FLANGE CS A181 150 10"	25 EA	0	0	0	1534	0	0	153	1687
600 .603012 .	SO FLANGE CS A181 150 12"	4 EA	0	0	0	362	0	0	36	398
600 .603014 .	SO FLANGE CS A181 150 14"	11 EA	0	0	0	1374	0	0	137	1511
600 .603016 .	SO FLANGE CS A181 150 16"	1 EA	0	0	0	166	0	0	17	183
600 .603026 .	THRD. FLG CS A181 150 2-1/2"	8 EA	2	78	10	118	0	0	13	219
600 .603027 .	THRD. FLG CS A181 150 3"	8 EA	2	78	12	136	0	0	15	241
600 .603059 .	BLIND FLG CS A181 150 3"	8 EA	2	78	12	99	0	0	11	200
600 .603062 .	BLIND FLG CS A181 150 4"	8 EA	3	117	16	133	0	0	15	281
600 .603068 .	BLIND FLG CS A181 150 6"	1 EA	1	39	3	26	0	0	3	71
600 .603080 .	BLIND FLG CS A181 150 16"	1 EA	1	39	8	217	0	0	23	287
600 .603607 .	FIELD JT BW CS S40 2-1/2"	24 EA	22	859	116	26	0	0	14	1015
600 .603610 .	FIELD JT BW CS S40 3"	117 EA	129	5037	678	156	0	0	83	5954
600 .603611 .	FIELD JT BW CS S80 3"	27 EA	37	1445	196	49	0	0	25	1715
600 .603613 .	FIELD JT BW CS S40 4"	136 EA	199	7770	1045	225	0	0	127	9167
600 .603619 .	FIELD JT BW CS S40 6"	67 EA	147	5739	776	229	0	0	101	6845
600 .603620 .	FIELD JT BW CS S80 6"	59 EA	162	6325	852	337	0	0	119	7633
600 .603624 .	FIELD JT BW CS S40 8"	96 EA	281	10971	1481	569	0	0	205	13226
600 .603626 .	FIELD JT BW CS S80 8"	130 EA	476	18585	2508	1333	0	0	384	22810
600 .603628 .	FIELD JT BW CS XS 10"	75 EA	344	13431	1808	962	0	0	277	16478
600 .603631 .	FIELD JT BW CS S40 10"	38 EA	139	5427	733	282	0	0	102	6544
600 .603634 .	FIELD JT BW CS STD 12"	14 EA	61	2382	323	137	0	0	46	2888
600 .603635 .	FIELD JT BW CS XS 12"	8 EA	44	1718	230	121	0	0	35	2104
600 .603642 .	FIELD JT BW CS STD 14"	21 EA	115	4490	605	227	0	0	83	5405
600 .603643 .	FIELD JT BW CS XS 14"	6 EA	42	1640	220	100	0	0	32	1992
600 .603648 .	FIELD JT BW CS XS 16"	6 EA	51	1991	269	114	0	0	38	2412
600 .605551 .	TUBING COPPER K 3/8"	680 LF	7	273	36	575	0	0	61	945
600 .605555 .	TUBING COPPER K 1/2"	217 LF	4	156	23	209	0	0	23	411
600 .607776 .	CPLG VICT + BOLTUP STD 4"	1 EA	1	39	4	12	0	0	2	57

--WORK BREAKDOWN--- FACIL.STANDRD.WKPKG	DESCRIPTION	QUANTITY	MANHOURS	LABOR	EQUIP USAGE	MATERIAL	SUB-CONTRACT	EQUIP-MENT	S/C OH&P	TOTAL DOLLARS
600 .607778 .	CPLG VICT + BOLTUP STD 6"	1 EA	1	39	5	21	0	0	3	68
600 .607779 .	CPLG VICT + BOLTUP STD 8"	4 EA	4	156	22	139	0	0	16	333
600 .607780 .	CPLG VICT+BOLTUP STD 10"	1 EA	1	39	6	49	0	0	6	100
600 .607781 .	CPLG VICT+BOLTUP STD 12"	2 EA	3	117	14	112	0	0	13	256
600 .651342 .	GATE VALVE, CAST STL 2-1/2" CRANE 47, CLASS 150, FLGD	8 EA	8	312	41	3821	0	0	386	4560
600 .651343 .	GATE VALVE, CAST STL 3" CRANE 47, CLASS 150, FLGD	21 EA	31	1210	161	10030	0	0	1019	12420
600 .651344 .	GATE VALVE, CAST STL 4" CRANE 47, CLASS 150, FLGD	13 EA	27	1054	142	7970	0	0	811	9977
600 .651347 .	GATE VALVE, CAST STL 8" CRANE 47, CLASS 150, FLGD	1 EA	3	117	18	1527	0	0	155	1817
600 .652103 .	GATE V VOGT FS 600 1" SW-12111	3 EA	1	39	8	137	0	0	15	199
600 .652106 .	GATE V VOGT FS 600 2" SW-12111	22 EA	22	859	113	2463	0	0	258	3693
600 .652283 .	BALL VALVE, CS 1/2" JAMESBURY A2236TT SCREWED ENDS, 2000 PSI	68 EA	28	1093	147	3822	0	0	397	5459
600 .652284 .	BALL VALVE, CS 3/4" JAMESBURY A2236TT SCREWED ENDS, 2000 PSI	15 EA	7	273	36	1132	0	0	117	1558
600 .652285 .	BALL VALVE, CS 1" JAMESBURY A2236TT SCREWED ENDS, 2000 PSI	50 EA	24	937	129	4889	0	0	502	6457
600 .653020 .	GATE VALVE, BRONZE 1-1/2" CRANE 1324, CLASS 150,SJ	2 EA	1	39	6	66	0	0	7	118
600 .653378 .	CHECK VALVE, BRONZE 2" CRANE 36, CLASS 200#, THD	1 EA	1	39	4	97	0	0	10	150
600 .653497 .	GATE VALVE, BRONZE 3" CRANE 431, CLASS 150, THD	4 EA	6	234	31	715	0	0	75	1055
600 .653716 .	CHECK VALVE, BRONZE 3" CRANE 36, CLASS 200, THD	1 EA	1	39	8	295	0	0	30	372
600 .655680 .	KNIFE GATE SS 150 4" DEZURIK 824 W/ HANDWHEEL OPER 304 SS WETTED PARTS, WAFER	3 EA	5	195	26	1084	0	0	111	1416
600 .655681 .	KNIFE GATE SS 150 6" DEZURIK 824 W/ HANDWHEEL OPER 304 SS WETTED PARTS, WAFER	4 EA	9	351	48	1772	0	0	182	2353
600 .655682 .	KNIFE GATE CI 150 8" DEZURIK 824 W/ HANDWHEEL OPER 304 SS WETTED PARTS, WAFER	2 EA	5	195	29	1208	0	0	124	1556
600 .655684 .	KNIFE GATE CI 150 12" DEZURIK 824 W/ HANDWHEEL OPER 304 SS WETTED PARTS, WAFER	4 EA	13	508	68	4181	0	0	425	5182

--WORK BREAKDOWN--- FACIL.	STANDRD.	WKPKG	DESCRIPTION	QUANTITY	MANHOURS	LABOR	EQUIP USAGE	MATERIAL	SUB-CONTRACT	EQUIP-MENT	S/C OH&P	TOTAL DOLLARS
600	.655685	.	KNIFE GATE CI 150 14" DEZURIK 824 W/ BEVEL GEAR OPR 304 SS WETTED PARTS, WAFER	2 EA	7	273	37	3634	0	0	367	4311
600	.686001	.	TEST & CLEAN 1/2"	143 LF	4	156	23	23	0	0	5	207
600	.686002	.	TEST & CLEAN 3/4"	281 LF	8	312	44	45	0	0	9	410
600	.686003	.	TEST & CLEAN 1"	440 LF	13	508	70	70	0	0	14	662
600	.686004	.	TEST & CLEAN 1-1/4"	823 LF	25	976	130	174	0	0	30	1310
600	.686007	.	TEST & CLEAN 2-1/2"	16 LF	1	39	5	4	0	0	1	49
600	.686008	.	TEST & CLEAN 3"	143 LF	9	351	45	38	0	0	8	442
600	.686009	.	TEST & CLEAN 4"	305 LF	21	820	112	97	0	0	21	1050
600	.686011	.	TEST & CLEAN 6"	80 LF	6	234	34	25	0	0	6	299
600	.686012	.	TEST & CLEAN 8"	110 LF	9	351	46	35	0	0	8	440
600	.686013	.	TEST & CLEAN 10"	421 LF	42	1640	221	134	0	0	36	2031
600	.686014	.	TEST & CLEAN 12"	69 LF	8	312	40	26	0	0	7	385
600	.686015	.	TEST & CLEAN 14"	79 LF	9	351	50	29	0	0	8	438
600	.686016	.	TEST & CLEAN 16"	82 LF	11	429	60	30	0	0	9	528
	TOTAL		PIPING		4,835		25,478		0		18,286	
						188,767		157,284		0		389,815
675			MECHANICAL									
675	.605555	.	TUBING COPPER K 1/2"	80 LF	2	78	8	77	0	0	9	172
675	.605563	.	TUBING COPPER K 3/4"	120 LF	2	78	13	211	0	0	22	324
675	.605568	.	TUBING COPPER K 1"	200 LF	4	156	21	469	0	0	49	695
675	.605572	.	TUBING COPPER K 1-1/4"	80 LF	3	117	17	240	0	0	26	400
675	.605577	.	TUBING COPPER K 1-1/2"	10 LF	0	0	2	38	0	0	4	44
675	.605582	.	TUBING COPPER K 2"	20 LF	1	39	5	120	0	0	13	177
675	.605603	.	90 EL COPPER SOLDER 1/2"	60 EA	2	78	13	35	0	0	5	131
675	.605604	.	90 EL COPPER SOLDER 3/4"	25 EA	1	39	7	33	0	0	4	83
675	.605605	.	90 EL COPPER SOLDER 1"	40 EEE	2	78	13	127	0	0	14	232
675	.605606	.	90 EL COPPER SOLDER 1-1/4"	4 EA	0	0	2	20	0	0	2	24
675	.605607	.	90 EL COPPER SOLDER 1-1/2"	4 EA	0	0	2	31	0	0	3	36
675	.605608	.	90 EL COPPER SOLDER 2"	1 EA	0	0	1	14	0	0	2	17
675	.605617	.	TEE COPPER SOLDER 1/2"	6 EA	0	0	2	6	0	0	1	9
675	.605618	.	TEE COPPER SOLDER 3/4"	4 EA	0	0	2	10	0	0	1	13
675	.605619	.	TEE COPPER SOLDER 1"	6 EA	1	39	4	43	0	0	5	91
675	.605620	.	TEE COPPER SOLDER 1-1/4"	5 EA	1	39	4	57	0	0	6	106
675	.605621	.	TEE COPPER SOLDER 1-1/2"	1 EA	0	0	1	16	0	0	2	19
675	.605622	.	TEE COPPER SOLDER 2"	1 EA	0	0	1	25	0	0	3	29
675	.605659	.	CPLG COPPER SOLDER 1/2"	6 EA	0	0	1	3	0	0	0	4
675	.605660	.	CPLG COPPER SOLDER 3/4"	3 EA	0	0	1	3	0	0	0	4
675	.605661	.	CPLG COPPER SOLDER 1"	8 EA	0	0	3	15	0	0	2	20
675	.605662	.	CPLG COPPER SOLDER 1-1/4"	6 EA	1	39	3	19	0	0	2	63
675	.606020	.	PIPE NO HUB 10 FT 1-1/4"	40 LF	3	117	15	64	0	0	8	204
675	.606021	.	PIPE NO HUB 10 FT 1-1/2"	40 LF	3	117	15	67	0	0	8	207
675	.606022	.	PIPE NO HUB 10 FT 2"	30 LF	3	117	14	55	0	0	7	193

--WORK BREAKDOWN--- FACIL.STANDRD.WKPKG	DESCRIPTION	QUANTITY	MANHOURS	LABOR	EQUIP USAGE	MATERIAL	SUB-CONTRACT	EQUIP-MENT	S/C OH&P	TOTAL DOLLARS
675 .606045 .	1/4 BEND CI NO HUB 1-1/2"	6 EA	1	39	5	15	0	0	2	61
675 .6060451.	1/4 BEND CI NO HUB 1-1/4"	2 EA	0	0	1	5	0	0	1	7
675 .606046 .	1/4 BEND CI NO HUB 2"	14 EA	2	78	13	37	0	0	5	133
675 .606047 .	1/8 BEND CI NO HUB 1-1/2"	1 EA	0	0	0	2	0	0	0	2
675 .606048 .	1/8 BEND CI NO HUB 2"	6 EA	1	39	3	15	0	0	2	59
675 .606053 .	SAN TEE CI NO HUB 1-1/2"	8 EA	1	39	4	26	0	0	3	72
675 .6060531.	SAN TEE CI NO HUB 1-1/4"	1 EA	1	39	6	10	0	0	2	57
675 .606054 .	SAN TEE CI NO HUB 2"	3 EA	0	0	1	11	0	0	1	13
675 .606063 .	P-TRAP CI NO HUB 1-1/2"	4 EA	1	39	4	15	0	0	2	60
675 .6060631.	P-TRAP CI NO HUB 1-1/4"	1 EA	0	0	1	4	0	0	1	6
675 .606064 .	P-TRAP CI NO HUB 2"	3 EA	1	39	3	11	0	0	1	54
675 .606633 .	PIPE NO HUB 10 FT 3"	20 LF	3	117	18	51	0	0	7	193
675 .606634 .	PIPE NO HUB 10 FT 4"	320 LF	54	2108	286	1060	0	0	135	3589
675 .606806 .	1/4 BEND CI NO HUB 3"	8 EA	2	78	11	28	0	0	4	121
675 .606807 .	1/4 BEND CI NO HUB 4"	20 EA	7	273	36	104	0	0	14	427
675 .606812 .	1/8 BEND CI NO HUB 4"	4 EA	1	39	4	19	0	0	2	64
675 .606831 .	SAN TEE CI NO HUB 4"	14 EA	4	156	19	97	0	0	12	284
675 .606842 .	WYE CI NO HUB 4"	10 EA	3	117	18	78	0	0	10	223
675 .606867 .	P-TRAP CI NO HUB 3"	5 EA	1	39	7	42	0	0	5	93
675 .606868 .	P-TRAP CI NO HUB 4"	1 EA	1	39	3	14	0	0	2	58
675 .608007 .	PIPE PVC D1785 PE S40 1-1/4"	20 LF	1	39	4	10	0	0	1	54
675 .608009 .	PIPE PVC D1785 PE S40 1-1/2"	100 LF	4	156	21	58	0	0	8	243
675 .608011 .	PIPE PVC D1785 PE S40 2"	60 LF	3	117	16	47	0	0	6	186
675 .608027 .	90 EL PVC SOCKET S40 1-1/4"	4 EA	0	0	1	3	0	0	0	4
675 .608029 .	90 EL PVC SOCKET S40 1-1/2"	6 EA	1	39	3	5	0	0	1	48
675 .608031 .	90 EL PVC SOCKET S40 2"	10 EA	1	39	6	13	0	0	2	60
675 .608053 .	TEE PVC SOCKET S40 1-1/2"	4 EA	0	0	2	4	0	0	1	7
675 .608055 .	TEE PVC SOCKET S40 2"	2 EA	0	0	2	3	0	0	1	6
675 .608129 .	CPLG PVC SOCKET S40 1-1/4"	1 EA	0	0	0	0	0	0	0	0
675 .608131 .	CPLG PVC SOCKET S40 1-1/2"	4 EA	0	0	2	2	0	0	0	4
675 .608133 .	CPLG PVC SOCKET S40 2"	2 EA	0	0	1	2	0	0	0	3
675 .608270 .	PIPE PVC D1785 PE S40 2-1/2"	100 LF	6	234	32	123	0	0	16	405
675 .608321 .	90 EL PVC SOCKET S40 2-1/2"	4 EA	1	39	3	16	0	0	2	60
675 .608341 .	TEE PVC SOCKET S40 2-1/2"	4 EA	1	39	4	21	0	0	3	67
675 .608391 .	CPLG PVC SOCKET S40 2-1/2"	4 EA	1	39	3	7	0	0	1	50
675 .608970 .	FLOOR DRAINS 3"	5 EA	15	586	79	368	0	0	45	1078
675 .608975 .	FLOOR DRAINS 4"	9 EA	27	1054	142	944	0	0	109	2249
675 .653019 .	GATE VALVE, BRONZE 1-1/4" CRANE 1324, CLASS 150, SJ	3 EA	1	39	7	88	0	0	10	144
675 .653020 .	GATE VALVE, BRONZE 1-1/2" CRANE 1324, CLASS 150,SJ	2 EA	1	39	6	66	0	0	7	118
675 .653021 .	GATE VALVE, BRONZE 2" CRANE 1324, CLASS 150, SJ	1 EA	1	39	4	47	0	0	5	95
675 .653436 .	BALL VALVE, BRASS 1/2" JAMESBURY A11MT SCREWED ENDS. 600 PSI	4 EA	2	78	9	209	0	0	22	318

--WORK BREAKDOWN--- FACIL.STANDRD.WKPKG	DESCRIPTION	QUANTITY	MANHOURS	LABOR	EQUIP USAGE	MATERIAL	SUB-CONTRACT	EQUIP-MENT	S/C OH&P	TOTAL DOLLARS
675 .653437 .	BALL VALVE, BRASS 3/4" JAMESBURY A11MT SCREWED ENDS, 600 PSI	6 EA	3	117	14	449	0	0	46	626
675 .653438 .	BALL VALVE, BRASS 1" JAMESBURY A11MT SCREWED ENDS, 600 PSI	7 EA	3	117	18	634	0	0	65	834
675 .675100 .	EF-1 EXHAUST FAN .50 HP/TEFC/120V/1800RPM/ GREENHECK MODEL BCF-108	1 EA	8	312	30	0	0	1471	3	1816
675 .675102 .	EF-2 EXHAUST FAN 3HP/TEFC/480V/1800RPM/ GREENHECK MODEL SPNE-36	1 EA	8	312	30	0	0	742	3	1087
675 .675104 .	EF-3 EXHAUST FAN 5HP/TEFC/480V/1800RPM/ GREENHECK MODEL SPNE-42	1 EA	8	312	30	0	0	918	3	1263
675 .675106 .	EF-4 EXHAUST FAN 1HP/TEFC/480V/1800RPM/ GREENHECK MODEL SPNE-36	1 EA	8	312	30	0	0	584	3	929
675 .675108 .	EF-5 EXHAUST FAN 3HP/TEFC/480V/1800RPM/ GREENHECK MODEL SPNE-36	1 EA	8	312	30	0	0	742	3	1087
675 .675110 .	EF-6 EXHAUST FAN .75HP/TEFC/480V/1800RPM/ GREENHECK MODEL SPNE-30	1 EA	8	312	30	0	0	508	3	853
675 .675120 .	AC-1 AIR CONDITIONER FAN W/COMPRESSOR/HEATER UNIT CORRECT AIR CORP MODEL SC24	1 EA	48	1872	181	0	0	5724	18	7795
675 .675125 .	AC-2 AIR CONDITIONER FAN W/COMPRESSOR/HEATER UNIT ADDISON MODEL PC044	1 EA	48	1872	181	0	0	5724	18	7795
675 .675130 .	AC-3 AIR CONDITIONER FAN W/COMPRESSOR/HEATER UNIT ADDISON MODEL PC044	1 EA	48	1872	181	0	0	5724	18	7795
675 .675135 .	HV-1 HEATING/VENTILATING UNIT W/UNIT HEATER 16KW BROD & MCCLUNG MODEL CRP-22	1 EA	48	1872	181	0	0	11584	18	13655
675 .675140 .	HV-2 HEATING/VENT. UNIT FAN W/UNIT HEATER 34KW BROD & MCCLUNG MODEL CRP-12	1 EA	48	1872	181	0	0	7983	18	10054
675 .675150 .	UH-1 UNIT HEATER A-G 10KW Q-MARK MODEL MUH-10-4	7 EA	112	4368	422	0	0	6307	42	11139
675 .675152 .	UH-2 UNIT HEATER A-U 15KW Q-MARK MODEL MUH-15-4	21 EA	336	13105	1265	0	0	21370	127	35867

--WORK BREAKDOWN--- FACIL.	STANDRD.	WKPKG	DESCRIPTION	QUANTITY	MANHOURS	LABOR	EQUIP USAGE	MATERIAL	SUB-CONTRACT	EQUIP-MENT	S/C OH&P	TOTAL DOLLARS
675	.675154	.	UH-3 UNIT HEATER A-N 20KW Q-MARK MODEL MUH-20-4	14 EA	224	8737	843	0	0	16324	84	25988
675	.675156	.	LV-1 LOUVERS A-X AM WARM & VENT MOD LF-31A-A	24 EA	96	3744	361	0	0	14399	36	18540
675	.675158	.	PRD-1 PRESSURE RELIEF DAMPER AM WARM & VENT MOD PR-10	1 EA	16	624	60	0	0	655	6	1345
675	.675200	.	DUCTWORK - FOR HEATING/VENTILATING AND AIR CONDITIONING UNITS	2165 LB	128	4997	0	1033	0	0	103	6133
675	.695550	.	ALLOWANCE FOR HANGERS AND SUPPORTS	1 LOT	80	3123	421	6731	0	0	715	10990
		TOTAL	MECHANICAL		1,465	57,149	5,449	14,325	0	100,759	1,981	179,663
700			ELECTRICAL AND INSTRUMENTATION									
700	.700000	.	5 KVA POWER CONDITIONER FOR UPS SYSTEM	1 EA	16	627	57	3180	0	0	324	4188
700	.700001	.	1.5 KW RECTIFIER PANEL	1 EA	16	627	57	0	0	0	6	690
700	.700002	.	10 KW ELECTRIC UNIT HEATER	27 EA	432	16928	1545	0	0	0	155	18628
700	.700003	.	20 KW ELECTRIC UNIT HEATERS	14 EA	224	8777	801	0	0	0	80	9658
700	.700004	.	PLC I/O PANELS	4 EA	192	7523	687	0	0	0	69	8279
700	.700005	.	PLC WORKSTATIONS COMPLETE	2 EA	128	5016	458	0	0	0	46	5520
700	.700006	.	CRT WORKSTATION PRINTERS	2 EA	8	313	29	0	0	0	3	345
700	.700007	.	LOCAL THERMOSTAT, NEMA #4	6 EA	48	1881	172	954	0	0	113	3120
700	.700008	.	EMERGENCY LIGHTING FIXTURE	10 EA	80	3135	286	3180	0	0	347	6948
700	.700009	.	ELECTRIC PHOTOCELL	1 EA	8	313	29	212	0	0	24	578
700	.700010	.	3/4" CONDUIT "T" FITTING	200 EA	200	7837	715	5300	0	0	602	14454
700	.700011	.	1" CONDUIT "T" FITTING	10 EA	10	392	36	371	0	0	41	840
700	.700012	.	1 1/4" CONDUIT "T" FITTING	25 EA	0	0	0	1855	0	0	186	2041
700	.700013	.	1 1/2" CONDUIT "T" FITTING	40 EA	40	1567	143	3604	0	0	375	5689
700	.700014	.	2" CONDUIT "T" FITTING	35 EA	35	1371	125	3154	0	0	328	4978
700	.700015	.	START-UP AND CHECK-OUT	1 LOT	800	31347	2861	1060	0	0	392	35660
700	.700016	.	TEMPORARY POWER AND LIGHT	1 LOT	800	31347	2861	31800	0	0	3466	69474
700	.713052	.	15KV LIGHTNING ARRESTER & MOUNTING HARDWARE TYPE LVBB	1 EA	2	78	7	65	0	0	7	157
700	.722121	.	3/4" GRS EXPOSED CONDUIT W/FITTINGS & SUPPORTS	14400 LF	1901	74489	6797	24941	0	0	3174	109401
700	.722122	.	1" GRS EXPOSED CONDUIT W/FITTINGS & SUPPORTS	2160 LF	324	12696	1158	4962	0	0	612	19428
700	.722123	.	1-1/4" GRS EXPOSED CONDUIT W/FITTINGS & SUPPORTS	2715 LF	440	17241	1572	9106	0	0	1068	28987
700	.722124	.	1-1/2" GRS EXPOSED CONDUIT W/FITTINGS & SUPPORTS	620 LF	125	4898	446	2571	0	0	302	8217

--WORK BREAKDOWN--- FACIL.STANDRD.WKPKG	DESCRIPTION	QUANTITY	MANHOURS	LABOR	EQUIP USAGE	MATERIAL	SUB-CONTRACT	EQUIP-MENT	S/C OH&P	TOTAL DOLLARS
700 .722125 .	2" GRS EXPOSED CONDUIT W/FITTINGS & SUPPORTS	1950 LF	478	18730	1708	10796	0	0	1250	32484
700 .722126 .	2-1/2" GRS EXPOSED CONDUIT W/FITTINGS & SUPPORTS	500 LF	162	6348	580	4812	0	0	539	12279
700 .722127 .	3" GRS EXPOSED CONDUIT W/FITTINGS & SUPPORTS	900 LF	363	14224	1297	10953	0	0	1225	27699
700 .731121 .	3/C #4 EPR 15KV SHIELDED COPPER CABLE	40 LF	3	118	9	354	0	0	36	517
700 .731124 .	3/C #1/0 EPR 15KV SHIELDED COPPER CABLE	70 LF	6	235	21	890	0	0	91	1237
700 .731125 .	3/C #2/0 EPR 15KV SHIELDED COPPER CABLE	100 LF	9	353	32	1431	0	0	146	1962
700 .732126 .	3/C #2/0 EPR 5KV SHIELDED COPPER CABLE	250 LF	20	784	72	2319	0	0	239	3414
700 .733042 .	#10 THHN, 1/C, CU, 600V WIRE	9500 LF	76	2978	276	1208	0	0	148	4610
700 .733201 .	3/C #12 600V PWR CBL TYPE TC	8000 LF	80	3135	288	4927	0	0	522	8872
700 .733202 .	3/C #10 600V PWR CBL TYPE TC	2200 LF	31	1215	110	1912	0	0	202	3439
700 .733203 .	3/C #8 600V PWR CBL TYPE TC	1000 LF	25	980	89	1408	0	0	150	2627
700 .733204 .	3/C #6 600V PWR CBL TYPE TC	700 LF	25	980	90	1288	0	0	138	2496
700 .733205 .	3/C #4 600V PWR CBL TYPE TC	200 LF	9	353	33	514	0	0	55	955
700 .733206 .	3/C #2 600V PWR CBL TYPE TC	130 LF	7	274	23	509	0	0	53	859
700 .733208 .	3/C #1/0 600V PWR CBL TYPE TC	670 LF	41	1607	146	3509	0	0	366	5628
700 .733209 .	3/C #2/0 600V PWR CBL TYPE TC	230 LF	16	627	57	1437	0	0	149	2270
700 .733213 .	3/C 350 MCM 600V PWR CBL TYPE TC	1200 LF	121	4741	433	17374	0	0	1781	24329
700 .733401 .	2/C #14 600V CONTROL CABLE TYPE TC	5500 LF	50	1959	176	2419	0	0	260	4814
700 .733402 .	3/C #14 600V CONTROL CABLE TYPE TC	1200 LF	12	470	43	613	0	0	66	1192
700 .733404 .	5/C #14 600V CONTROL CABLE TYPE TC	2200 LF	26	1019	95	1782	0	0	188	3084
700 .733407 .	8/C #14 600V CONTROL CABLE TYPE TC	600 LF	9	353	32	585	0	0	62	1032
700 .734121 .	1PR #16 SHIELDED CABLE	8500 LF	85	3331	306	1352	0	0	166	5155
700 .734512 .	COAXIAL CABLE, RG A/U 59 75 OHMS, FIRE RATED	200 LF	3	118	11	350	0	0	36	515
700 .741001 .	1/C #6 TO 1/0 15KV TERM INCL HI-POTTING	18 EA	72	2821	258	1431	0	0	169	4679
700 .742006 .	1/C #2/0 TO 4/0 5KV TERM. INCL HI-POTTING	12 EA	48	1881	172	890	0	0	106	3049
700 .743001 .	1/C #16 TO #10 SOLDERLESS TERMINAL LUGS,600V	2893 EA	463	18142	1655	1135	0	0	279	21211
700 .743002 .	1/C #8 TO #4 SOLDERLESS TERMINAL LUGS,600V	78 EA	21	823	75	103	0	0	18	1019

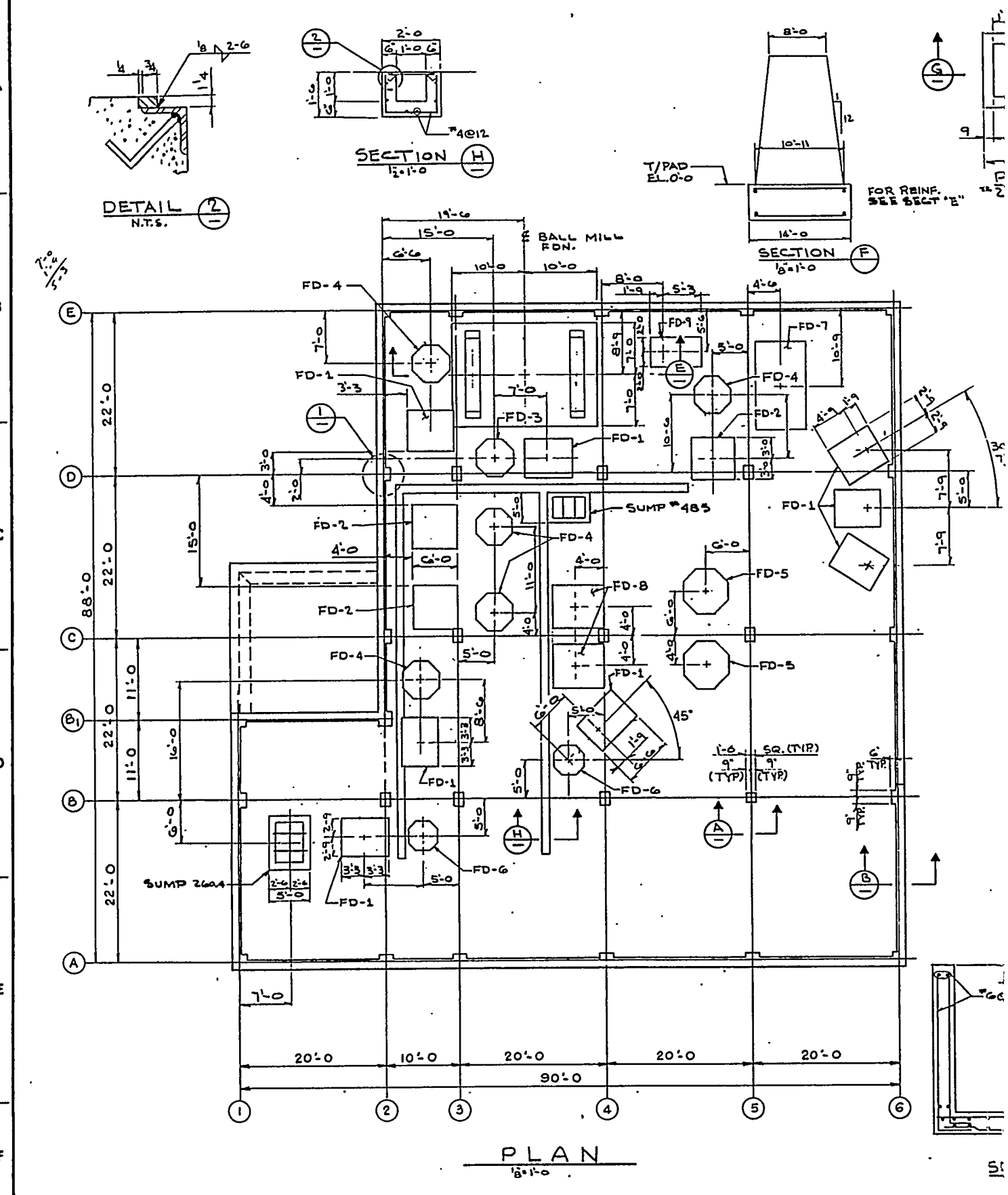
--WORK BREAKDOWN--- FACIL.	STANDRD.	WKPKG	DESCRIPTION	QUANTITY	MANHOURS	LABOR	EQUIP USAGE	MATERIAL	SUB-CONTRACT	EQUIP-MENT	S/C OH&P	TOTAL DOLLARS
700	.743003	.	1/C #2 TO #1 SOLDERLESS TERMINAL LUGS,600V	6 EA	2	78	8	18	0	0	3	107
700	.743004	.	1/C #1/0 TO #2/0 SOLDERLESS TERMINAL LUGS,600V	48 EA	24	940	86	285	0	0	37	1348
700	.743008	.	1/C 350 MCM SOLDERLESS TERMINAL LUGS,600V	114 EA	130	5094	465	1601	0	0	207	7367
700	.743009	.	1/C 500 MCM SOLDERLESS TERMINAL LUGS,600V	20 EA	27	1058	95	281	0	0	38	1472
700	.751021	.	FEEDER BREAKER DRAWOUT TYPE, 1200A, 500 MVA, 13.8KV	3 EA	180	7053	644	0	0	79500	64	87261
700	.751209	.	XFORMER, PAD MTD, OIL FILLED 13.8KV/480/277V,3PH,1000 KVA	1 EA	80	3135	286	0	0	15688	29	19138
700	.751228	.	XFORMER, PAD MTD, SILICON FLD 13.8KV/480/277V,2500 KVA	1 EA	140	5486	501	0	0	48654	50	54691
700	.752050	.	STARTER FVNR 4.16KV TO 1250 HP CLASS E-2	1 EA	40	1567	143	0	0	13886	14	15610
700	.753006	.	480V DRAWOUT AIR CIRCUIT BRKR 800A (ELECTRIC)	8 EA	192	7523	687	0	64	61056	69	69399
700	.753010	.	480V DRAWOUT AIR CIRCUIT BRKR 4000A (ELECTRIC)	1 EA	60	2351	215	0	8	45707	22	48303
700	.753150	.	COMBINATION CKT BRKR STARTER MCC MOUNTED, NEMA 1, CLASS 2 TYPE B, 480V, FVNR SIZE 1	45 EA	135	5290	483	0	0	45792	48	51613
700	.753151	.	COMBINATION CKT BRKR STARTER MCC MOUNTED, NEMA 1, CLASS 2 TYPE B, 480V, FVNR SIZE 2	7 EA	42	1646	150	0	0	8533	15	10344
700	.753152	.	COMBINATION CKT BRKR STARTER MCC MOUNTED, NEMA 1, CLASS 2 TYPE B, 480V, FVNR SIZE 3	5 EA	40	1567	143	0	0	9275	14	10999
700	.753153	.	COMBINATION CKT BRKR STARTER MCC MOUNTED, NEMA 1, CLASS 2 TYPE B, 480V, FVNR SIZE 4	9 EA	108	4232	386	0	0	30910	39	35567
700	.753154	.	COMBINATION CKT BRKR STARTER MCC MOUNTED, NEMA 1, CLASS 2 TYPE B, 480V, FVNR SIZE 5	2 EA	36	1411	129	0	0	14034	13	15587
700	.753180	.	CKT BRKR MCC MTD,480V-15-100A	75 EA	75	2939	268	0	0	29018	27	32252
700	.753182	.	CKT BRKR MCC MTD,480V,400A	2 EA	10	392	36	0	0	3328	4	3760
700	.753190	.	MCC,MAIN BRKR,480V,600A	2 EA	32	1254	114	0	0	4632	11	6011
700	.753191	.	MCC,MAIN BRKR,480V,800A	4 EA	72	2821	258	0	0	13059	26	16164
700	.753231	.	TRANSFORMER,DRY INDOOR 5 KVA,480V-120/208V,3PH	1 EA	11	431	39	0	0	413	4	887
700	.753234	.	TRANSFORMER,DRY INDOOR 30 KVA,480V-120/208V,3PH	1 EA	20	784	72	0	0	1060	7	1923
700	.753301	.	UPS 5 KVA 480V INCLUDING 30 MIN BATTERY BACKUP	1 EA	48	1881	172	0	0	21200	17	23270

--WORK BREAKDOWN--- FACIL.STANDRD.WKPKG	DESCRIPTION	QUANTITY	MANHOURS	LABOR	EQUIP USAGE	MATERIAL	SUB-CONTRACT	EQUIP-MENT	S/C OH&P	TOTAL DOLLARS
700 .753412 .	36 CKT PANEL BOARD NEMA 1 277/480V,4W,225A/3P,MAIN LUGS INCL 20A/1P BKRS.	2 EA	45	1763	159	0	0	3286	16	5224
700 .761013 .	FLUO LTG FIXTURE, TROFFER, SURF MTD, 2'X 4', W/2-40W LAMPS (ACRYLIC LENS)	6 EA	8	313	28	382	0	0	41	764
700 .761015 .	FLUO LTG FIXTURE, TROFFER, SURF MTD, 2'X 4', W/4-40W LAMPS (ACRYLIC LENS)	18 EA	27	1058	97	1507	0	0	160	2822
700 .761063 .	HPS, SURFACE MOUNTED 2'X 2', 400W LAMP	2 EA	7	274	24	704	0	0	73	1075
700 .761066 .	HPS, LOW BAY, RECESSED MTD 150W LAMP	121 EA	303	11873	1082	41556	0	0	4264	58775
700 .762007 .	RECEPT CORROSION RESISTANT 15A,125V INCL BOX & COVER	30 EA	26	1019	91	655	0	0	75	1840
700 .762022 .	WELDING RECEPT 100A 3PH 600V	5 EA	15	588	54	1174	0	0	123	1939
700 .762031 .	TOGGLE SWITCH SINGLE POLE 15A 120V INCL BOX & COVER	10 EA	7	274	25	74	0	0	10	383
700 .762303 .	PUSHBUTTON START/STOP,NEMA 4 CHANNEL MOUNTED	49 EA	196	7680	701	6441	0	0	714	15536
700 .762313 .	SELECTOR SW, HANDS-OFF-AUTO NEMA 4, CHANNEL MOUNTED	6 EA	24	940	86	731	0	0	82	1839
700 .763017 .	#4/0 STRANDED, BCW, 600V	500 LF	10	392	36	956	0	0	99	1483
700 .763021 .	500 MCM STRANDED, BCW, 600V	1200 LF	29	1136	103	4910	0	0	501	6650
700 .763081 .	GROUND ROD 5/8"X 10'	6 EA	6	235	21	82	0	0	10	348
700 .763212 .	500 MCM AWG CADWELD	60 EA	120	4702	429	684	0	0	111	5926
700 .772005 .	11-LINE PHONE	2 EA	9	353	33	0	0	721	3	1110
700 .772107 .	PAGING MICROPHONE	9 EA	9	353	32	0	0	2385	3	2773
700 .772111 .	WP HORN TYPE SPEAKER	9 EA	18	705	64	0	0	1431	6	2206
700 .794100 .	PROCESS CONTROLS - EQUIPMENT/ DESIGN/FIELD SERVICES	1 LOT	3380	207802	0	0	0	164258	0	372060
700 .800100 .	PRESSURE TRANSMITTERS - ELECTRICAL ROSEMOUNT 1151GP	3 EA	12	470	43	0	0	3180	4	3697
700 .800102 .	FLOW TRANSMITTERS - MAGNETIC/ ELECTRICAL	1 EA	4	157	14	0	0	6042	1	6214
700 .800104 .	LEVEL SWITCHES - FLOATS	2 EA	8	313	29	0	0	1272	3	1617
700 .800106 .	LEVEL TRANSMITTERS D/P FLANGE ROSEMOUNT 1151LT-4-E-GO-M-12-D	9 EA	36	1411	129	0	0	14215	13	15768
700 .800110 .	BUTTERFLY CONTROL VALVES 2"	6 EA	12	469	63	0	0	6360	6	6898
700 .800112 .	BUTTERFLY CONTROL VALVES 3"	1 EA	2	78	11	0	0	1166	1	1256
700 .800114 .	BUTTERFLY CONTROL VALVES 6"	2 EA	8	312	42	0	0	2756	4	3114

--WORK BREAKDOWN--- FACIL.STANDRD.WKPKG		DESCRIPTION	QUANTITY	MANHOURS	LABOR	EQUIP USAGE	MATERIAL	SUB-CONTRACT	EQUIP-MENT	S/C OH&P	TOTAL DOLLARS
700	.800116 .	BUTTERFLY CONTROL VALVES 14"	1 EA	8	312	42	0	0	2332	4	2690
700	.800120 .	ANALYZER - PH ROSEMOUNT 2000 1054PH	1 EA	8	313	29	0	0	2226	3	2571
700	.800122 .	ANALYZER - DENSITY-NUCLEAR	3 EA	24	940	86	0	0	18603	9	19638
700	.800124 .	ANALYZER - TURBIDITY	2 EA	16	627	57	0	0	7844	6	8534
700	.800126 .	POWER POSITIONER - PNEUMATIC	2 EA	32	1254	114	0	0	3604	11	4983
	TOTAL	ELECTRICAL AND INSTRUMENTATION		14,003	624,051	38,033	234,657	72	687,426	27,274	1,611,513
900		INDIRECTS AND DISTRIBUTABLES									
900	.901005 .	SURVEY SERVICES	1 LOT	0	0	0	0	10000	0	0	10000
900	.901010 .	TEMPORARY FIELD FAB SHOP	1 LOT	240	8819	1116	5300	0	0	642	15877
900	.901015 .	TEMPORARY POWER	1 LOT	240	9404	858	10600	0	0	1146	22008
900	.901035 .	FIELD CONSTRUCTION TRAILERS (2 EA)	12 MO	0	0	0	6360	0	0	636	6996
900	.901040 .	TOOL TRAILERS (2 EA)	12 MO	0	0	0	5088	0	0	509	5597
900	.901045 .	PORT A JOHNS (3 EA)	12 MO	0	0	0	2862	0	0	286	3148
900	.901050 .	POTABLE DRINKING WATER	1 LOT	0	0	0	1060	0	0	106	1166
900	.901055 .	ALLOWANCE FOR BARRICADES AND LIGHTS	1 LOT	160	5879	744	1590	0	0	233	8446
900	.901060 .	PICK UP TRUCKS (2 EA) RENTAL	12 MO	0	0	0	7632	0	0	763	8395
900	.901065 .	ALLOWANCE FOR FUEL, OIL AND GREASE FOR PICK UP TRUCKS	1 LOT	0	0	0	4240	0	0	424	4664
900	.901070 .	FIELD WAREHOUSE	1 LOT	320	11758	1487	12720	0	0	1421	27386
	TOTAL	INDIRECTS AND DISTRIBUTABLES		960	35,860	4,205	57,452	10,000	0	6,166	113,683
901		ENGINEERING									
901	.901015 .	DESIGN ENGINEERING SERVICES W/BURDEN AND EXPENSES FOR SITE SPECIFIC DESIGN	1 LOT	0	0	0	0	600000	0	0	600000
	TOTAL	ENGINEERING		0	0	0	0	600,000	0	0	600,000
902		PROJECT/CONSTRUCTION MANAGEMENT									
902	.902005 .	CONSTRUCTION MANAGEMENT PERSONNEL W/BURDEN AND EXPENSES	1 LOT	0	0	0	0	250000	0	0	250000
902	.902020 .	PROJECT MANAGEMENT SERVICES W/BURDEN AND EXPENSES	1 LOT	0	0	0	0	350000	0	0	350000

--WORK BREAKDOWN--- FACIL.STANDRD.WKPKG		DESCRIPTION	QUANTITY	MANHOURS	LABOR	EQUIP USAGE	MATERIAL	SUB-CONTRACT	EQUIP-MENT	S/C OH&P	TOTAL DOLLARS
TOTAL		PROJECT/CONSTRUCTION MANAGEMENT		0		0		600,000		0	
					0		0		0		600,000
903		FIELD OFFICE EXPENSES									
903	.903005 .	ICFKE FIELD OFFICE TRAILER	12 MO	0	0	0	6360	0	0	0	6360
903	.903012 .	TRAILER HOOK UP AND REMOVAL	1 EA	80	2940	372	0	1000	0	0	4312
903	.903015 .	FIELD VEHICLE FOR CONSTR. MANAGEMENT	12 MO	0	0	0	5088	0	0	0	5088
903	.903020 .	OFFICE SUPPLIES	12 MO	0	0	0	2544	0	0	0	2544
903	.903022 .	COPY MACHINE	12 MO	0	0	0	1908	0	0	0	1908
903	.903025 .	COMPUTERS	2 EA	0	0	0	10600	0	0	0	10600
903	.903030 .	TELEPHONE/FAX SERVICE	12 MO	0	0	0	3816	0	0	0	3816
903	.903060 .	UTILITY SERVICE	12 MO	0	0	0	3180	0	0	0	3180
TOTAL		FIELD OFFICE EXPENSES		80		372		1,000		0	
					2,940		33,496		0		37,808
904		INSURANCE/TAXES/PERMITS/									
904	.904105 .	ALL RISK INSURANCE	1 LOT	0	0	0	74200	0	0	0	74200
904	.904110 .	1% BOND	1 LOT	0	0	0	99640	0	0	0	99640
TOTAL		INSURANCE/TAXES/PERMITS/		0		0		0		0	
					0		173,840		0		173,840
REPORT TOTAL				48,319		229,765		1,211,072		169,948	
					1,937,022		1,677,178		4,675,561		9,900,546

ENGINEERING DRAWINGS



NO.	DATE	REVISION	BY CHK	APP.	APP.	REFERENCE DRAWINGS	NUMBER	NOTES	DESCRIPTION COST ACCOU
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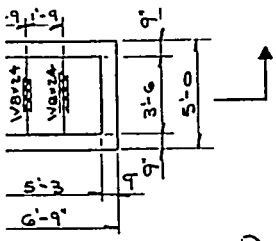
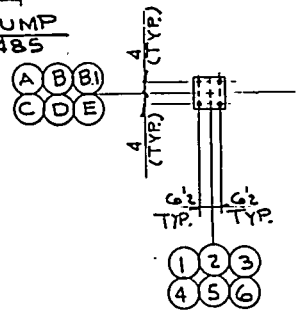
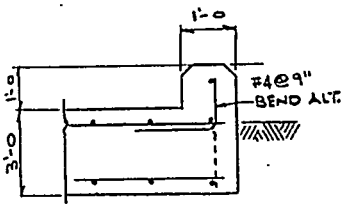


LAN SUMP
60.4 # 485



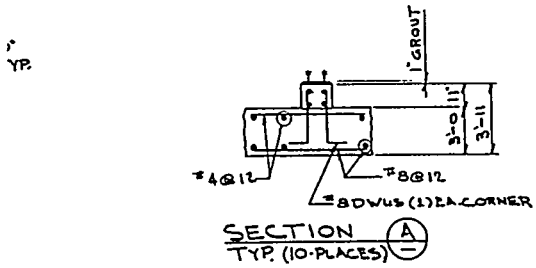
ANCHOR BOLT LOCATION



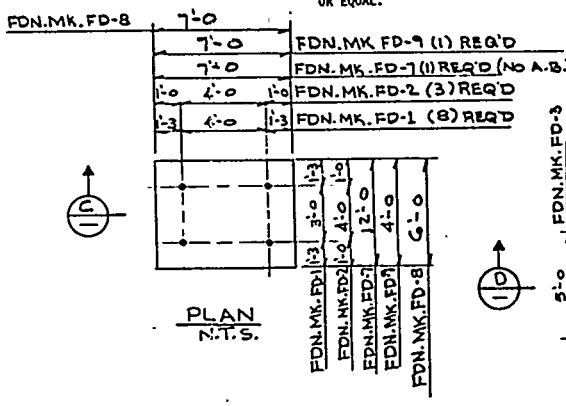
SECTION (B) N.T.S.

CONCRETE NOTES:

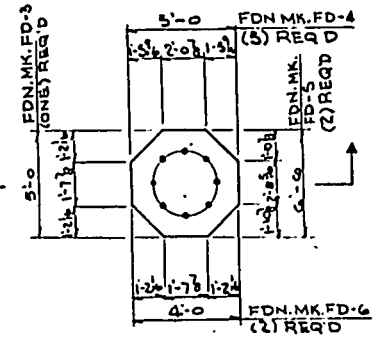
1. DESIGN AND CONSTRUCTION OF REINFORCED CONCRETE SHALL CONFORM TO THE BUILDING CODE REQUIREMENTS FOR REINFORCED CONCRETE (ACI 318), LATEST EDITION.
2. ALL REINFORCING STEEL SHALL BE ASTM A615, GRADE 60.
3. ALL ANCHOR BOLTS SHALL CONFORM TO ASTM A36 UNLESS NOTED.
4. SPLICES AND DEVELOPMENT IN REINFORCING STEEL SHALL CONFORM TO ACI 318. CLASS "B" UNLESS NOTED, ALL SPLICES TO BE STAGGERED.
5. WELDED WIRE FABRIC FOR CONCRETE REINFORCMENT SHALL CONFORM TO ASTM A185.
6. CONSTRUCTION JOINT LOCATIONS SHOWN ON DRAWINGS SHALL BE ADHERED TO UNLESS OTHERWISE APPPROVED BY THE OWNER.
7. EMBEDDED STEEL TO BE SET FLUSH (+/-1/16") WITH SURFACE OF CONCRETE UNLESS OTHERWISE SHOWN OR NOTED.
8. ALL EXPOSED CONCRETE EDGES SHALL BE CHAMFERED 1" AT 45°.
9. ALL CONDUITS, PIPES, DRAINS, ETC., EMBEDDED IN OR INSTALLED BELOW CONCRETE SHALL BE IN PLACE BEFORE PLACEMENT OF CONCRETE.
10. FOUNDATION EXCAVATIONS SHALL BE BACKFILLED WITH WELL GRADED AND WELL COMPACTED GRANULAR FILL.
11. CONCRETE: MINIMUM f'_c=4000 PSI AT 28 DAYS, UNLESS NOTED.
12. CEMENT: ASTM C150, TYPE I (AIR-ENTRAINED).
13. DESIGN SOIL BEARING PRESSURE = 3000 PSF FOR ALL FOUNDATIONS.
14. GROUT REQUIRED FOR LEVELING EQUIPMENT BASES AND COLUMNS, ETC. SHALL BE NONMETALLIC NONSHRINK GROUT EMBECO 929 AS MANUFACTURED BY MASTER BUILDERS OR EQUAL.



SECTION (A) TYP. (10-PLACES)



PLAN N.T.S.



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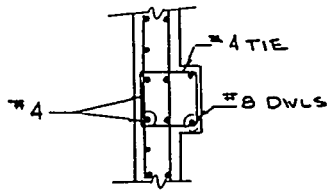
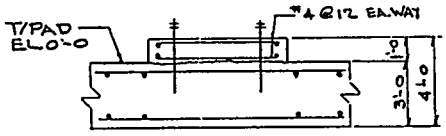
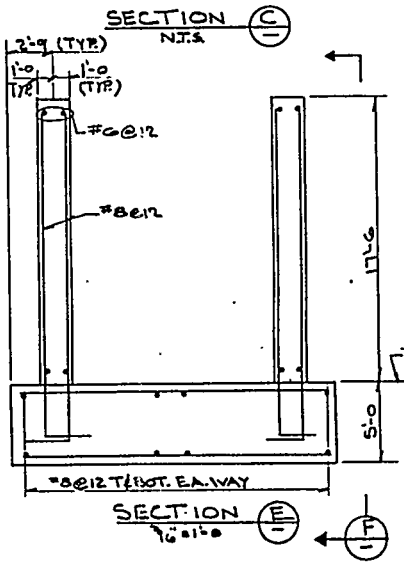


DETAIL (1) TYP. (13-PLACES)



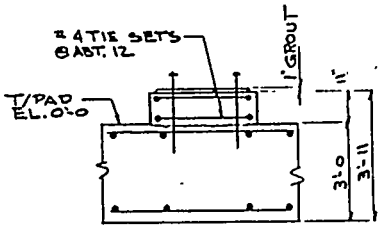
FOR REINF. SEE SECTION "A"

SECTION (C) N.T.S.



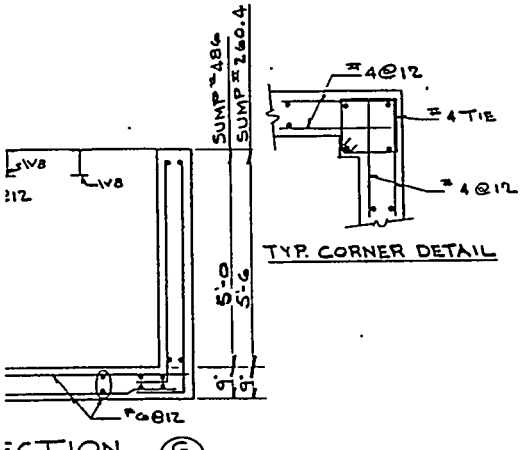
SECTION (E) 1/4"=1'-0

SECTION (F)



FOR REINF. SEE SECTION "A"

SECTION (D) N.T.S.



TYP. CORNER DETAIL

SECTION (G) 1/2"=1'-0

NOTE:
ALL EQUIMENT ANCHOR BOLTS ON HOLD FOR VENDER INFO.

CONSTRUCTION APPROVAL	APPROVAL	DATE	SCALE 3/8" = 1'-0	DATE	PROFESSIONAL SEAL
			DESIGNED BY J. MICIKAS		
			DRAWN BY E. JAMISON		
			CHECKED BY		
			APPROVED BY		
			APPROVED BY		

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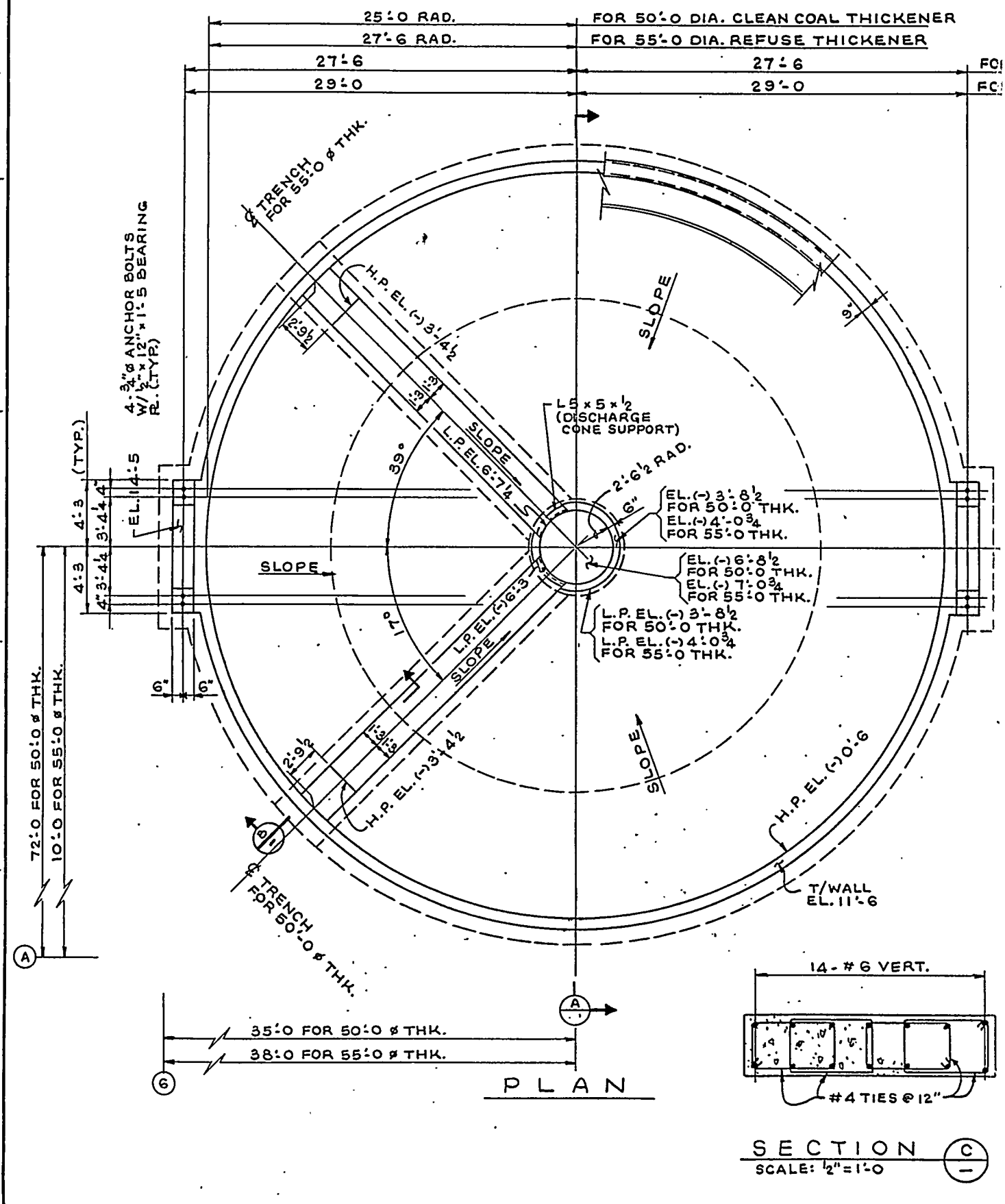
Pittsburgh, PA 15222-1207
(412) 281-8121, TELEX: 199121

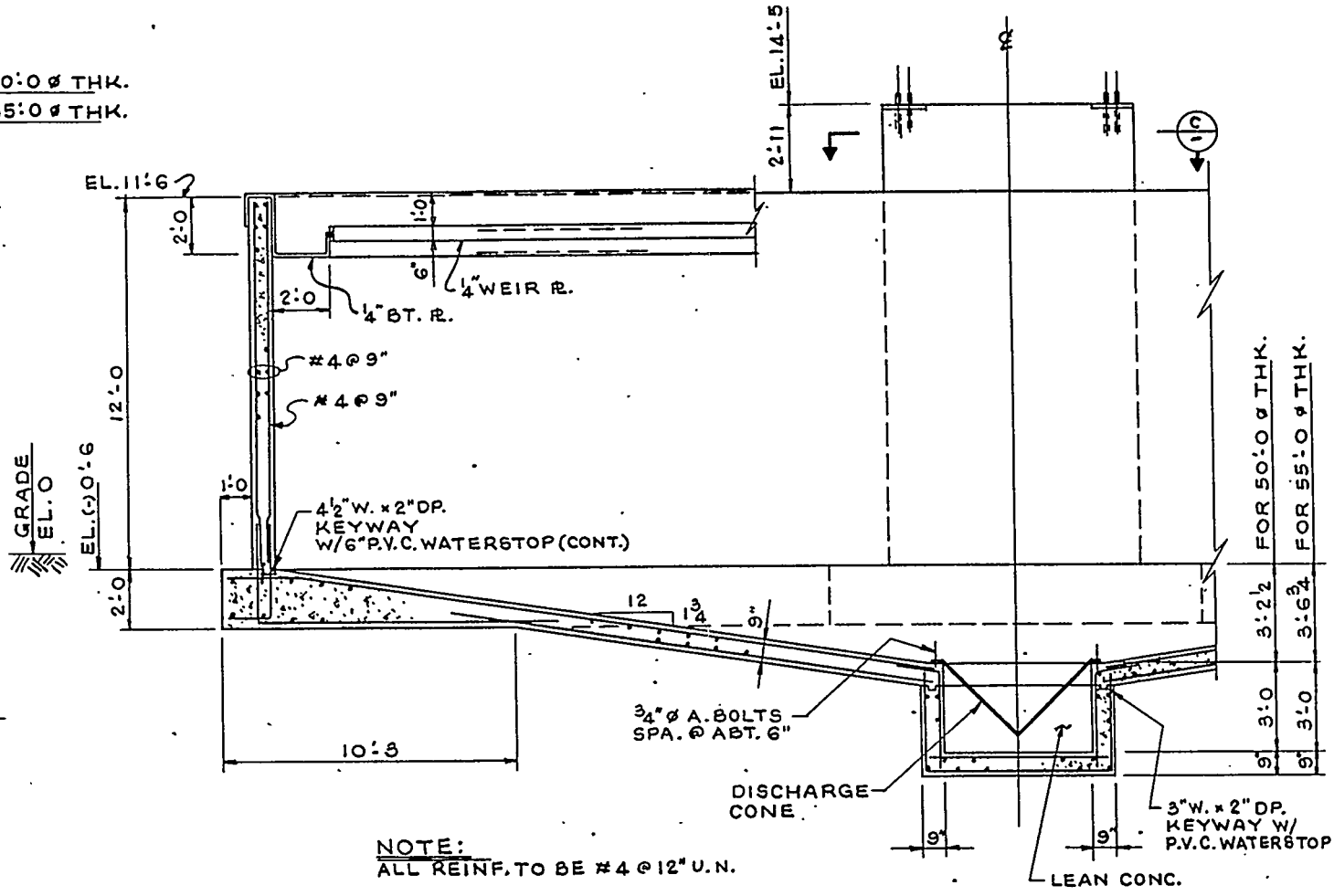
UNITED STATES DEPARTMENT OF ENERGY
ADVANCED FROTH FLOTATION PROCESS
FOUNDATION
PLAN, SECTIONS & DETAILS

JOB No. 88107-250-00 | DWG. No. 10-20-1001 | REVISION R.



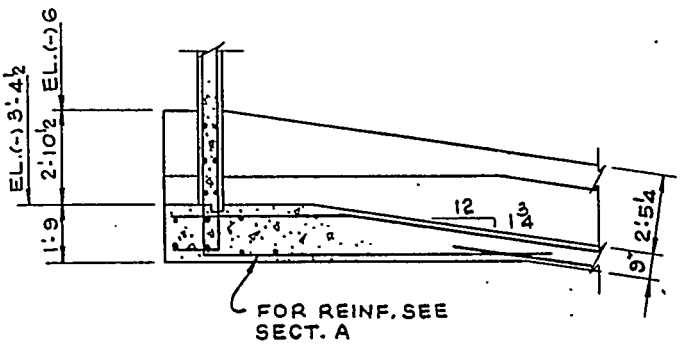
NO.	DATE	REVISION	BY	APP.	APP.	REFERENCE DRAWINGS	NUMBER	NOTES	DESCRIPTION	COST ACCT.

R 50:0 ø THK.
R 55:0 ø THK.

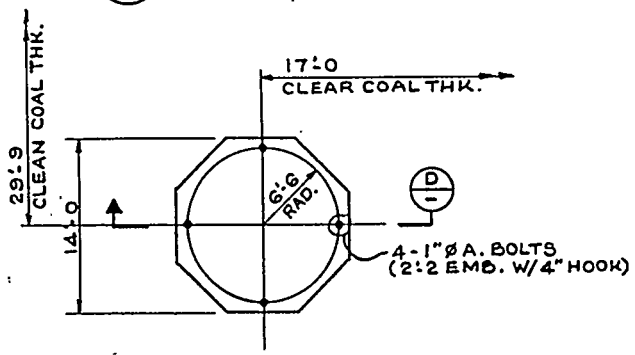


NOTE:
ALL REINF. TO BE #4 @ 12" U.N.

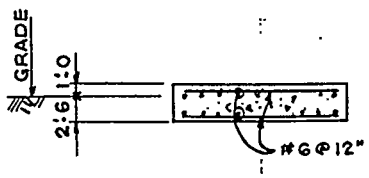
SECTION A
SCALE: 3/8" = 1:0



SECTION B
SCALE: 3/8" = 1:0



PLAN



SECTION D

CONSTRUCTION APPROVAL	APPROVAL	DATE	SCALE: 1/4" = 1:0 U.N.	DATE	PROFESSIONAL SEAL
			DESIGNED BY		
			DRAWN BY E. JAMISON		
			CHECKED BY		
			APPROVED BY		
			APPROVED BY		

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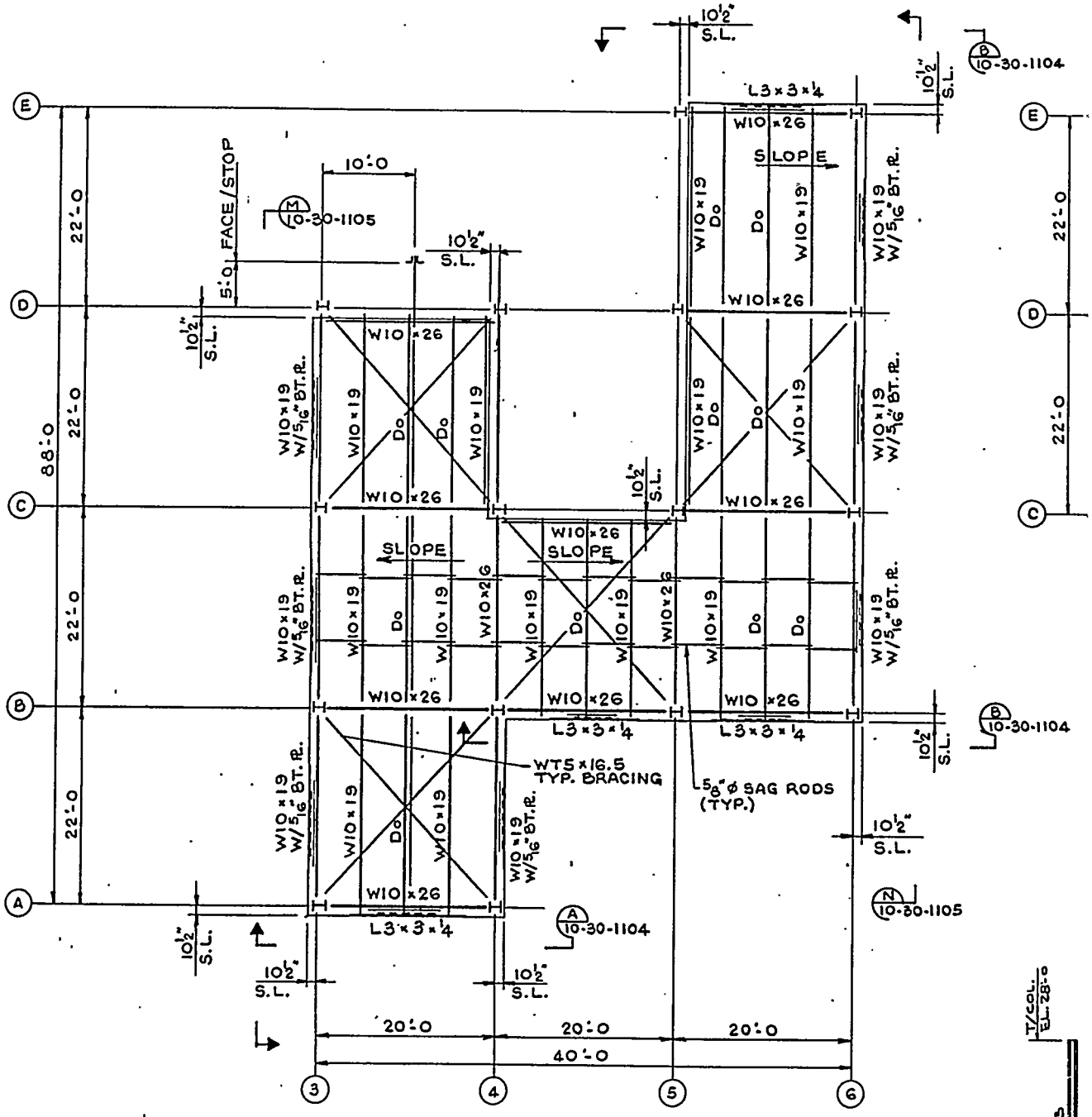
ICF KAISER ENGINEERS INC.
Four Gateway Center
Pittsburgh, PA 15222-1207
(412) 281-8121, TELEX: 199121

UNITED STATES DEPARTMENT OF ENERGY
ADVANCED FROTH FLOTATION PROCESS
FOUNDATIONS
50:0 DIA. CLEAN COAL THICKENER AND
55:0 DIA. REFUSE THICKENER

JOB No. 88107-250-00 | DWG. No. 10-20-1004 | REVISION R.



PARTIAL ROOF PLAN

SCALE: 1/8" = 1'-0

T/COL. EL. 28'-0

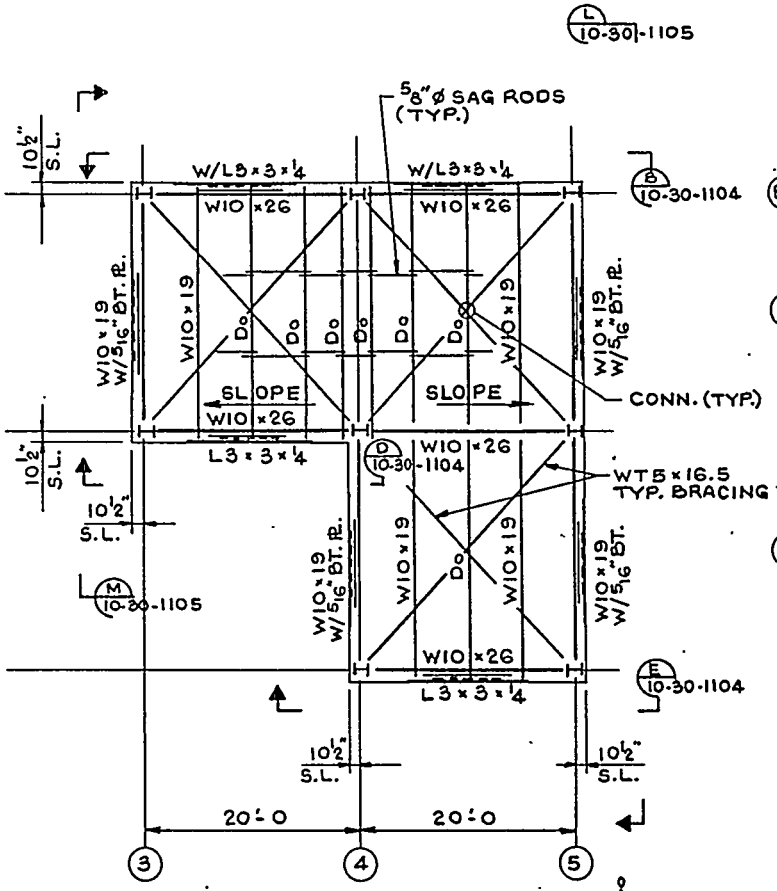
W10×33

BOT. BASE PL. EL. 1'-5

COLUMN LOCATION CONT. ON DWG. 10-40-1203

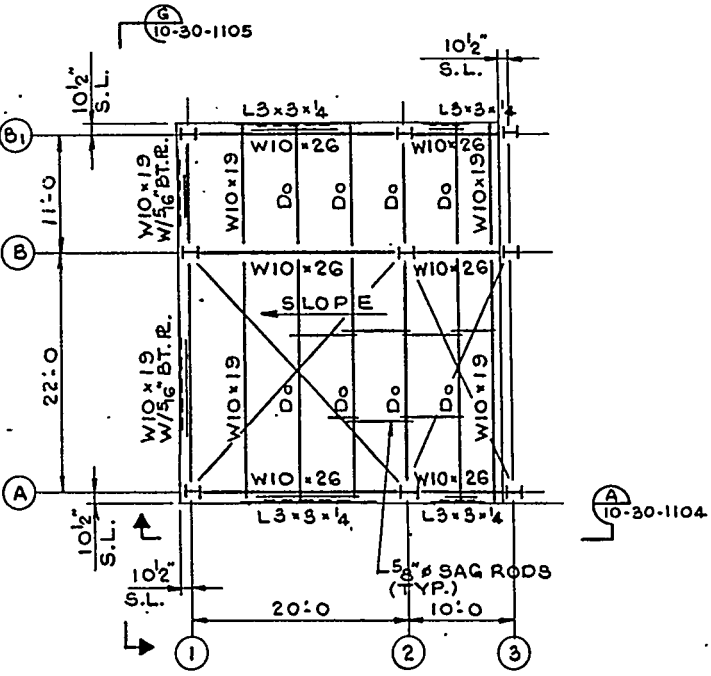
A1, B, C-1

NO.	DATE	REVISION	BY	APP.	APP.	REFERENCE DRAWINGS	NUMBER	NOTES	DESCRIPTION	COST ACCOU
										WORK COVERED BY THIS DRAWIN CHARGED TO COST ACCOUNT AND



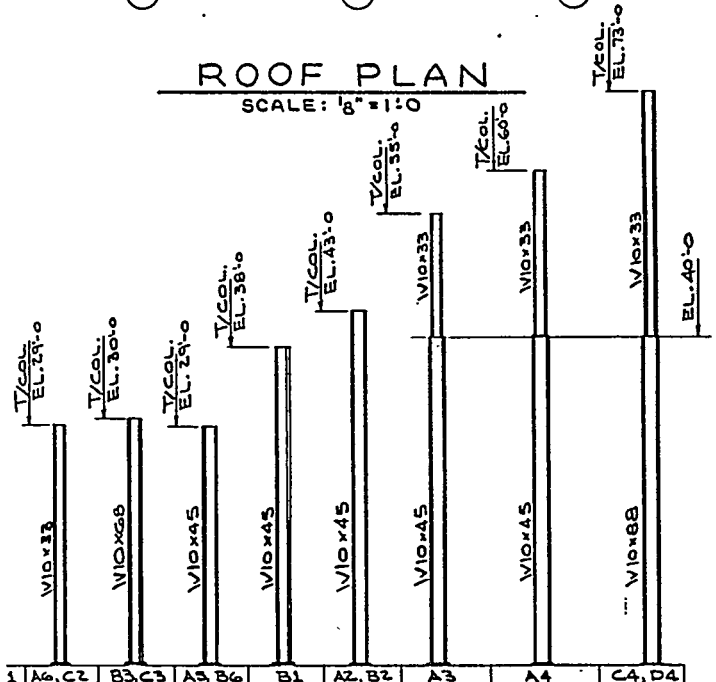
ROOF PLAN

SCALE: 1/8" = 1:0



PARTIAL ROOF PLAN

SCALE: 1/8" = 1:0



STRUCTURAL STEEL GENERAL NOTES:

1. DESIGN FABRICATION AND ERECTION OF STRUCTURAL STEEL SHALL BE IN ACCORDANCE WITH THE LATEST ISSUE OF THE AMERICAN INSTITUTE OF STEEL CONSTRUCTION SPEC. FOR THE DESIGN, FABRICATION, AND ERECTION OF STRUCTURAL STEEL FOR BUILDINGS, LATEST AMENDMENT.
2. STRUCTURAL STEEL SHALL CONFORM TO ASTM DESIGNATION A-36.
3. BOLTED CONNECTIONS TO BE WITH 3/4" ASTM A325 BOLTS WITH ONE WASHER, SLIP-CRITICAL TYPE UNLESS NOTED. BOLTED CONNECTIONS SHALL HAVE MINIMUM 2 BOLTS.
4. ALL FIELD CONNECTIONS FOR NONSTRUCTURAL APPLICATIONS TO BE MADE WITH 3/4" DIA. ASTM A307 MACHINE BOLTS.
5. ALL WELDED CONNECTIONS TO BE IN ACCORDANCE WITH THE LATEST AWS STRUCTURAL WELDING CODE AWS D1.1. ALL ELECTRODES SHALL BE OF THE E-70 SERIES
6. GUSSET PLATES SHALL BE A MINIMUM 3/4" THICK UNLESS NOTED.
7. GRATING: WELDED STEEL GALVANIZED GRATING WITH 1" X 3/16 BEARING BARS AT 1 3/16" O.C. AND 1/4" CROSSBARS @ 4"O.C. ALL FREE EDGES OF GRATING SHALL BE BANDED, AND COMPLETED WITH HOLD DOWN CLIPS.
8. STAIR TREADS SHALL BE WELDED STEEL GALVANIZED GRATING WITH 1 X 3/16" BEARING BARS FURNISHED WITH SAFETY NOSING.
9. HANDRAIL SHALL BE BAR AND ROD TYPE IN ACCORDANCE WITH OSHA STANDARDS.
10. LADDERS SHALL BE IN ACCORDANCE WITH OSHA STANDARDS.
11. METAL DECK SHALL BE GALV. 1 1/2" V-GRIP/20 GAGE.
12. FIBER GLASS-REINFORCED GRATING (FRP) SHALL BE 1" RECTANGULAR MESH.
13. FOR ROOFING AND SIDING NOTES SEE DWG. 10-40-1201.

NOTE

WORK THIS DWG. WITH DWGS. 10-30-1102 THRU. 10-30-1106

CONSTRUCTION APPROVAL	APPROVAL	DATE	SCALE: 1/8" = 1:0	DATE
			DESIGNED BY J. MICIKAS	6/17/94
			DRAWN BY E. JAMISON	6/17/94
			CHECKED BY	
			APPROVED BY	
			APPROVED BY	

PROFESSIONAL SEAL

ICF KAISER ENGINEERS

ICF KAISER ENGINEERS INC.
Four Gateway Center
Pittsburgh, PA 15222-1207
(412) 281-8121, TELEX: 199121

UNITED STATES DEPARTMENT OF ENERGY
ADVANCED FROTH FLOTATION PROCESS
STRUCTURAL
ROOF PLAN

JOB No. 88107-250-00 | DWG. No. 10-30-1101 | REVISION R-

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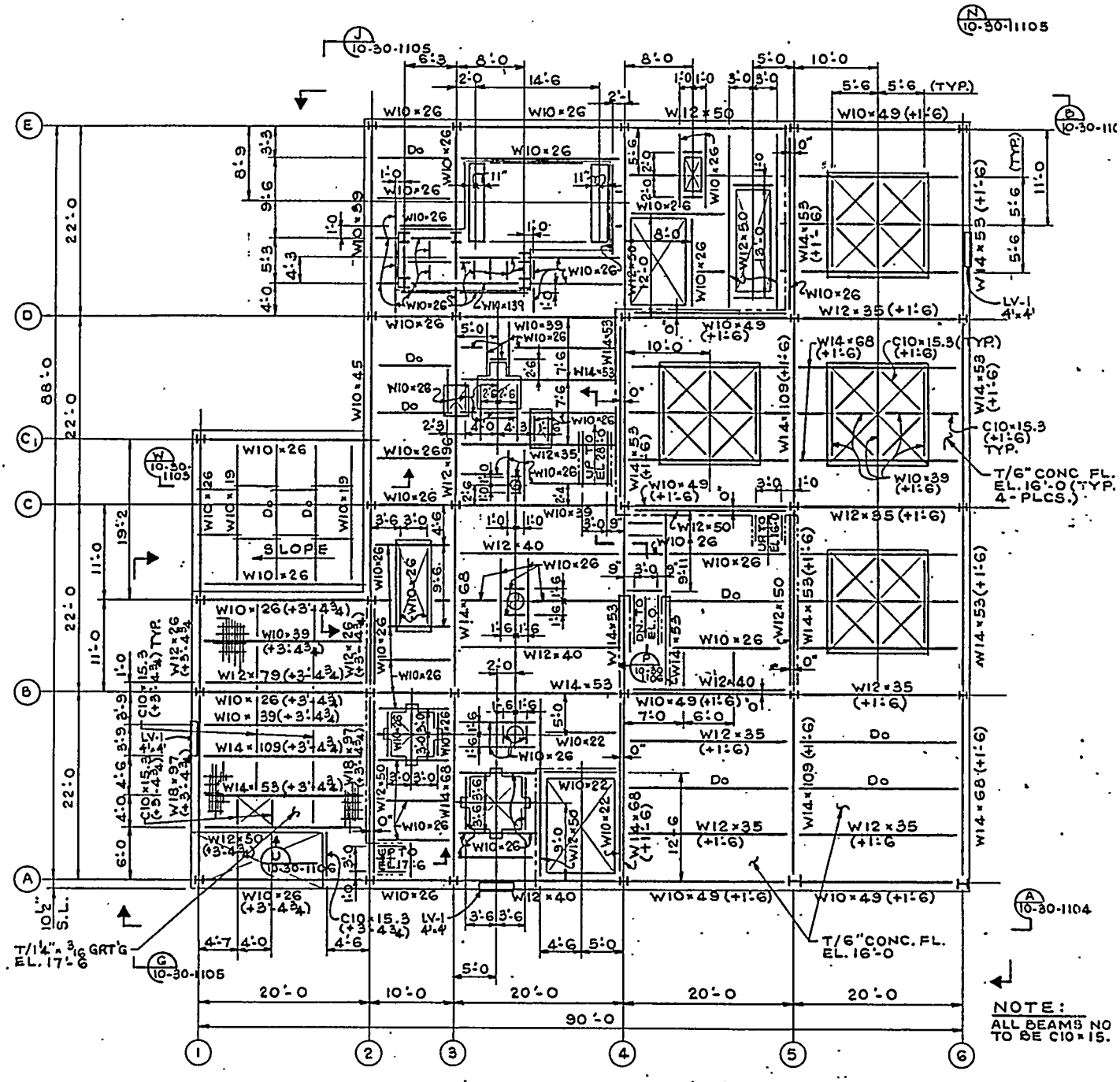
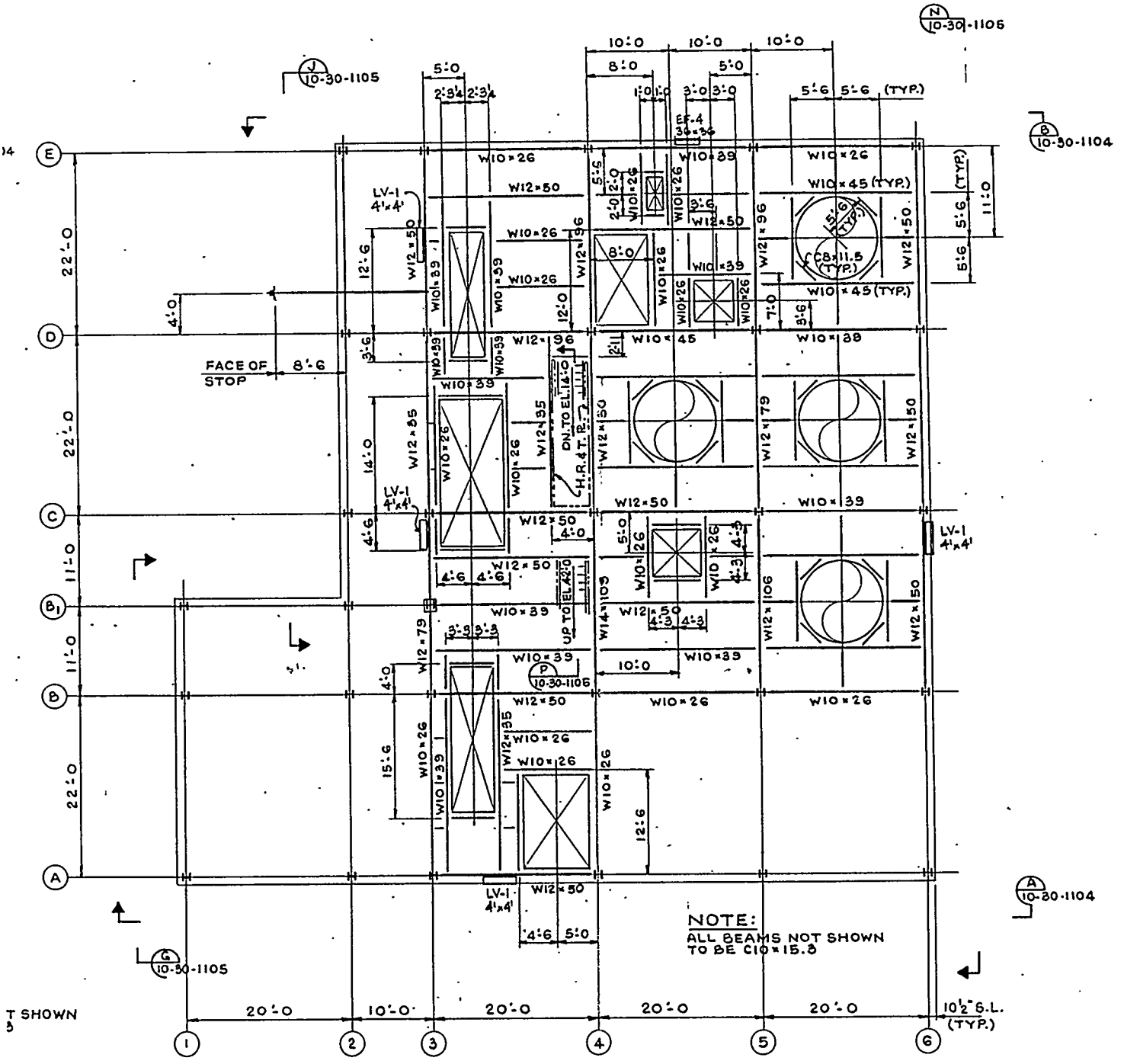


NOTE:
ALL BEAMS NO TO BE C10×15.

PLAN @ EL. 14'-0 (T/6" CONC. FL.) U.N.

T/STL. (-) 6" U.N.

NO.	DATE	REVISION	BY	APP.	APP.	REFERENCE DRAWINGS	NUMBER	NOTES	DESCRIPTION	COST ACCOUNT
									WORK COVERED BY THIS DRAWING CHARGED TO COST ACCOUNT ABOVE	



PLAN @ EL. 28'-0 (T/6" CONC. FL)

T/STL. (-)6"

NOTE:
WORK THIS DWG. WITH DWGS. 10-30-11014
10-30-1105 THRU. 10-30-1106

CONSTRUCTION APPROVAL	APPROVAL	DATE	SCALE: 1/8" = 1'-0	DATE
			DESIGNED BY J. MICIKAS	6/17/94
			DRAWN BY E. JAMISON	6/17/94
			CHECKED BY	
			APPROVED BY	
			APPROVED BY	

PROFESSIONAL SEAL

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UNITED STATES DEPARTMENT OF ENERGY
ADVANCED FROTH FLOTATION PROCESS
STRUCTURAL
PLAN @ EL. 14'-0 & 28'-0

JOB No. 88107-250-00 | DWG. No. 10-30-1102 | REVISION R-

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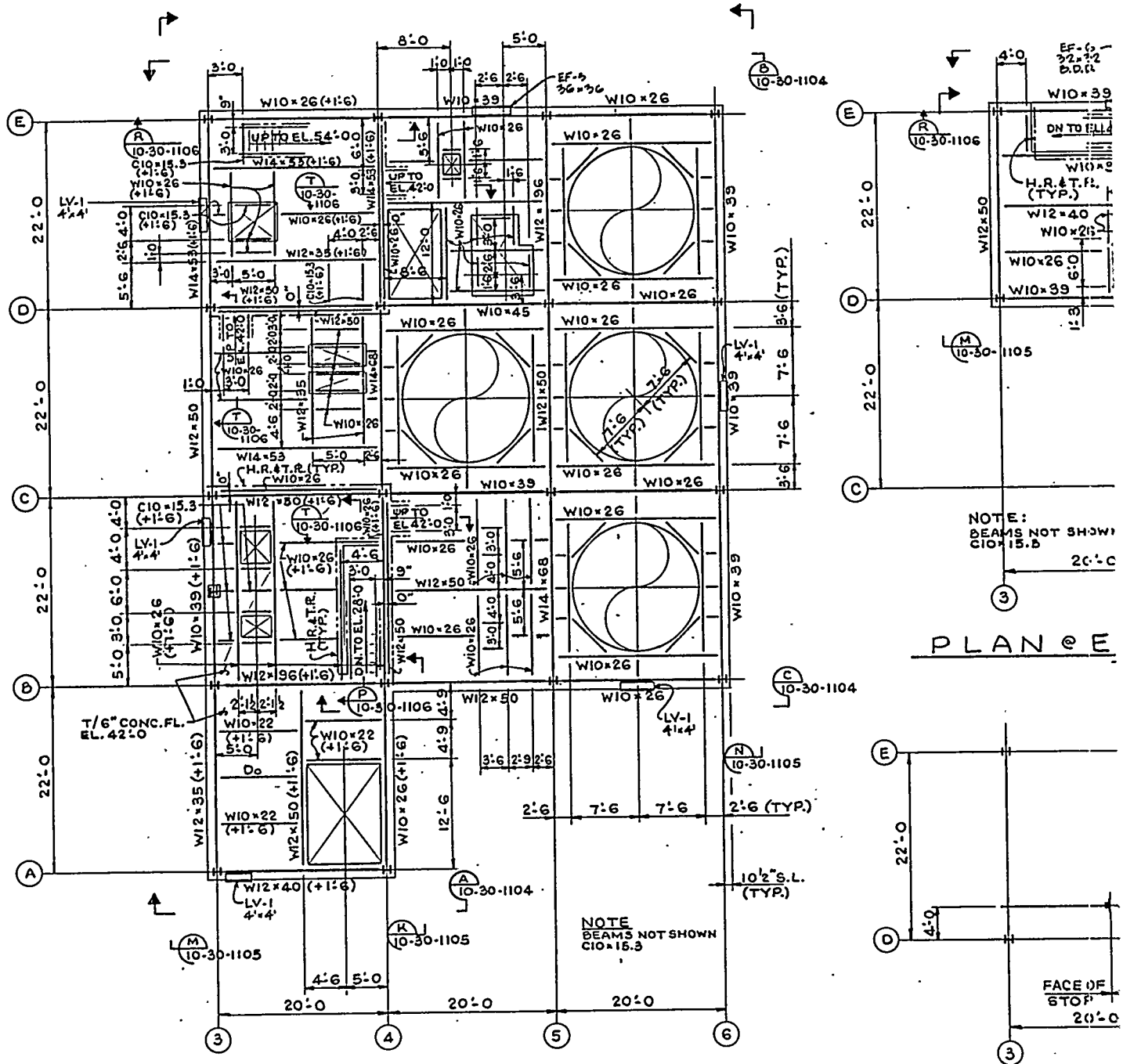
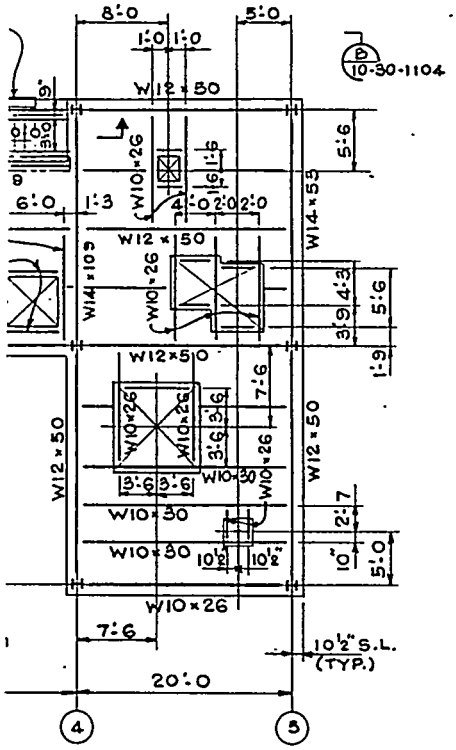
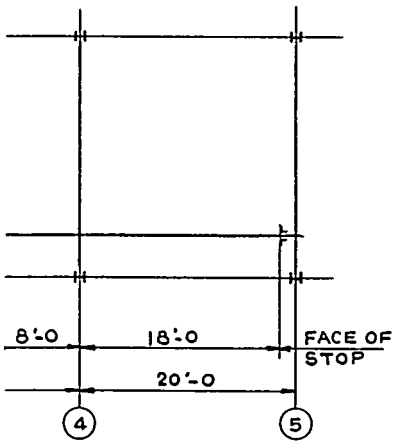


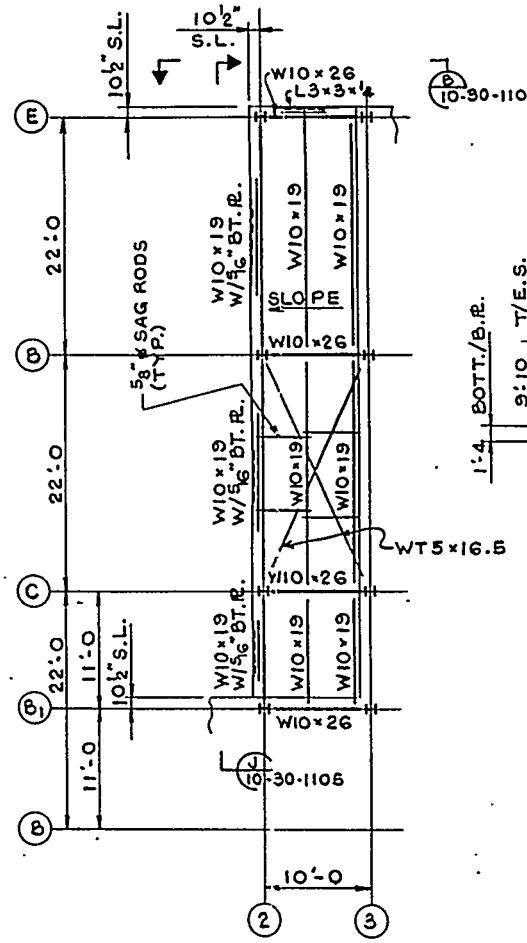
NO.	DATE	REVISION	APP.	APP.	REFERENCE DRAWINGS	NUMBER	NOTES	DESCRIPTION	COST ACCOUNT
								WORK COVERED BY THIS DRAWING CHARGED TO COST ACCOUNT ABOVE	



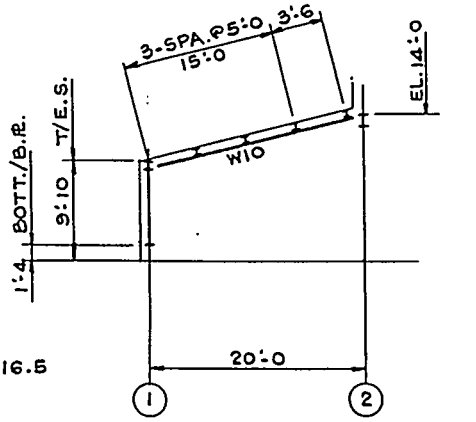
L. 54'-0 (T/6" CONC. FL.)
T/STL. (-) 6"



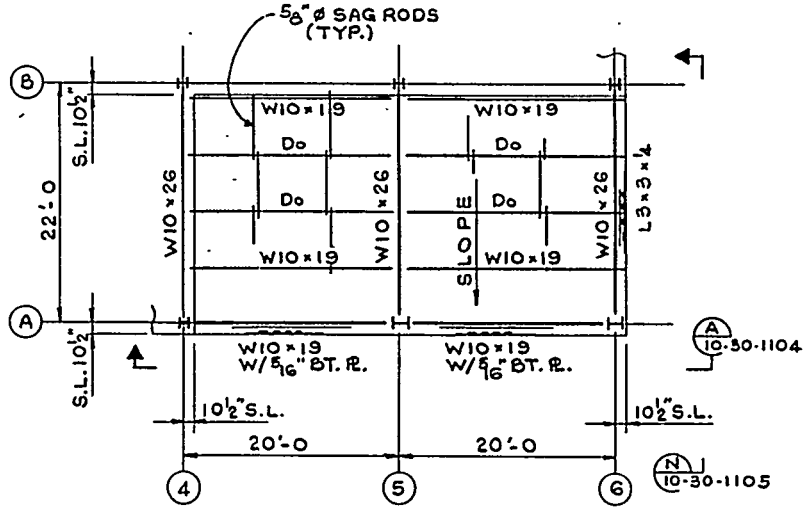
EL. 64'-0 (BOTT./LIFT BEAM)



PARTIAL ROOF PLAN



SECTION W 10-30-1102



PARTIAL ROOF PLAN

NOTE:
WORK THIS DWG. WITH DWGS. 10-30-1101, 10-30-1102 & 10-30-1104 THRU. 10-30-1106

CONSTRUCTION APPROVAL	APPROVAL	DATE	SCALE: 1/8"=1'-0	DATE
			DESIGNED BY J. MICIKAS	6/17/94
			DRAWN BY E. JAMISON	6/17/94
			CHECKED BY	
			APPROVED BY	
			APPROVED BY	

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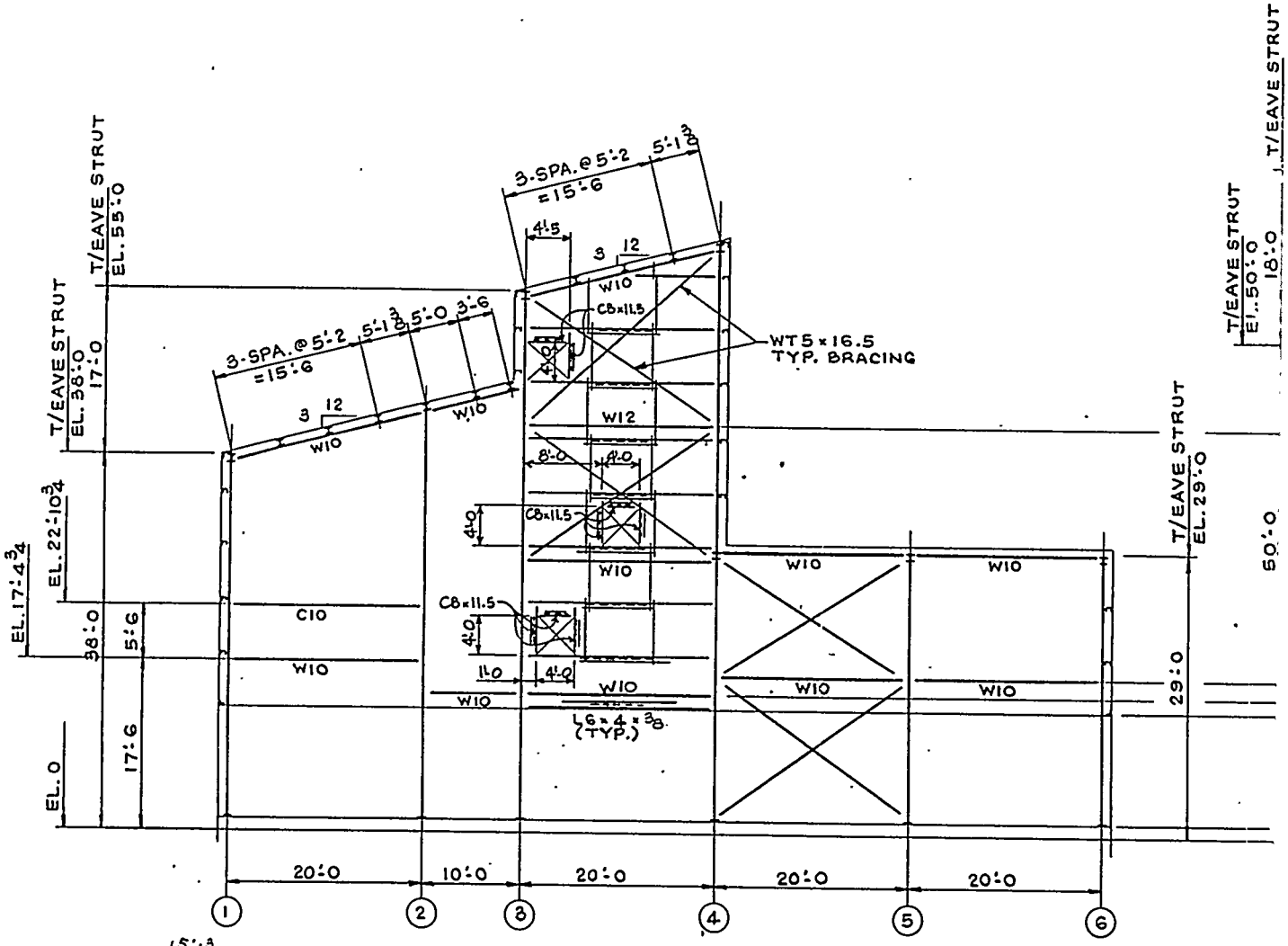
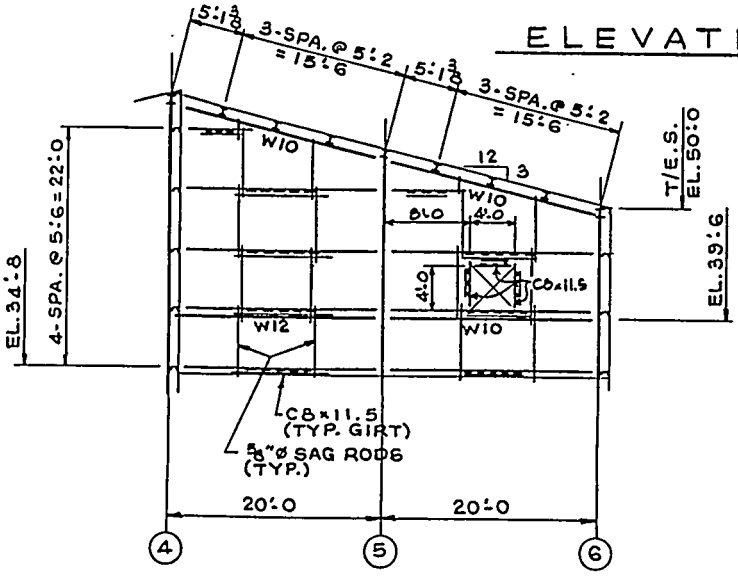
(412) 281-8121, TELEX: 199121

UNITED STATES DEPARTMENT OF ENERGY
ADVANCED FROTH FLOTATION PROCESS
STRUCTURAL
PLAN @ EL. 40'-0, 54'-0 & 64'-0

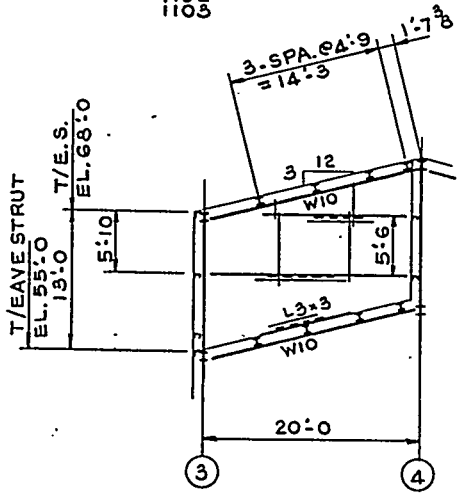
JOB No. 88107-250-00 | DWG. No. 10-30-1103 | REVISION R.



ELEVATION (A) 10-30-1101 1102 1103

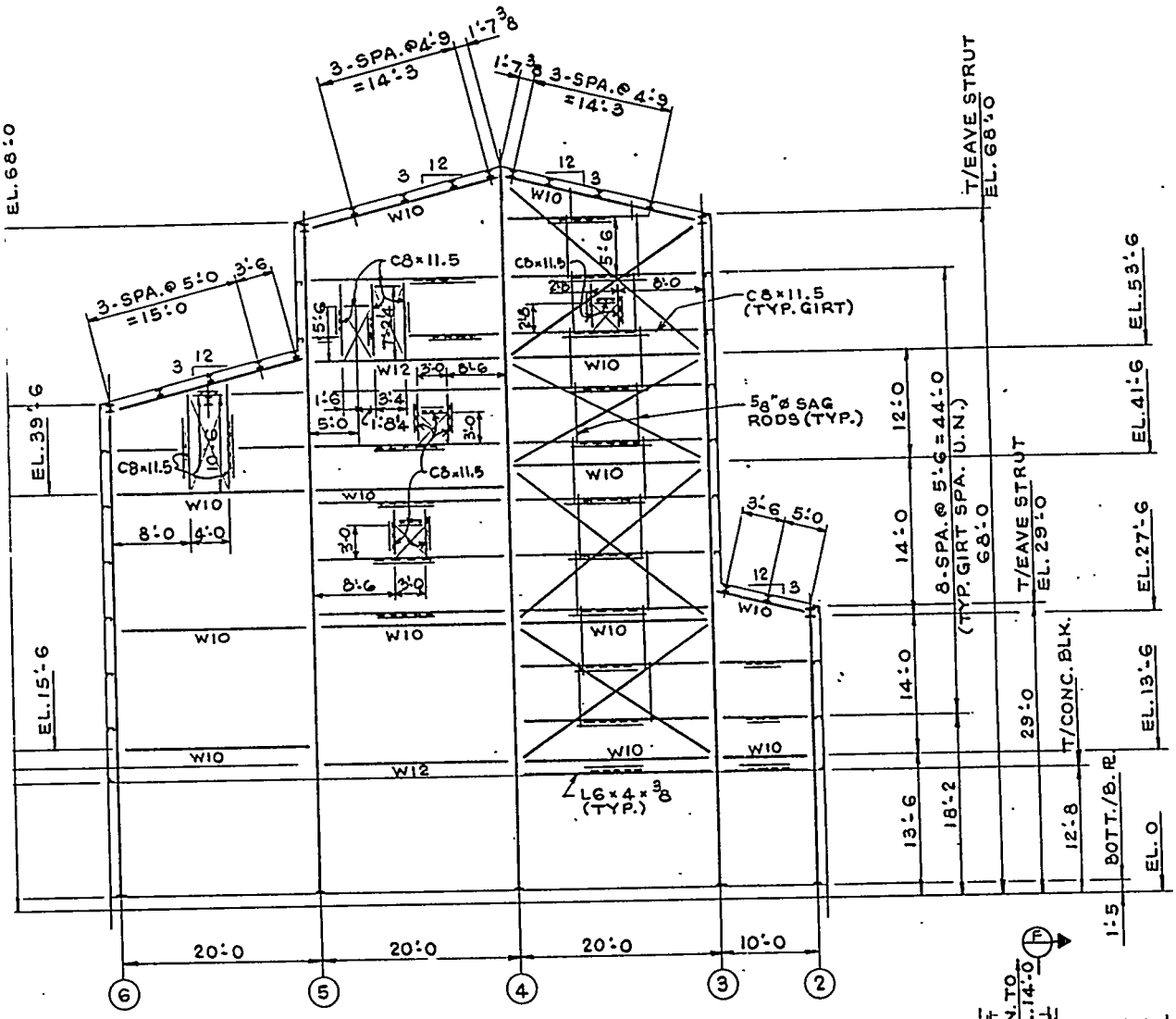


SECTION (C) 10-30-1103

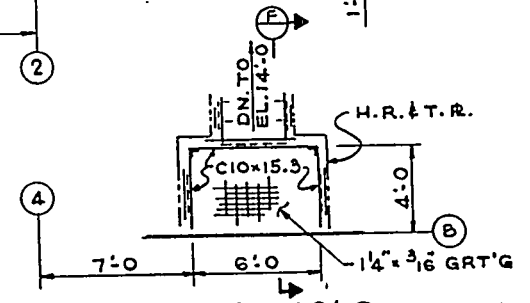


SECTION (D) 10-30-1101

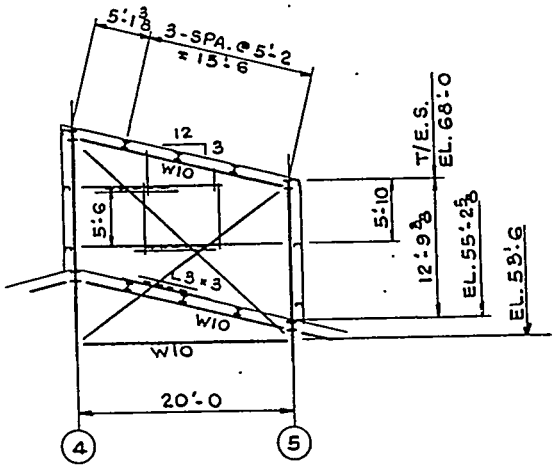
NO.	DATE	REVISION	BY	CHK.	APP.	APP.	REFERENCE DRAWINGS	NUMBER	NOTES	DESCRIPTION	COST ACCOUNT
										WORK COVERED BY THIS DRAWING CHARGED TO COST ACCOUNT ABOVE	



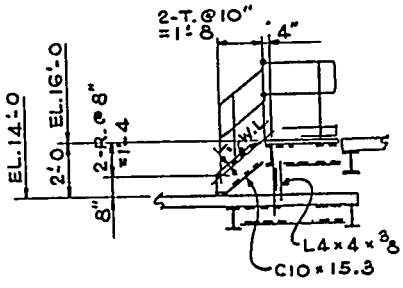
ELEVATION (B) 10-30-1101 1102 1103



PLAN @ EL. 16'-0 (T/GRT'G)
T/STL. (-) 1/4"



SECTION (E) 10-30-1101



SECTION (F) 1

WORK THIS DWG. WITH DWGS. 10-30-1101 THRU. 10-30-1103, 10-30-1105 & 10-30-1106

CONSTRUCTION APPROVAL	APPROVAL	DATE	SCALE: 1/8" = 1'-0	DATE
			DESIGNED BY J. MICIKAS	6/17/94
			DRAWN BY E. JAMISON	6/17/94
			CHECKED BY	
			APPROVED BY	
			APPROVED BY	

PROFESSIONAL SEAL

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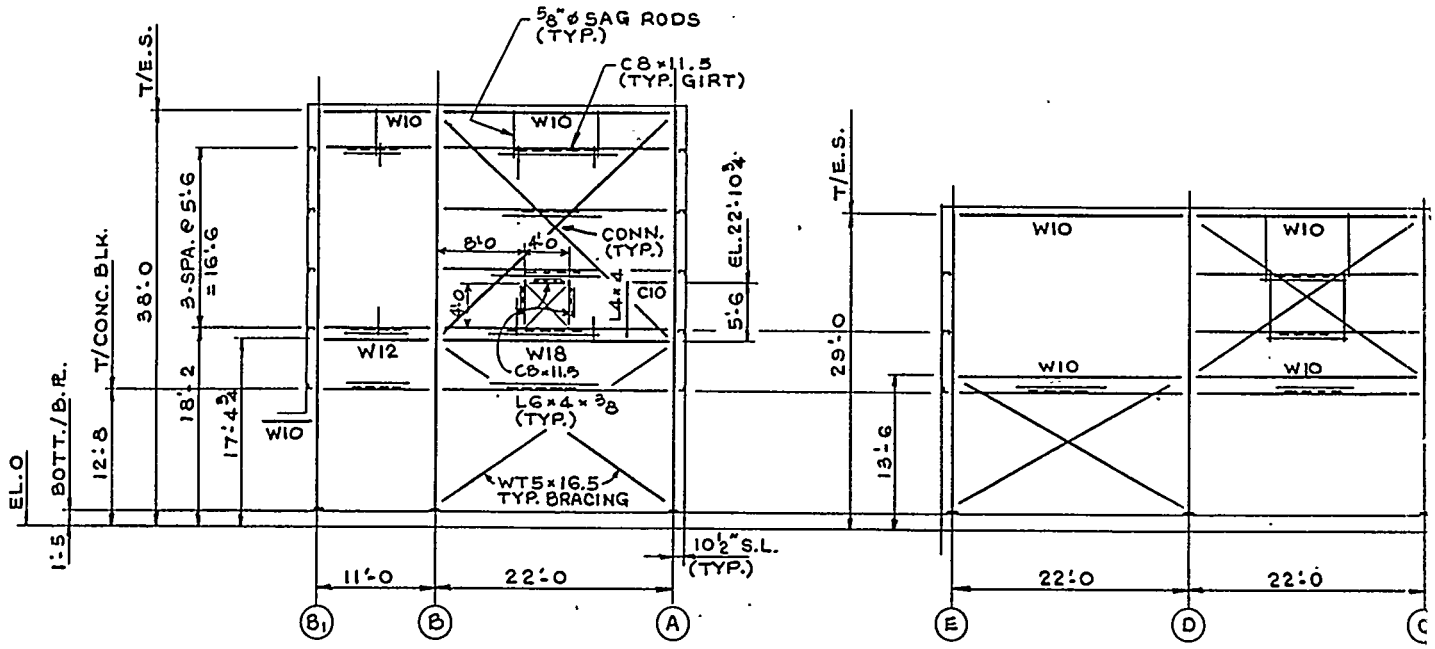
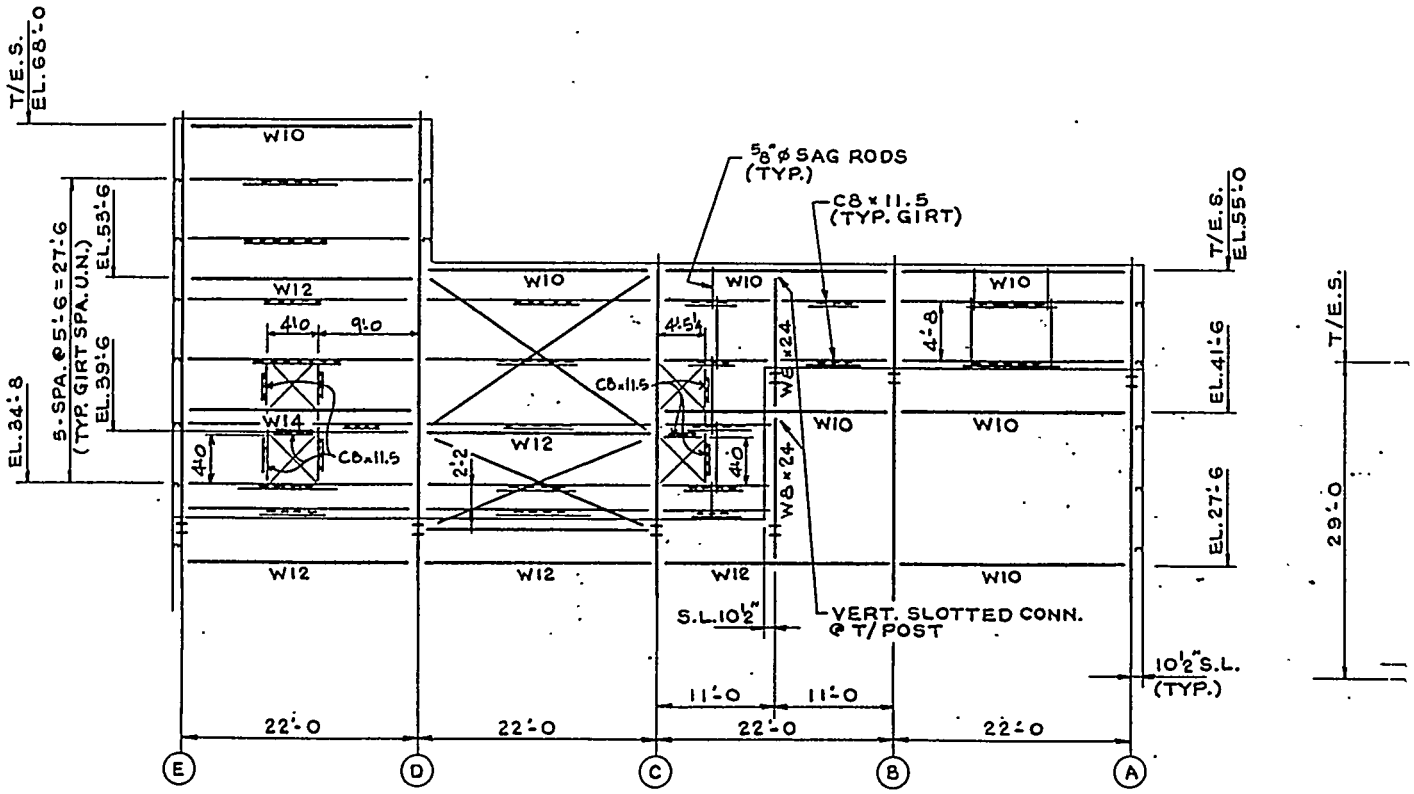
UNITED STATES DEPARTMENT OF ENERGY
ADVANCED FROTH FLOTATION PROCESS
STRUCTURAL
ELEVATIONS & SECTIONS

JOB No. 88107-250-00 | DWG. No. 10-30-1104 | REVISION R-



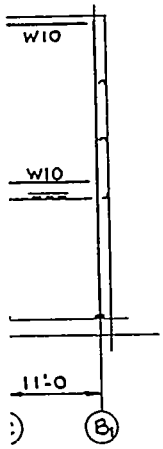
SECTION G
10-30-1101 1102

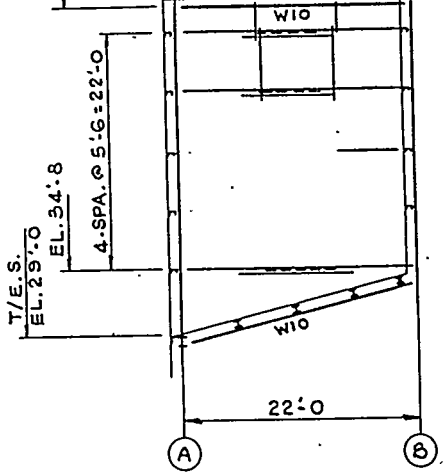
SECTION J
10-30-



SECTION M
10-30-1101 & 1103

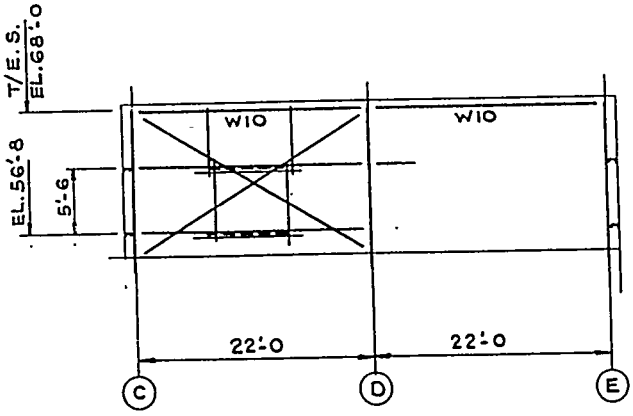
NO.	DATE	REVISION	BY	CHK.	APP.	APP.	REFERENCE DRAWINGS	NUMBER	NOTES	DESCRIPTION	COST ACCOU
										WORK COVERED BY THIS DRAWIN CHARGED TO COST ACCOUNT #	



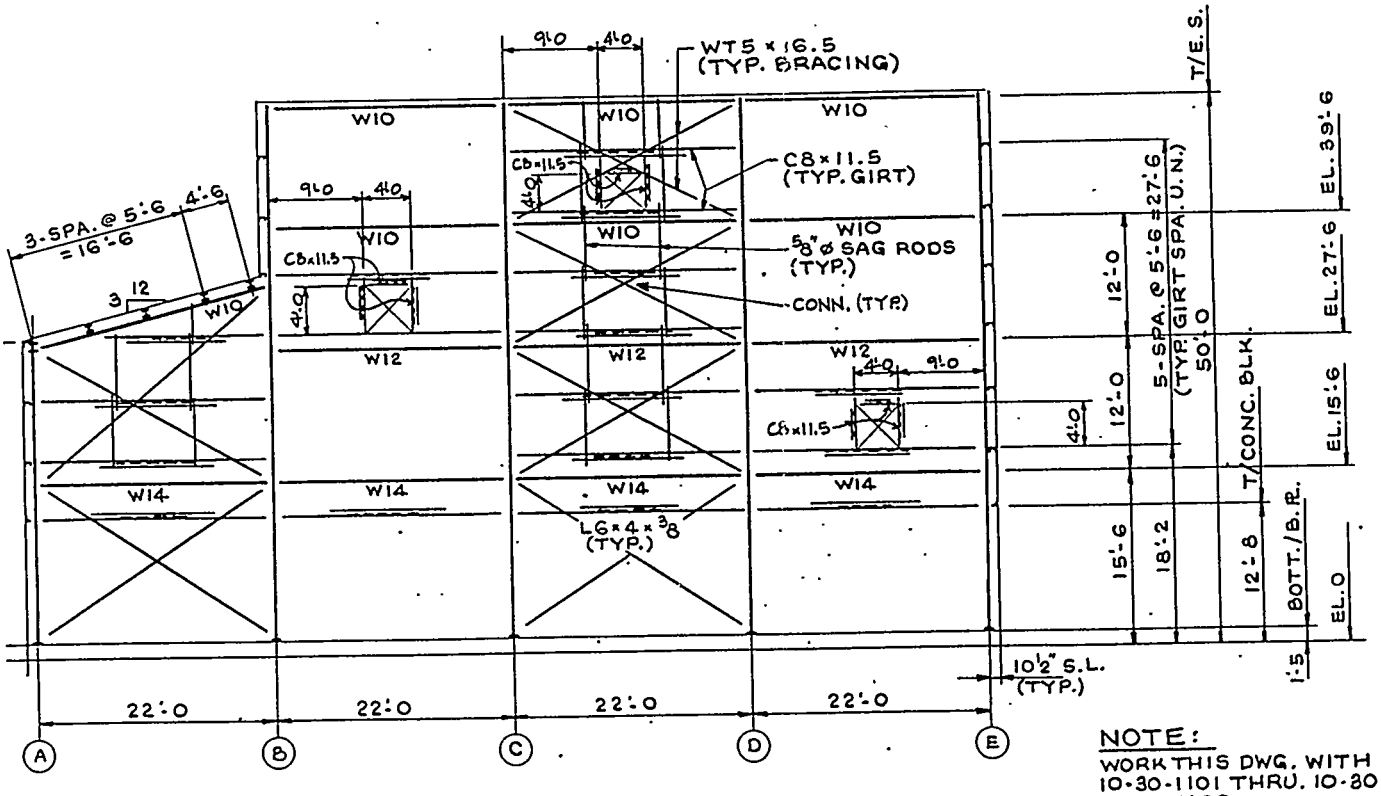


SECTION (K) 10-30-1101 1103

1102
1105



SECTION (L) 10-30-1101



ELEVATION (N) 10-30-1101, 1102 & 1103

NOTE:
WORK THIS DWG. WITH DWGS. 10-30-1101 THRU. 10-30-1104 & 10-30-1106

CONSTRUCTION APPROVAL	APPROVAL	DATE	SCALE: 1/8" = 1'-0	DATE	PROFESSIONAL SEAL
			DESIGNED BY J. MICIKAS	6/17/94	
			DRAWN BY E. JAMISON	6/17/94	
			CHECKED BY		
			APPROVED BY		
			APPROVED BY		

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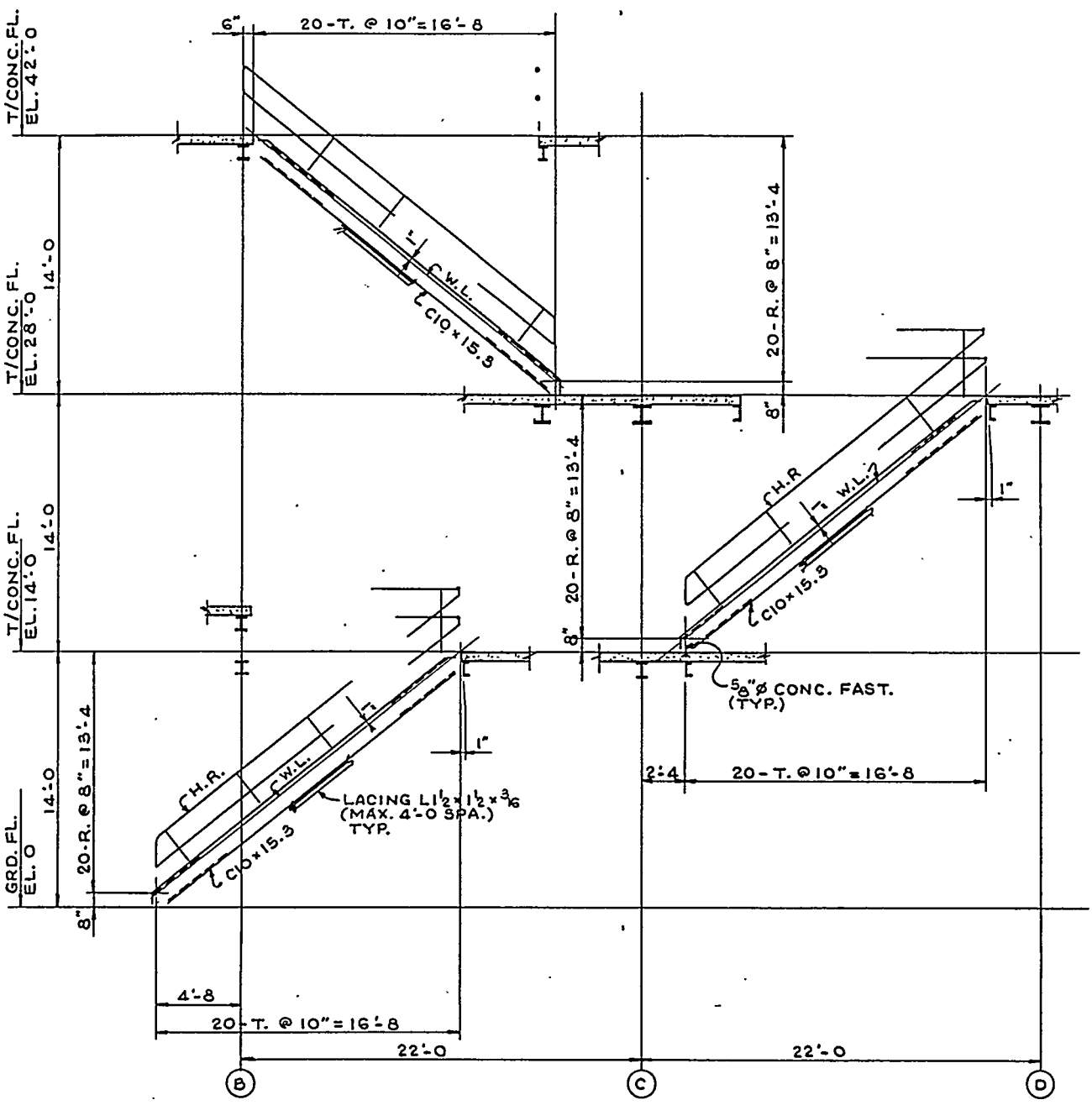
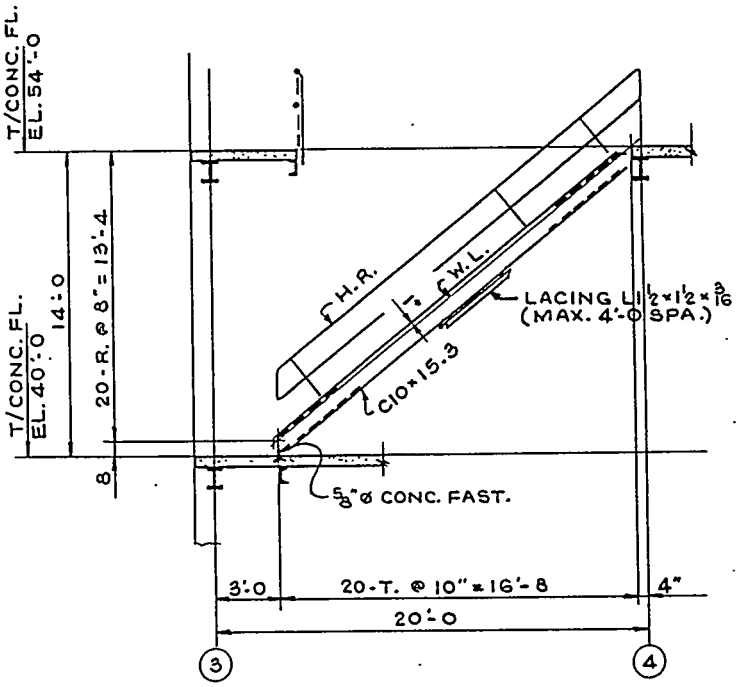
UNITED STATES DEPARTMENT OF ENERGY
ADVANCED FROTH FLOTATION PROCESS
STRUCTURAL
ELEVATION & SECTIONS

JOB No. 88107-250-00 | DWG. No. 10-30-1105 | REVISION R.

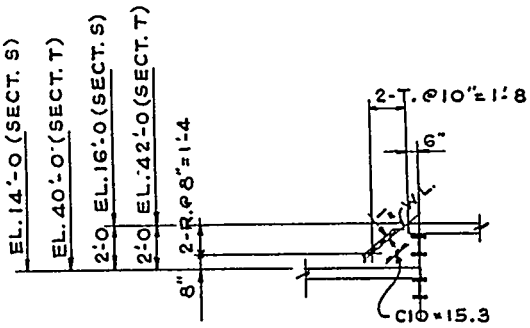


SECTION (P) 10·30·1102 1103

NO.	DATE	REVISION	BY	CHK.	APP.	APP.	REFERENCE DRAWINGS	NUMBER	NOTES	DESCRIPTION	COST ACCOUNT
										WORK COVERED BY THIS DRAWING CHARGED TO COST ACCOUNT ABOVE	

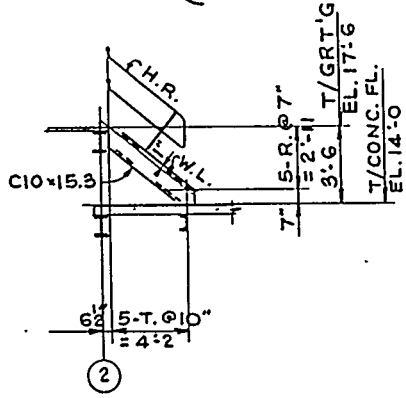


SECTION R 10-30-1103

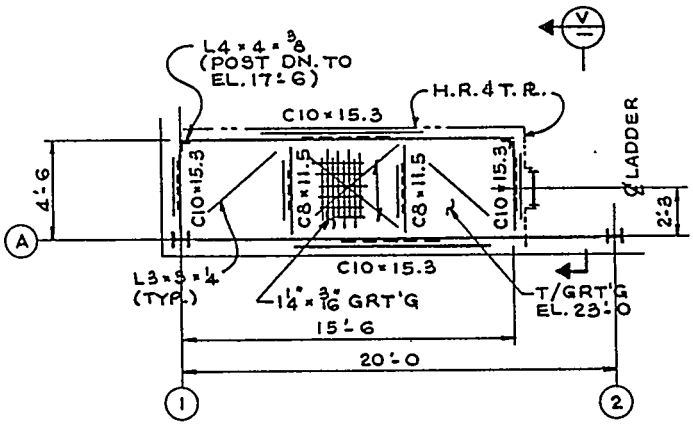


SECTION S (AS SHOWN & NOTED) 10-30-1102

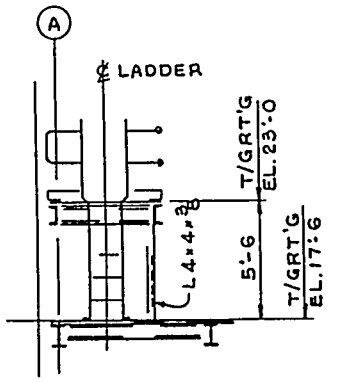
SECTION T (AS SHOWN & NOTED) 10-30-1103



SECTION U 10-30-1102



PLAN @ EL. 23'-0



SECTION V 1

NOTE

WORK THIS DWG. WITH DWGS. 10-30-1101 THRU. 10-30-1105

CONSTRUCTION APPROVAL	APPROVAL	DATE	SCALE: 1/4"=1'-0	DATE
			DESIGNED BY J. MICIKAS	6/17/94
			DRAWN BY E. JAMISON	6/17/94
			CHECKED BY	
			APPROVED BY	
			APPROVED BY	

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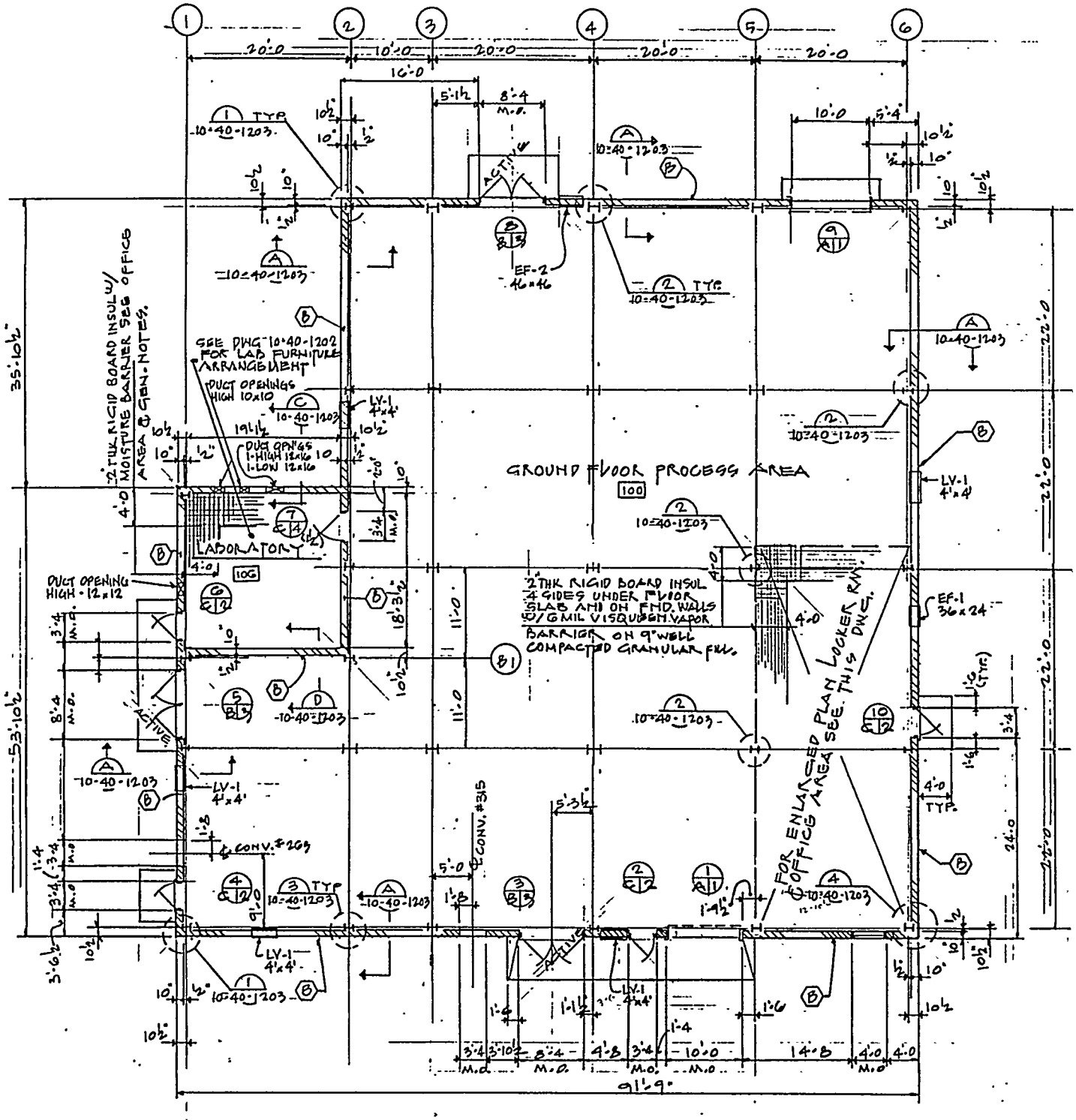
(412) 281-8121, TELEX: 199121

UNITED STATES DEPARTMENT OF ENERGY
ADVANCED FROTH FLOTATION PROCESS
STRUCTURAL
STAIRS SECTIONS & DETAILS

JOB No. 88107-250-00 | DWG. No. 10-30-1106 | REVISION R.

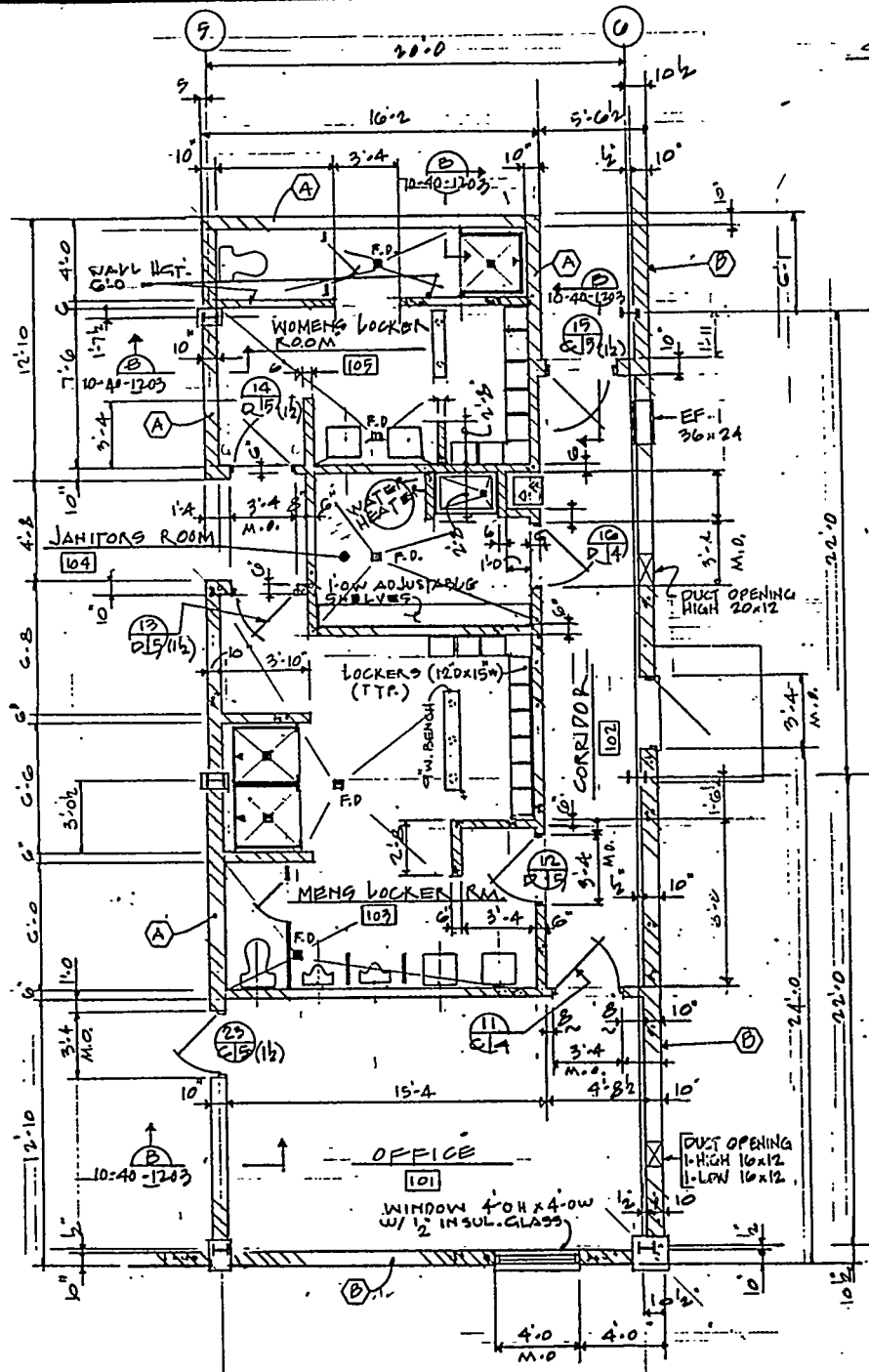
5 6 7 8 9



GROUND FLOOR PLAN

SCALE: 1/8"-1'-0"

NO.	DATE	REVISION	BY	APP.	APP.	REFERENCE DRAWINGS	NUMBER	NOTES	DESCRIPTION	COST ACCOUNT



ENLARGED PLAN OF OFFICE & LOCKER ROOM AREAS

SCALE: 1/4" = 1'-0

NOTE: 1.) BOTTOM OF LOW DUCT OPENINGS ARE 1'-4 ABOVE TOP OF SLAB.
2.) TOP OF HIGH DUCT OPENINGS ARE 7'-4 ABOVE TOP OF SLAB.

GENERAL NOTES:

1. CONTRACTOR TO INSTALL 2" THK RIGID BOARD INSUL. WITH 6 MIL VISQUEEN MOISTURE BARRIER UNDER CONC. FLR SLAB AND ON FACE OF FOUNDATION WALL. (SEE PLANS)
2. SEE DWG 10-40-1204 FOR ROOM FINISH SCHEDULE.
3. FOR DOOR & DOOR HARDWARE SCHEDULE SEE 10-40-1204
4. SEE DWGS 10-30-1101 THRU 10-30-1106 FOR STRUCTURAL STEEL AND DWGS 10-20-1001 THRU 10-20-1004 FOR FOUNDATIONS.
5. WORK THIS DWG W/ DWGS 10-40-1202 THRU 10-40-1204
6. LEGEND:
   - ROOM OR AREA NO.
   - WALL TYPE
   - DOOR NUMBER
   - HARDWARE GROUP NO.
   - FIRE RATING
   - DOOR TYPE
7. INTERIOR OFFICE AND LOCKER ROOM WALLS TO BE 6"W x 8'H x 1'-4 LG CONC. BLK W/ 9GA GALV. TRUSS TYPE JOINT REINF. AT EVERY 2ND COURSE. WALL HGT TO BE 8'-8" H. UNLESS OTHERWISE NOTED. TOP OF WALL BLK TO BE LINTEL BLK W/ #4 REINF BAR FILLED WITH CONC.
8. WALL TYPE (A) 10"W x 8'H x 1'-6 LG W/ 9GA GALV. TRUSS TYPE JOINT REINF. AT EVERY 2ND COURSE. WALL HGT TO BE 8'-8" H. TOP OF WALL BLK TO BE LINTEL BLK W/ 2 - CONT #4 REINF BARS FILLED WITH CONC.
9. WALL TYPE (B) SAME CONC. BLK SIZE AND REINF AS WALL TYPE "A" EXCEPT HEIGHT OF WALL TO BE 11'-4.
10. WINDOW - TO BE 16GA PRESSED METAL FRAME SAME PROFILE AS DOOR FRAME MATERIAL W/ ½" INSL GLASS, RUBBER GASKETS & ½" x ½" CHANNEL GLASS STOPS.
11. LINTELS:
    - 6" CONC BLK - PRECAST, REINF'D CONC. 6"W x 8"H W/ 8" TYP END BEARING EACH END.
    - 10" CONC BLK - C8 x 11.5 W/ 8½" W CONT. PL. W/ 8" TYP. END BEARING EACH END.
12. REFERENCE DWG'S
    - GEN. ARRANGEMENT 10-50-0201 THRU 10-50-0205
    - PLUMBING / HVAC 10-55-0701 & 10-55-0702
    - ELECTRICAL 10-70-2402
13. ROOFING: 3" x 24 GA CORR. GALV. PAINTED COMPLETE WITH ALL CLOSERS AND FASTENERS FOR WATERTIGHT CONDITION.
14. SIDING: 1" x 24 GA., 4" GALV. PAINTED RIBBED SIDING WITH ALL CLOSERS AND FASTENERS FOR WATERTIGHT CONDITION. USE TRANSLUCENT PANELS FOR WINDOWS AS SHOWN ON GEN. ARRGT. DWGS #10-50-0201 AND 10-50-0202.
15. FLASHING TO MATCH GAUGE OF ROOFING AND SIDING.

ALL ROOFING AND SIDING AS MFD. BY B. G. SMITH CONSTRUCTION PRODUCTS OR APPROVED EQUAL.

CONSTRUCTION APPROVAL	APPROVAL	DATE	SCALE: AS NOTED	DATE
			DESIGNED BY J. MICIKAS	6/17/94
			DRAWN BY F. MINERONE	6/17/94
			CHECKED BY	
			APPROVED BY	
			APPROVED BY	

PROFESSIONAL SEAL

ICF KAISER ENGINEERS

ICF KAISER ENGINEERS INC.
Four Gateway Center
Pittsburgh, PA 15222-1207
(412) 281-8121, TELEX: 199121

UNITED STATES DEPARTMENT OF ENERGY

ADVANCED FROTH FLOATATION PROCESS
GROUND FLOOR PLAN / ENLARGED PLAN OFFICE AND LOCKER ROOMS & GENERAL NOTES

JOB No. 88107-250-00 | DWG. No. 10-40-1201 | REVISION R.

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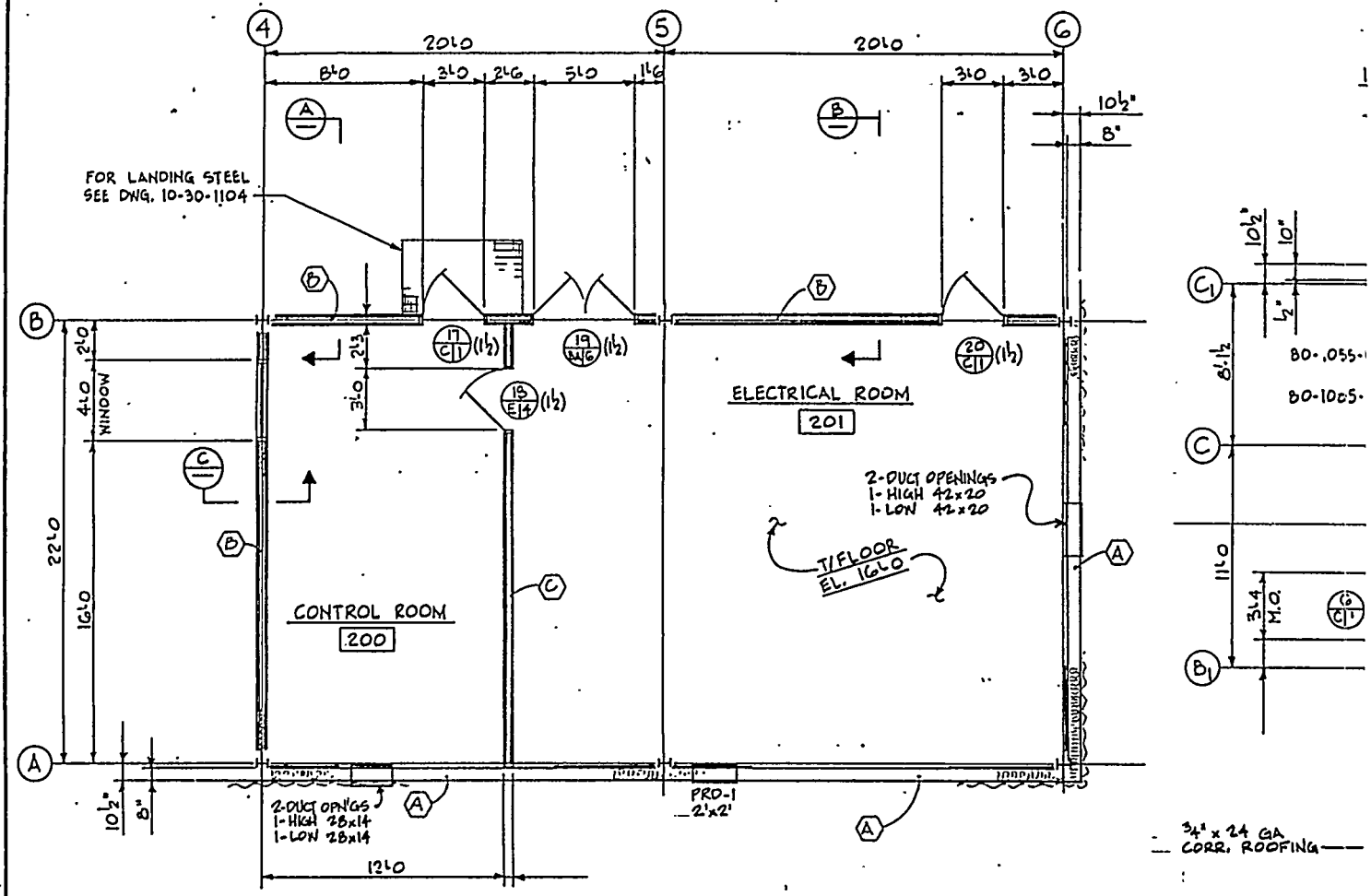
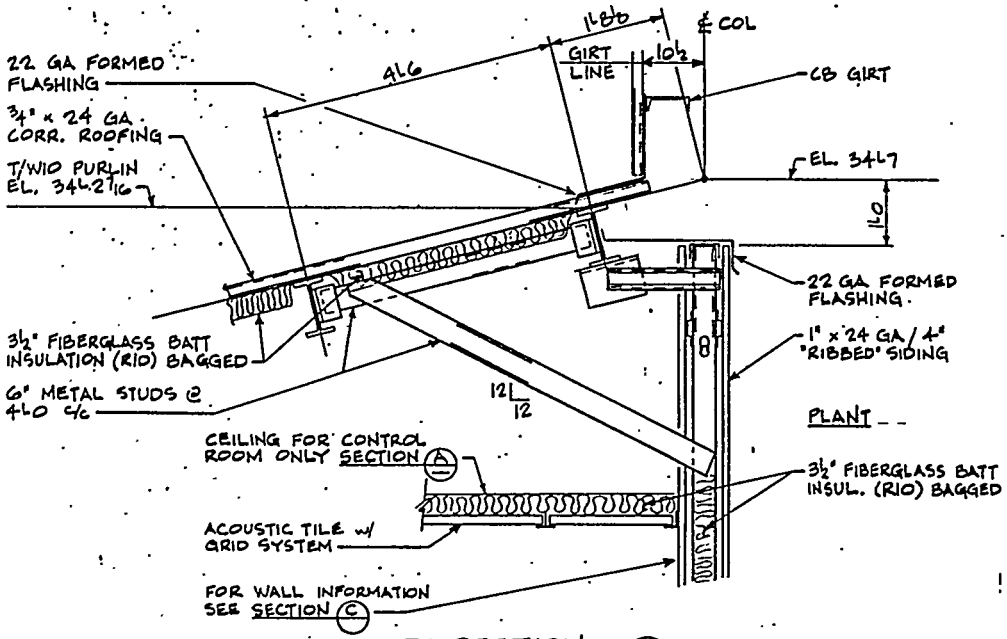


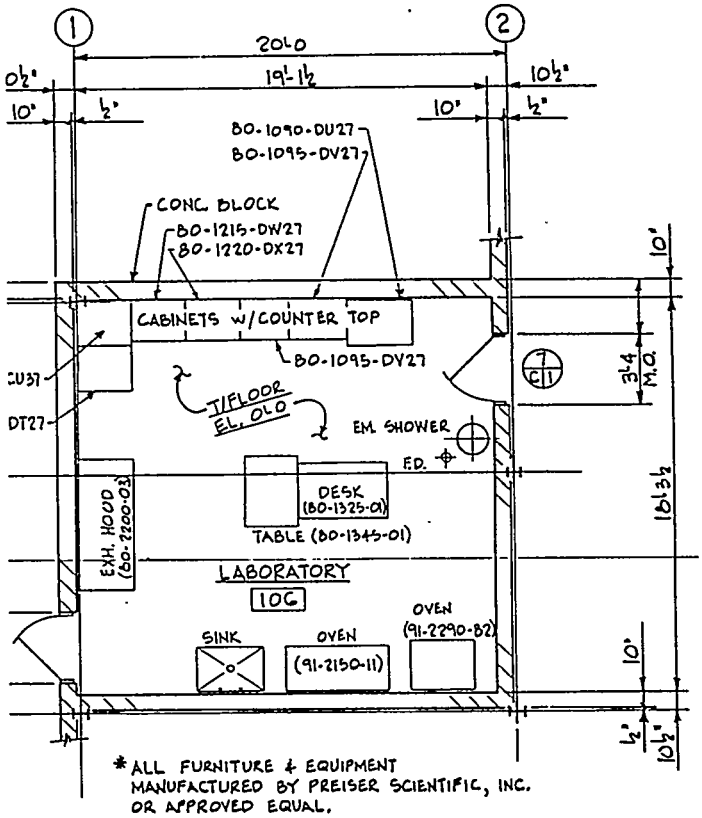
PLAN - M.C.C. ROOM



SECTION A AS NOTED

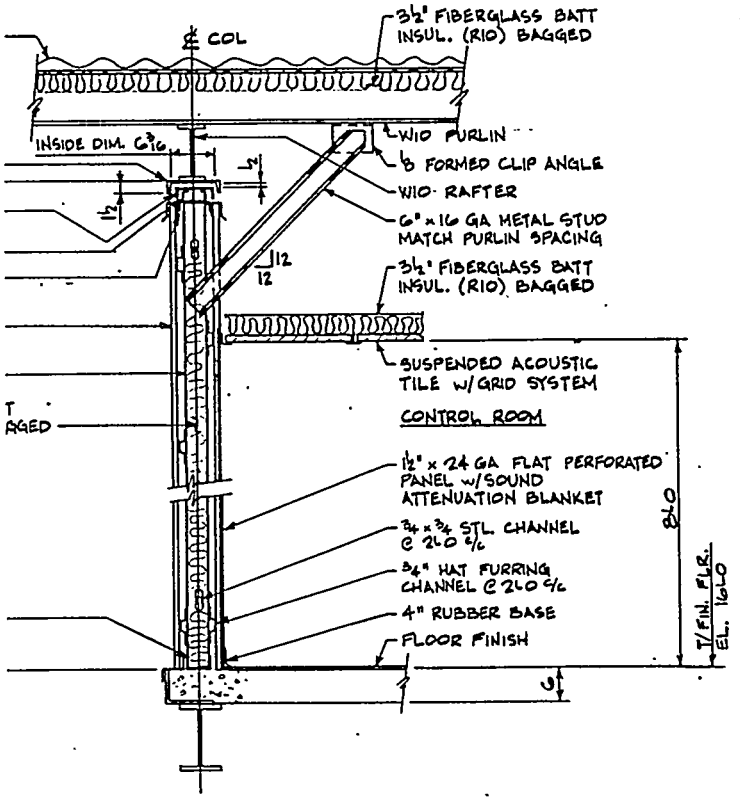
SECTION B

NO.	DATE	REVISION	BY CHK	APP.	APP.	REFERENCE DRAWINGS	NUMBER	NOTES	DESCRIPTION	COST ACCOU
									WORK COVERED BY THIS DRAWING CHARGED TO COST ACCOUNT NO.	



*ALL FURNITURE & EQUIPMENT MANUFACTURED BY PREISER SCIENTIFIC, INC. OR APPROVED EQUAL.

PLAN - LABORATORY



SECTION ℄

NOTES:

1. WALL TYPE "A" (EXTERIOR BLDG. CORNER)
   - EXTERIOR SIDING TO BE 1" x 22 GA/4" RIBBED GALV STEEL WITH "KYNAR" FINISH, ATTACHED TO CB x 11.5 GIRT SYSTEM.
   - GIRT SPACE TO BE INSULATED WITH 6" FIBERGLASS BATT BAGGED.
   - INTERIOR PANEL TO BE 1½" x 24 GA PERFORATED, GALV STEEL WITH "KYNAR" FINISH. INTERIOR PANEL TO BE SUPPLIED WITH SOUND ATTENUATION BLANKET.
2. WALL TYPE "B"
   - 6 x 16 GA GALV METAL STUD @ 16" o.c. COMPLETE WITH TOP & BOTTOM RUNNER CHANNELS REINFORCED THRU CENTER WITH ¾ x ¾ STEEL CHANNEL AT 2'0 c/c WELDED TO THE WEB OF THE METAL STUDS. ¾" HAT FURRING CHANNEL AT 2'0 CENTERS ARE ATTACHED TO METAL STUD FOR THE ATTACHMENT OF FINISHED SIDING PANELS. INSTALL 3½" OF BAGGED BATT INSULATION.
   - SIDING FACING PLANT TO BE 1" x 22 GA/4" RIBBED GALV STEEL WITH "KYNAR" FINISH.
   - INTERIOR ROOM SIDING TO BE 1½" x 24 GA PERFORATED, GALV STEEL W/"KYNAR" FINISH. INTERIOR PANEL TO BE SUPPLIED WITH SOUND ATTENUATION BLANKET.
   - FINISHED WALL TO ATTACH TO FLOOR STEEL ABOVE W/FINISH WALL HGT. OF 12'0.
3. WALL TYPE "C"
   - CONSTRUCTION OF WALL STUD SYSTEM SAME AS WALL TYPE "B"
   - FINISH PANEL ON ELECTRICAL ROOM SIDE TO BE 1½ x 22 GA "C-WALL", GALV STEEL WITH "KYNAR" FINISH.
   - FINISH PANEL ON CONTROL ROOM SIDE TO BE THE SAME PERFORATED PANEL AND SOUND INSULATION AS WALL TYPE "B"
4. ALL SIDING INSTALLED COMPLETE WITH ALL REQUIRED CLOSURES, CAULKING, METAL TRIM ITEMS FOR AN AIR TIGHT CONDITION.

   ALL SIDING LISTED SHALL BE AS MANUFACTURED BY E.G. SMITH CONSTRUCTION PRODUCTS INC. OR APPROVED EQUAL.
5. FOR WINDOW SPEC. SEE GENERAL NOTES ON DRAWING 10-40-1201.
6. WORK THIS DWG. WITH DWGS. 10-40-1201, 10-40-1203, 10-40-1204.
7. FOR LISTING OF REFERENCE DRAWINGS AND LEGEND SEE DWG. 10-40-1201.

NOTE: 1.) BOTTOM OF LOW DUCT OPENINGS ARE 1'-4 ABOVE TOP OF SLAB.
2.) TOP OF HIGH DUCT OPENINGS ARE 7'-4 ABOVE TOP OF SLAB.

CONSTRUCTION APPROVAL	APPROVAL	DATE	SCALE: ¼" & ¾" = 1'-0	DATE
			DESIGNED BY J.MICIKAS	6/9/84
			DRAWN BY D.J. WALKOWSKI	6/9/84
			CHECKED BY	
			APPROVED BY	
			APPROVED BY	

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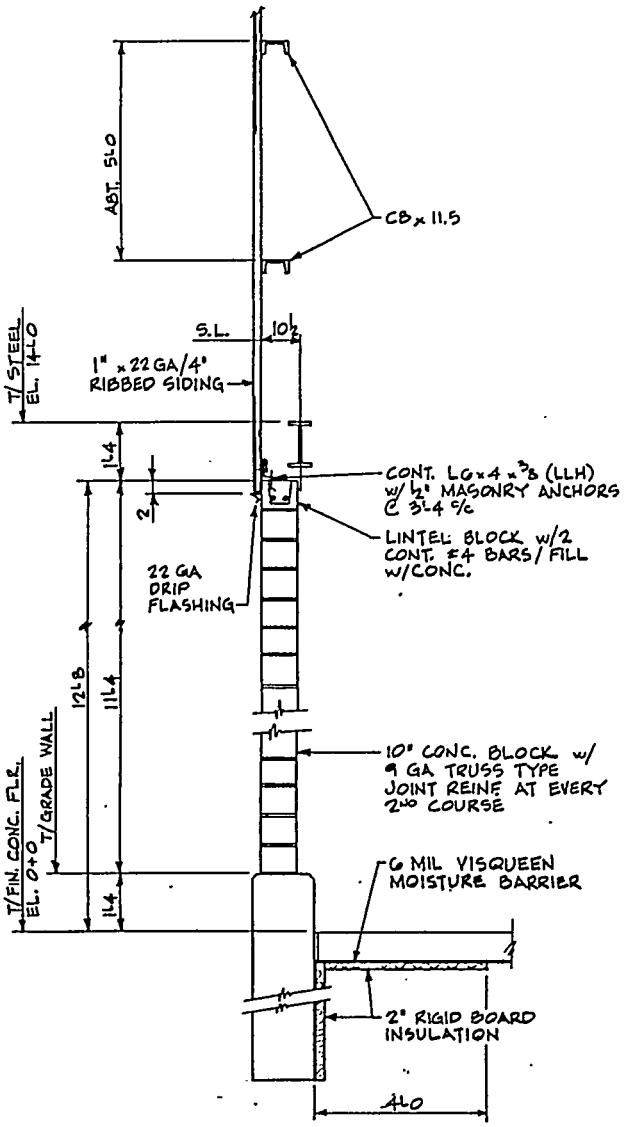
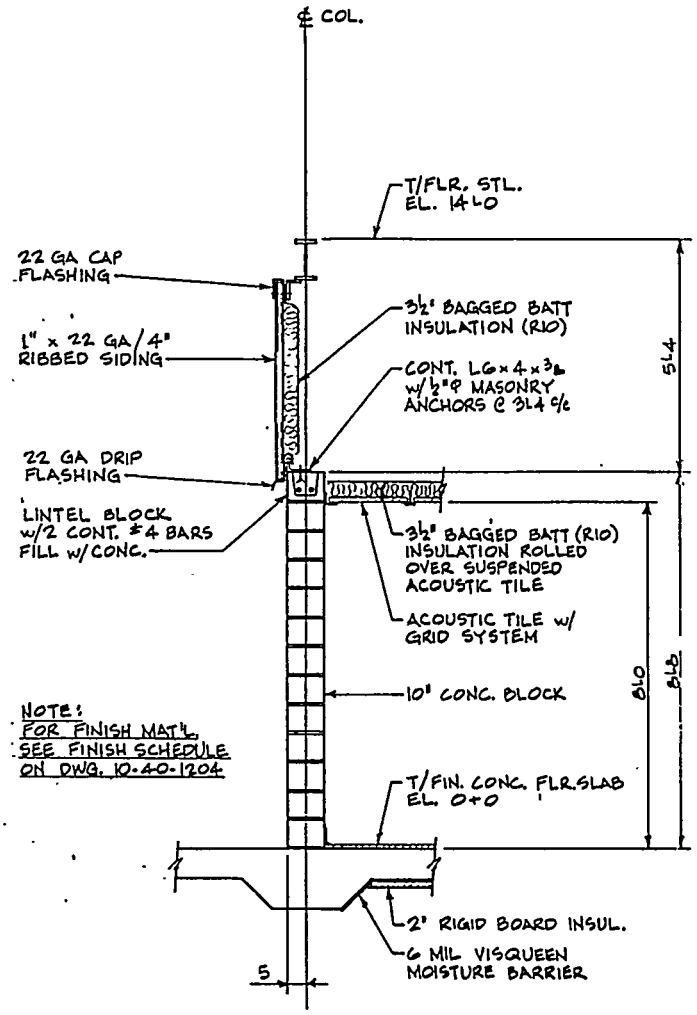
UNITED STATES DEPARTMENT OF ENERGY
ADVANCED FROTH FLOTATION PROCESS
M.C.C. ROOM PLAN, LABORATORY PLAN, NOTES AND SECTIONS

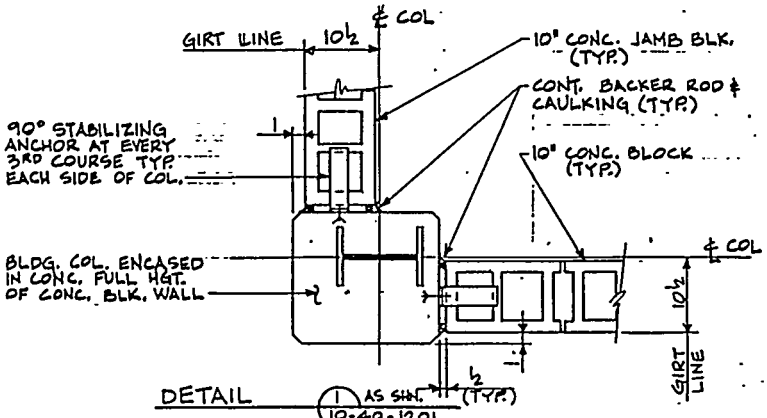
JOB No. 88107-250-00 | DWG. No. 10-40-1202 | REVISION R-



SECTION (A) 10-40-1201

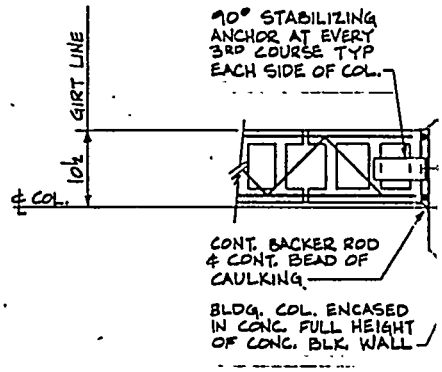


SECTION (B) 10-40-1201



DETAIL (1) AS SHN. 10-40-1201

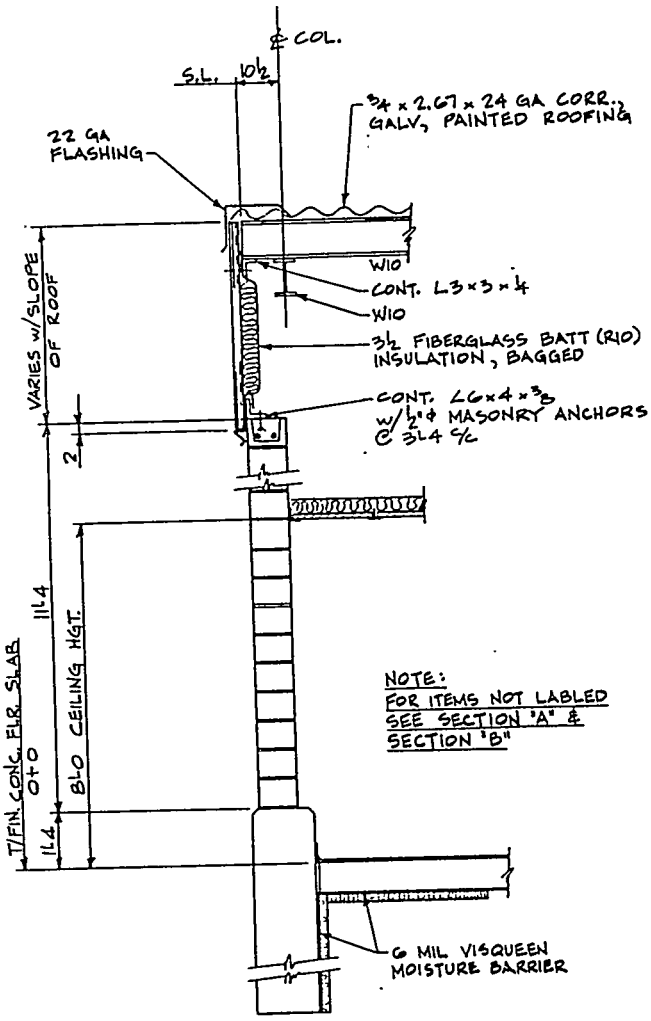
DETAIL (4) SIMILAR 10-40-1201



DETA

DETA

NO.	DATE	REVISION	BY	APP.	APP.	REFERENCE DRAWINGS	NUMBER	NOTES	DESCRIPTION COST ACCOU
									WORK COVERED BY THIS DRAWI CHARGED TO COST ACCOUNT NO



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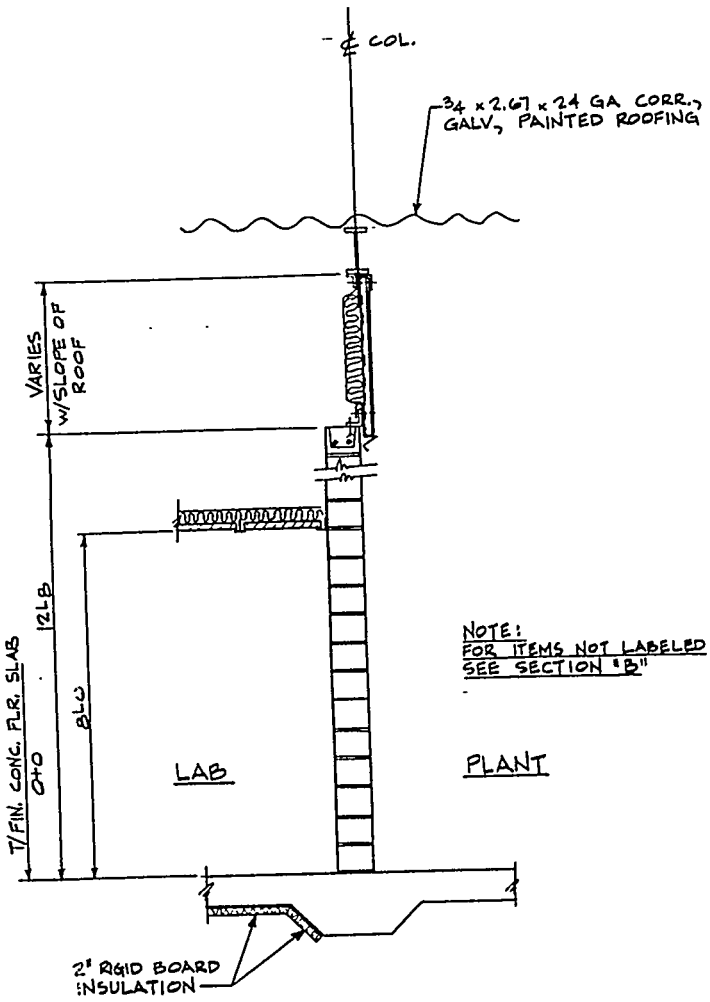

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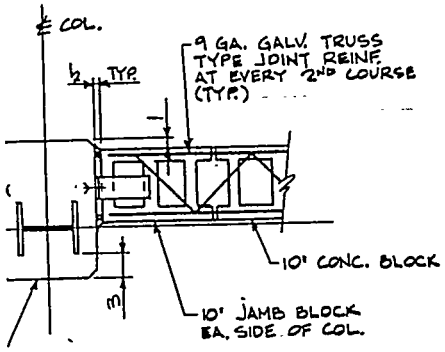
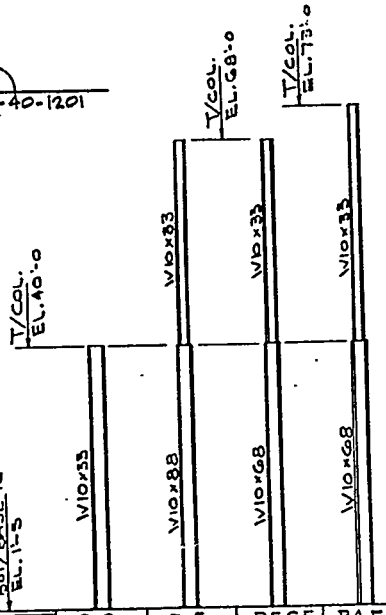
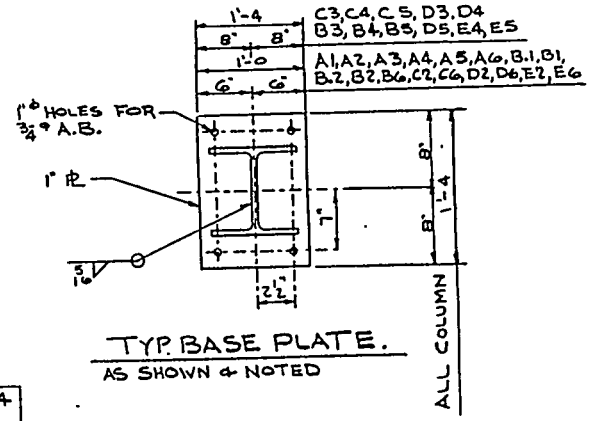




COLUMN LOCATION	B2	D5	B5, C5, E5	B4, E4



TYP. BASE PLATE.
AS SHOWN & NOTED

IL (2) AS SHOWN 10-40-1201
IL (3) SIMILAR 10-40-1201

CONSTRUCTION APPROVAL	APPROVAL	DATE	SCALE: ½" = 1'-0	DATE
			DESIGNED BY F. MINCIRONE	6/9/94
			DRAWN BY D.J. WALKOWSKI	6/9/94
			CHECKED BY	
			APPROVED BY	
			APPROVED BY	

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UNITED STATES DEPARTMENT OF ENERGY

ADVANCED FROTH FLOTATION PROCESS
WALL SECTIONS & DETAILS

JOB No. 88107-250-00 | DWG. No. 10-40-1203 | REVISION R-

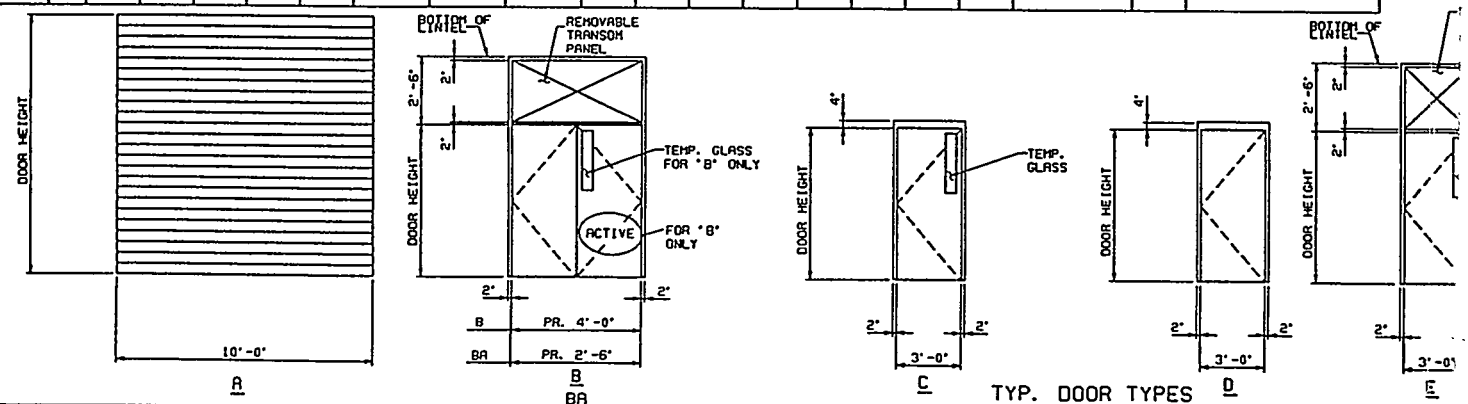
ROOM FINISH SCHEDULE

BUILDING OR AREA		DRAWING NUMBER	ROOM NAME	ROOM NUMBER	CEILING	WALLS	FLOOR	BASE	DOOR FRAMES		WINDOW FRAMES		TOILET PARTITION	URINAL SCREEN	LOCKERS			
									INTERIOR	EXTERIOR	INTERIOR	EXTERIOR						
ADVANCED FROTH FLOTATION PROCESSING BUILDING	GROUND FLOOR, OFFICE & LOCKER ROOMS	10-40-1201	GRD. FLR.	100	C/1	C/1	A/2	-	1	1	-	-	-	-	-			
			OFFICE	101	D	B/1	E	2	1	1	1	1	-	-	-			
			CORRIDOR	102	D	B/1	E	2	1	1	-	-	-	-	-			
			MEN'S LOCKER ROOM	103	D	B/3	E	G	1	1	-	-	1	1	1			
			JANITOR'S CLOSET	104	D	B/3	E	G	1	1	-	-	-	-	-			
			WOMEN'S LOCKER ROOM	105	D	B/3	E	G	1	1	-	-	1	-	1			
			LAB	106	D	B/3	E	G	1	1	-	-	-	-	-			
	M. C. C. ROOM	10-40-1202	CONTROL RM.	200	D	H	I	F	1	1	1	1						
			ELECT. RM.	201	C/1	H	A/2	-	1	1	-	-						
			-															

COLOR SELECTED BY OWNER - 1

DOOR SCHEDULE

BUILDING OR AREA		DRAWING NUMBER	DOOR NUMBER	ROOM NUMBER	DOOR TYPE	DOOR SWING	DOOR SIZE			DOOR MATERIAL	DETAILS			LOUVER SIZE	HARDWARE GROUP NUMBER	DOOR/FRAME FIRE RATING	DOOR FRAME		DOOR/FRAME FINISH	REMARKS
							WIDTH	HEIGHT	THICKNESS		HEAD	JAMB	SILL				MAT'L	SIZE		
ADVANCED FROTH FLOTATION PROCESSING BUILDING	GROUND FLOOR, OFFICE & LOCKER ROOMS	10-40-1201	1	100	A	-	10'-0"	10'-0"	-	-			-	-	1	-	-	-	SHOP PRIME PAINTED FEILD FINISH PAINTED	OVERHEAD ROLL-UP DOOR
			2	100	C	LHRB	3'-0"	7'-0"	1¾"	H.M.			-	-	2	-	P.M.	2" JAMB & 4" HEAD		
			3	100	B	RHRB LHRB	PR. 4'-0"	7'-0"	1¾"	H.M.			-	-	3	-	P.M.	2" HEAD & SILL		w/REMOVABLE TRANSOM
			4	100	C	RHRB	3'-0"	7'-0"	1¾"	H.M.			-	-	2	-	P.M.	2" JAMB & 4" HEAD		
			5	100	B	RHRB LHRB	PR. 4'-0"	7'-0"	1¾"	H.M.			-	-	3	-	P.M.	2" JAMB & SILL		w/REMOVABLE TRANSOM
			6	106	C	RHRB	3'-0"	7'-0"	1¾"	H.M.			-	-	2	-	P.M.	2" JAMB & 4" HEAD		
			7	106	C	RH	3'-0"	7'-0"	1¾"	H.M.			-	-	4	1½	P.M.	2" JAMB & 4" HEAD		
			8	100	B	RHRB LHRB	PR. 4'-0"	7'-0"	1¾"	H.M.			-	-	3	-	P.M.	2" JAMB & HEAD		w/REMOVABLE TRANSOM
			9	100	A	-	10'-0"	10'-0"	-	-			-	-	1	-	-	-		OVERHEAD ROLL-UP DOOR
			10	102	C	RHRB	3'-0"	7'-0"	1¾"	H.M.			-	-	2	-	P.M.	2" JAMB & 4" HEAD		
			11	101	C	RHRB	3'-0"	7'-0"	1¾"	H.M.			-	-	4	-	P.M.	2" JAMB & 4" HEAD		
			12	103	D	RH	3'-0"	7'-0"	1¾"	H.M.			-	-	5	-	P.M.	2" JAMB & 4" HEAD		
			13	103	D	LH	3'-0"	7'-0"	1¾"	H.M.			-	-	5	1½	P.M.	2" JAMB & 4" HEAD		
			14	105	D	RH	3'-0"	7'-0"	1¾"	H.M.			-	-	5	1½	P.M.	2" JAMB & 4" HEAD		
			15	102	C	RH	3'-0"	7'-0"	1¾"	H.M.			-	-	5	1½	P.M.	2" JAMB & 4" HEAD		
			16	104	D	RHRB	3'-0"	7'-0"	1¾"	H.M.			-	-	4	-	P.M.	2" JAMB & 4" HEAD		
			23	101	C	LHRB	3'-0"	7'-0"	1¾"	H.M.			-	-	5	1½	P.M.	2" JAMB & 4" HEAD		
	M. C. C. ROOM	10-40-1202	17	200	C	LHRB	3'-0"	7'-0"	1¾"	H.M.			-	-	1	1½	P.M.	2" JAMB & 4" HEAD		
			18	201	E	LH	3'-0"	7'-0"	1¾"	H.M.			-	-	4	1½	P.M.	2" JAMB & HEAD		w/REMOVABLE TRANSOM
			19	201	BA	LHRB RHRB	PR. 2'-6"	7'-0"	1¾"	H.M.			-	-	6	1½	P.M.	2" JAMB & SILL		w/REMOVABLE TRANSOM
			20	201	C	LHRB	3'-0"	7'-0"	1¾"	H.M.			-	-	1	1½	P.M.	2" JAMB & 4" HEAD		
	EL. 40'-0" & EL. 54'-0"	10-30-1103	21	ELEV. 40'-0"	F	LHRB RHRB	PR. 4'-0"	10'-0"	1¾"	H.M.			-	-	8	-	P.M.	2" JAMB & SILL		
			22	ELEV. 54-0"	C	LHRB	3'-0"	7'-0"	1¾"	H.M.			-	-	7	1½	P.M.	2" JAMB & 4" HEAD		



TYP. DOOR TYPES

NO	DATE	REVISION	BY	CH	APP	APP	REFERENCE DRAWINGS	NUMBER	NOTES	DESCRIPTION	COST A
										WORK COVERED BY THIS ACC CHARGED TO COST ACCOUNT	

EMARKS
ater

FINISH SCHEDULE KEYS:

MATERIAL
A - CONCRETE
B - CONCRETE BLOCK
C - EXPOSED STRUCTURE
D - 2'x4' ACOUSTIC TILE, LAY IN TYPE w/MYLAR FINISH INSTALLED IN 2'x4' SUSPENDED FIRE RATED GRID (8'-0" CEILING HEIGHT A.F.F.)
E - SEAMLESS EPOXY RESIN FLOOR
F - 4" RUBBER w/SANITARY COVE
G - 4" SEAMLESS EPOXY RESIN BASE w/SANITARY COVE
H - PRE-FINISHED METAL PANEL
I - COMPOSITION TILE (⅛" THK.)

FINISH
1 - PAINT
2 - STEEL TROWEL / PENETRATING SEALER
3 - EPOXY PAINT

HARDWARE SCHEDULE

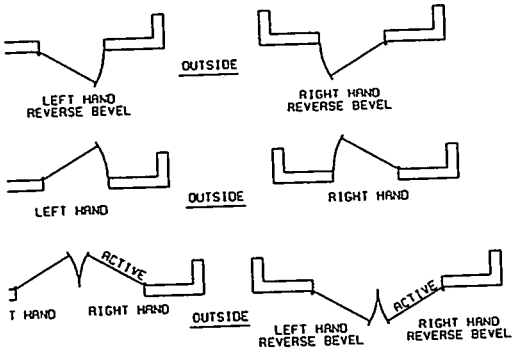
DESCRIPTION	HARDWARE GROUP NUMBER 1	2	3	4	5	6	7	8	9	10	REMARKS
1½ PAIR 4½" x 4½" B.B. PAINTED STEEL HINGES PER LEAF		•	•	•	•	•	•				
DOOR CLOSER SURFACE MOUNTED W/SEX BOLTS		•	AL	•	•		•				
RIM TYPE EXIT DEVICE W/OUTSIDE LEVER TRIM SET AND CYLINDER		•	AL								
RIM TYPE EXIT DEVICE W/OUTSIDE LEVER TRIM SET							•				
LEVER LATCH SET					•						
LOCKSET W/CYLINDER	•			•							
THRESOLD 5" ALUMINUM SADDLE		•	•	•							
HEAD AND JAMB WEATHER STRIPPING		•	•	•			•				
ASTRICAL STRIP (AT DOUBLE DOORS) WEATHER STRIPPING			•				•				
HARDWARE AS SUPPLIED BY DOOR MANUFACTURER									•		
PUSH/PULLS							BL				
DEAD BOLTS - HEAD & SILL			IL				BL				
KICK PLATES, 8" HIGH S.STEEL (EACH FACE)		•	BL	•	•	•	BL	•			
DOOR STOP		•	•	•	•			•			
DOOR STOP W/HOOK							BL				
SAFETY BOTTOM BAR	•										
RUBBER SILENCERS		•	•	•	•	•	•	•			

HARDWARE SCHEDULE LEGEND:
AL - ACTIVE LEAF
IL - INACTIVE LEAF
BL - BOTH LEAFS

ALL KEYING SHALL BE MASTER KEYED TO OWNERS SYSTEM.

SUPPLY NUMBER OF KEYS AS DIRECTED BY OWNER

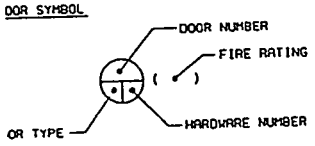
PAIRS OF DOORS-KEY SIDE
HT HAND LEAF IS ALWAYS
IVE UNLESS SPECIFIED OTHERWISE.



DOOR SWING DESIGNATIONS

SEND

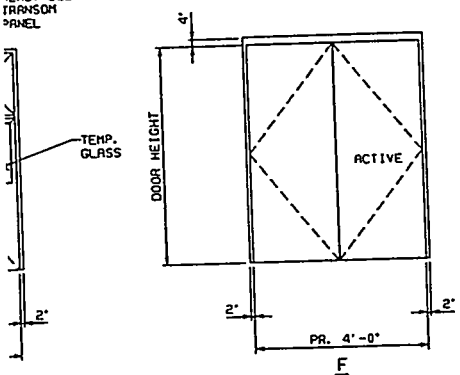
DOOR SYMBOL



DOOR / FRAME NOTES:

1. DOORS SHALL BE 18 GA., INSULATED, GALVANIZED, PRIME PAINTED, REINF. FOR ALL HARDWARE ITEMS. SEE SCHEDULE FOR FIRE RATING.
2. DOOR FRAMES SHALL BE 2x5¾x16 GA. OR 2x4¾x16 GA. GALVANIZED, PRIME PAINTED, REINF. FOR HARDWARE ITEMS. SEE SCHEDULE FOR FIRE RATING.

REMOVABLE TRANSOM PANEL



F

NOTE:

WORK THIS DRAWING WITH DRAWINGS 10-40-1201 & 10-40-1202

CONSTRUCTION APPROVAL	APPROVAL	DATE

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SCALE: NONE	DATE
DESIGNED BY: F. MINGRONE	6/9/94
DRAWN BY: D.J. WALKOWSKI	6/9/94
CHECKED BY:	
APPROVED BY:	
APPROVED BY:	

PROFESSIONAL SEAL

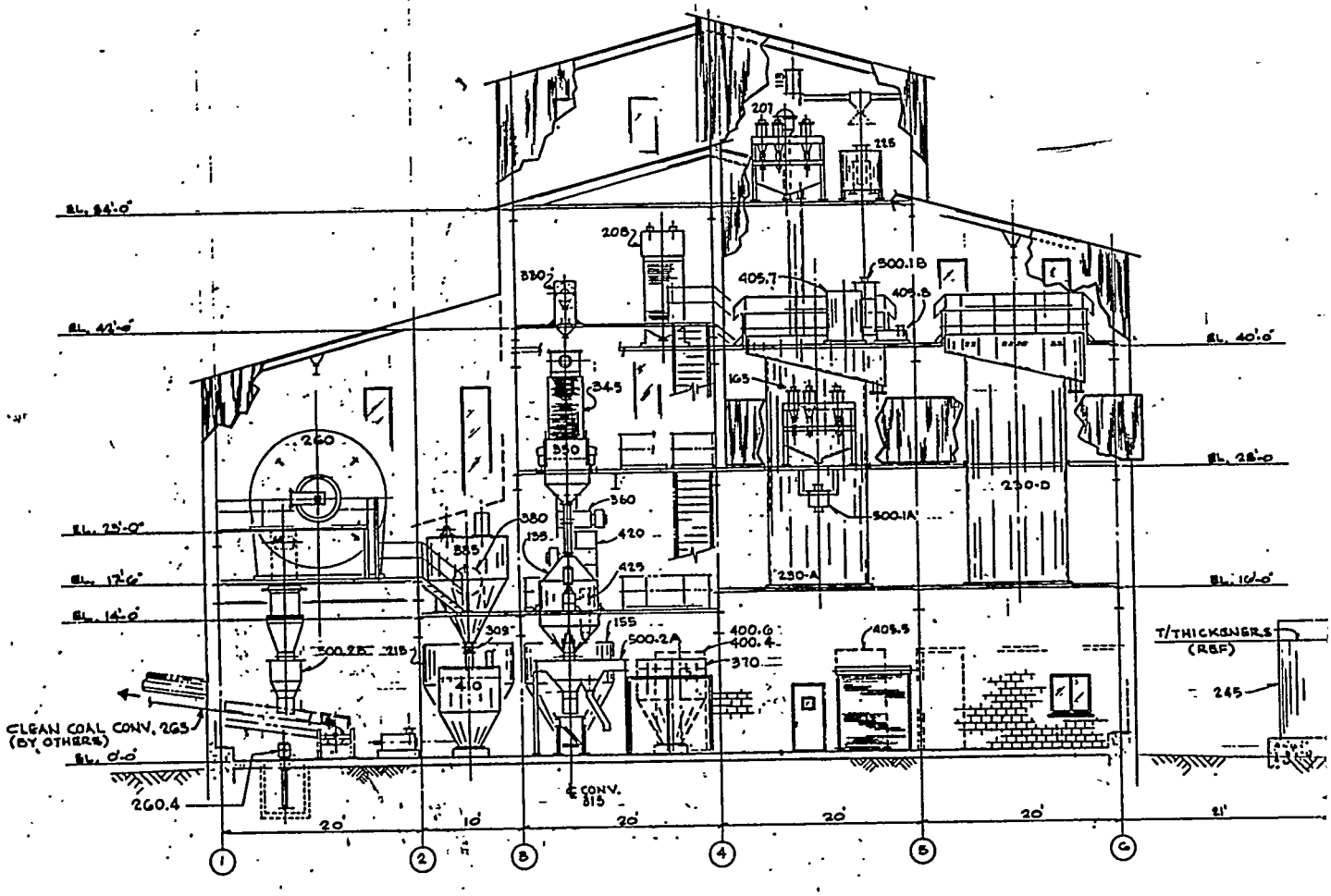
ICF KAISER ENGINEERS, INC.
FOUR GATEWAY CENTER
PITTSBURGH, PA 15222-1287
(412) 497-2000

ICF KAISER

UNITED STATES DEPARTMENT OF ENERGY
ADVANCED FROTH FLOATATION
DOOR SCHEDULE AND FINISH SCHEDULE

JOB NO. 88107-250	DWG. NO. 10-40-1204	REVISION R-

...\88107250\10401204.dgn walkowski



ELEVATION (A) 10-50-0203 THRU 0205.

NO.	DATE	REVISION	BY	APP.	APP.

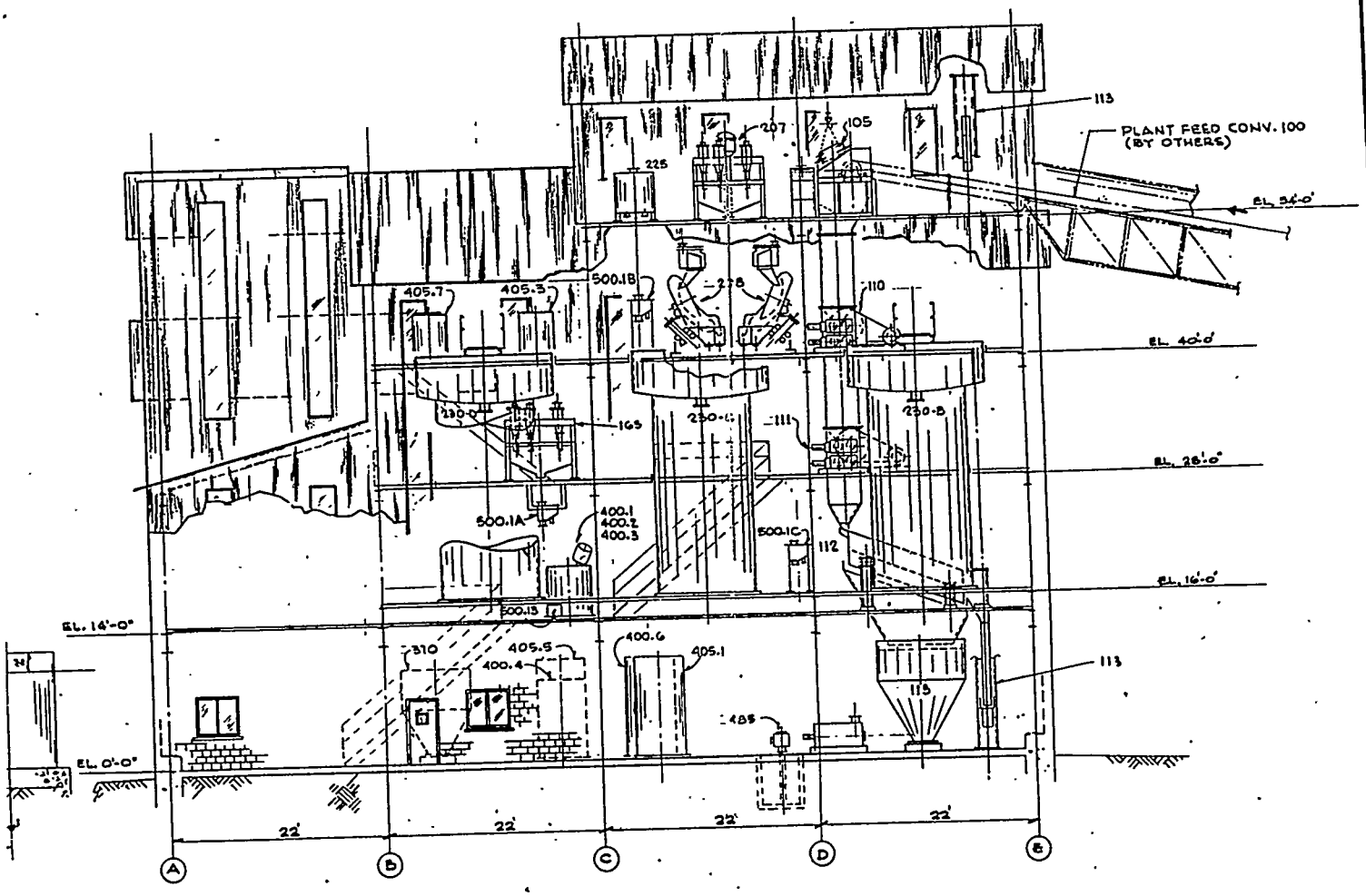
REFERENCE DRAWINGS

NUMBER

NOTES

DESCRIPTION COST AC

WORK COVERED BY THIS DR CHARGED TO COST ACCOUNT



ELEVATION (B) 10-50-0203 THRU 0205

WORK THIS DWG WITH DWG 10-50-0202
10-50-0203
10-50-0204
10-50-0205

CONSTRUCTION APPROVAL	APPROVAL	DATE	SCALE: 1/8" = 1'-0"	DATE
			DESIGNED BY: B. POGIERNICKI	4/5/94
			DRAWN BY: B. POGIERNICKI/BA	5/10/94
			CHECKED BY:	
			APPROVED BY:	
			APPROVED BY:	

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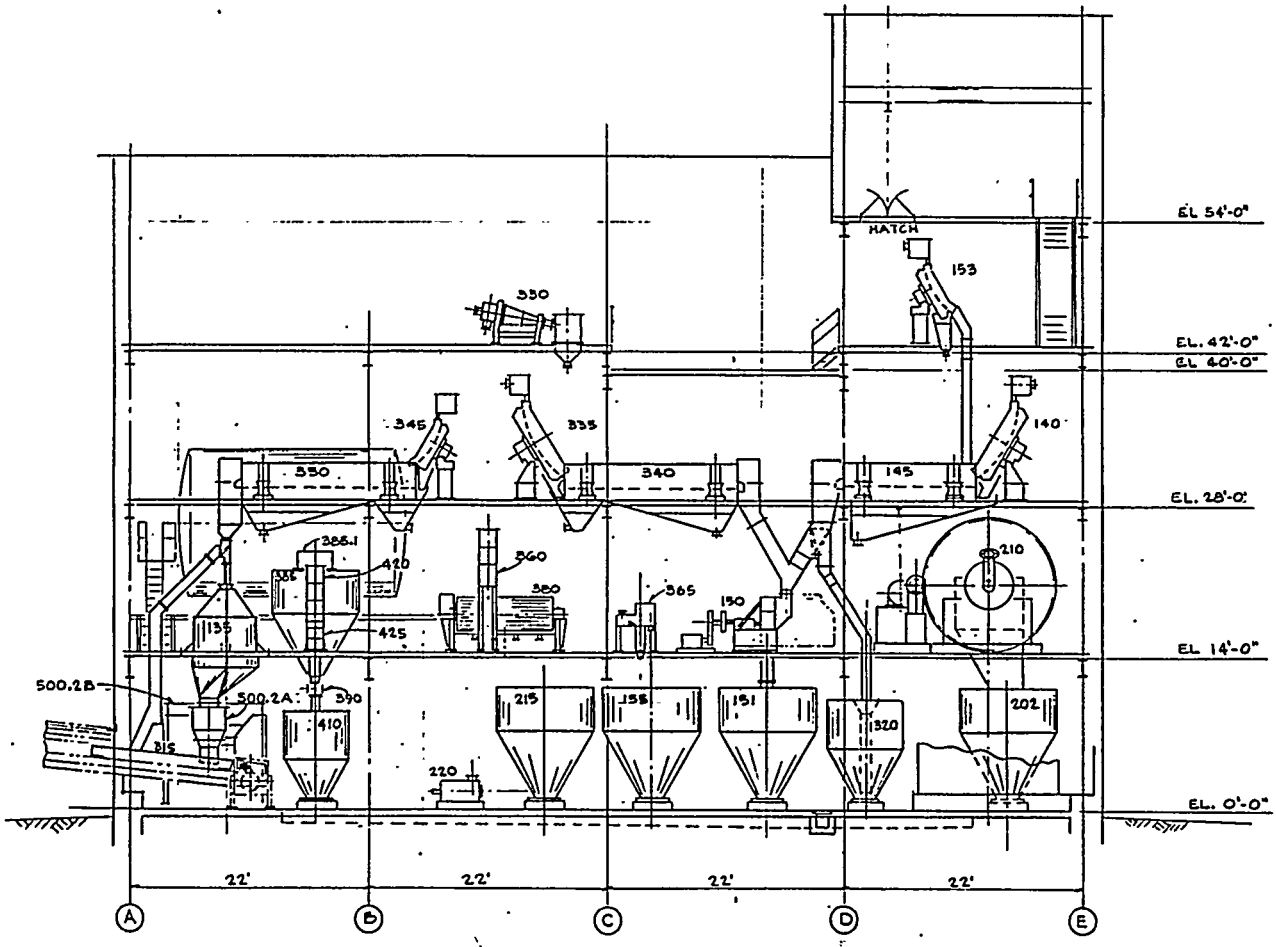
ICF KAISER ENGINEERS

ICF KAISER ENGINEERS INC.
Four Gateway Center
Pittsburgh, PA 15222-1207
(412) 281-8121, TELEX: 199121

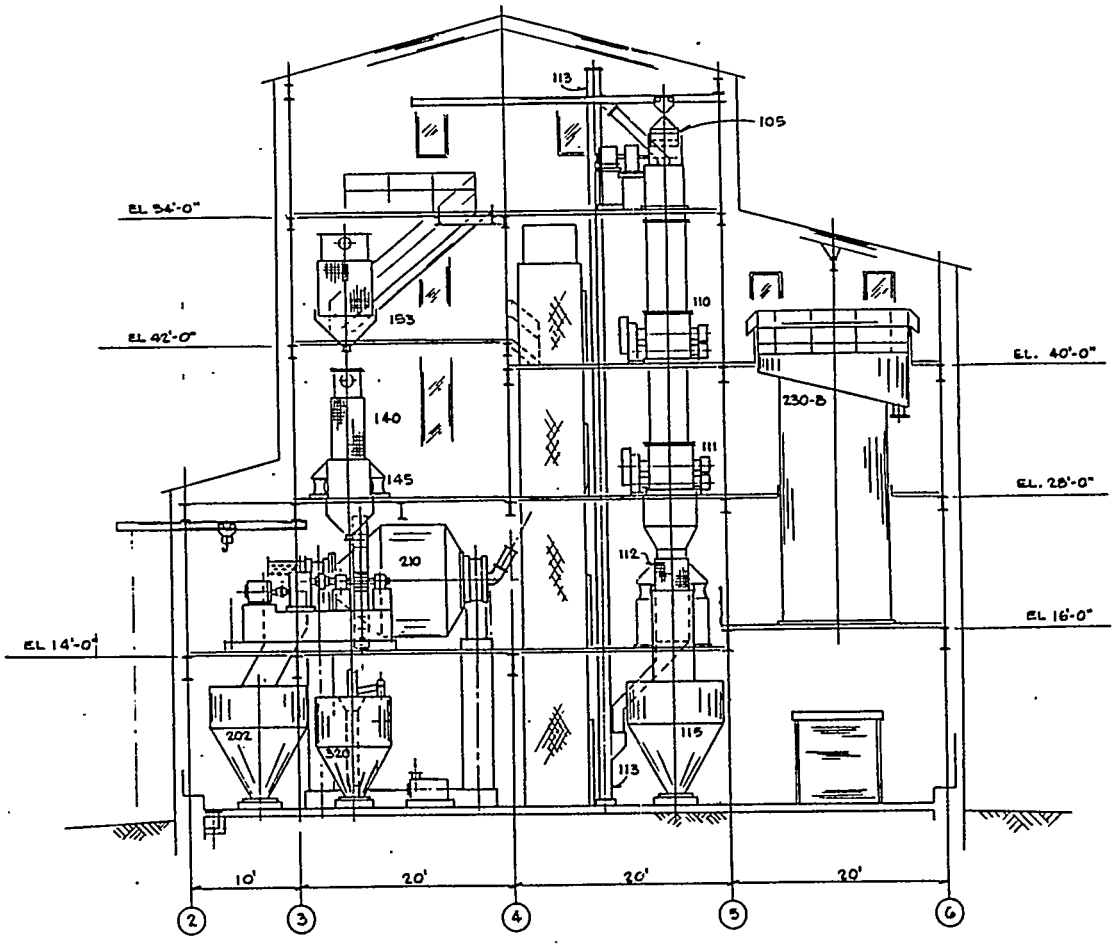
UNITED STATES DEPARTMENT OF ENERGY
ADVANCED FROTH FLOTATION PROCESS
ELEVATIONS A & B
GENERAL ARRANGEMENT

JOB No. 88107-250-00 | DWG. No. 10-50-0201 | REVISION R-



SECTION (C)
10-50-0203 THRU 0204

NO.	DATE	REVISION	BY	CHK	APP.	APP.	REFERENCE DRAWINGS	NUMBER	NOTES	DESCRIPTION	COST ACCOUNT
										WORK COVERED BY THIS DRAWING CHARGED TO COST ACCOUNT ABOVE	



SECTION (C)
10-50-0203 THRU 0205

WORK THIS DWG WITH DWG 10-50-0201
10-50-0203
10-50-0204
10-50-0205

CONSTRUCTION APPROVAL	APPROVAL	DATE	SCALE: 1/8"=1'-0"	DATE
			DESIGNED BY	
			DRAWN BY R.L./E.Z.	5/10/94
			CHECKED BY	
			APPROVED BY	
			APPROVED BY	

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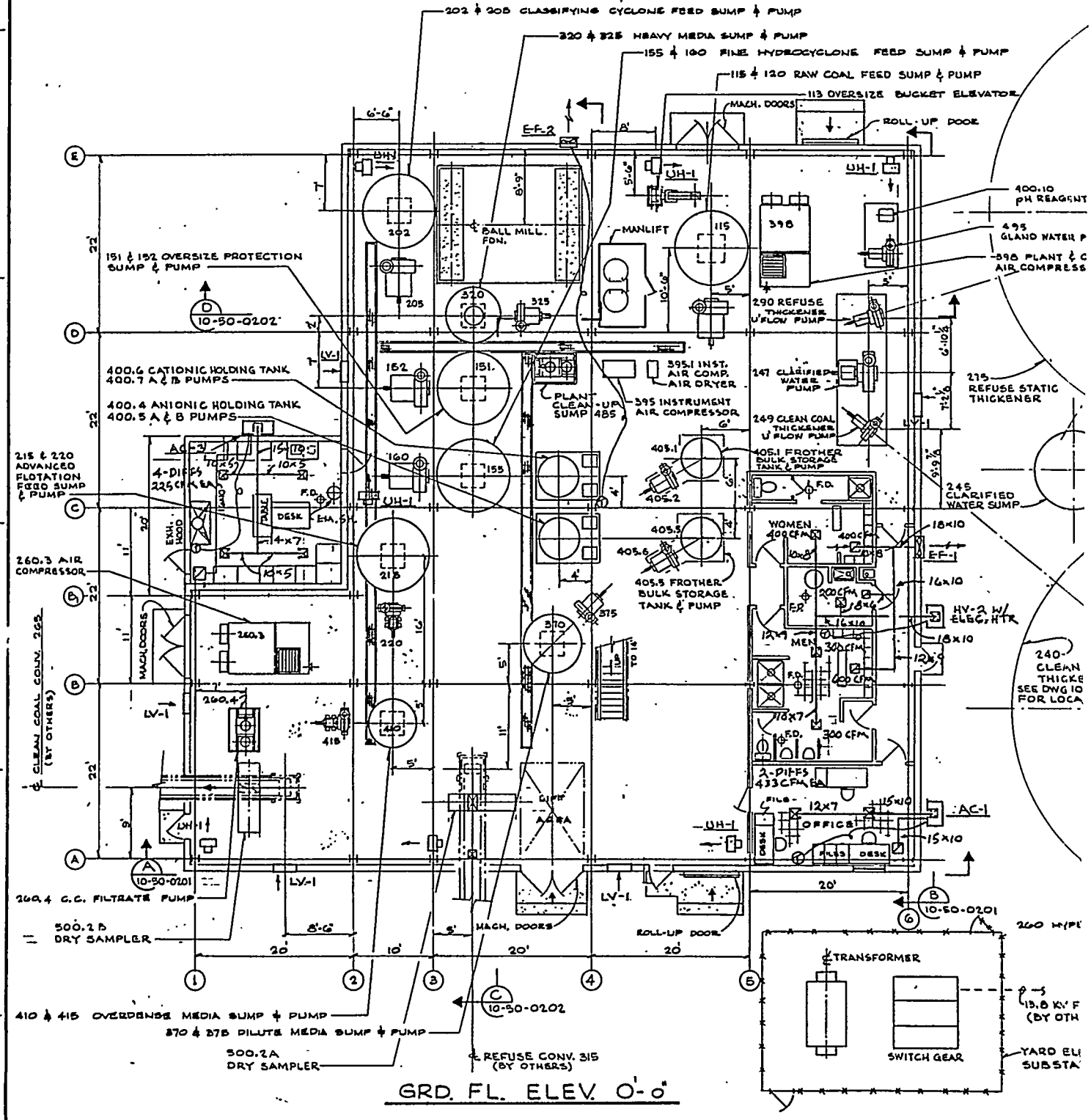
UNITED STATES DEPARTMENT OF ENERGY
ADVANCED FROTH FLOTATION PROCESS
SECTIONS C & D
GENERAL ARRANGEMENT

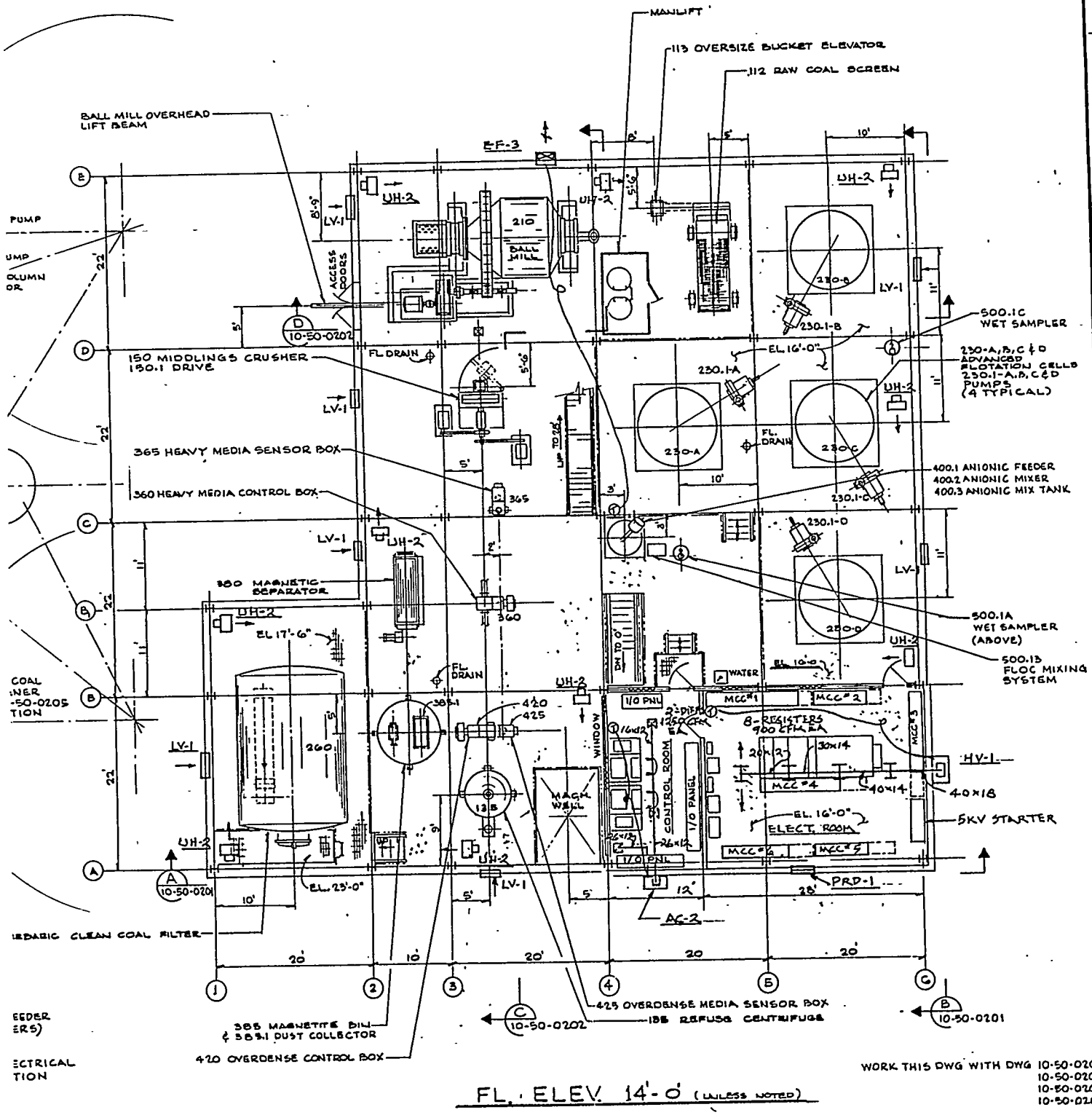
JOB No. 88107-250-00 | DWG. No. 10-50-0202 | REVISION R.



NO.	DATE	REVISION	BY	APP.	APP.	REFERENCE DRAWINGS	NUMBER	NOTES	DESCRIPTION	COST ACCOU

T HTR SCHEDULE

10KW
15KW
20KW



FL. ELEV. 14'-0" (UNLESS NOTED)

WORK THIS DWG WITH DWG 10-50-0201
10-50-0202
10-50-0204
10-50-0205

CONSTRUCTION APPROVAL	APPROVAL	DATE	SCALE: 1/8" = 1'-0"	DATE
			DESIGNED BY E. POCIERNICKI	4/5/96
			DRAWN BY E. POCIERNICKI/ RL 8.7	5/10/96
			CHECKED BY	
			APPROVED BY	
			APPROVED BY	

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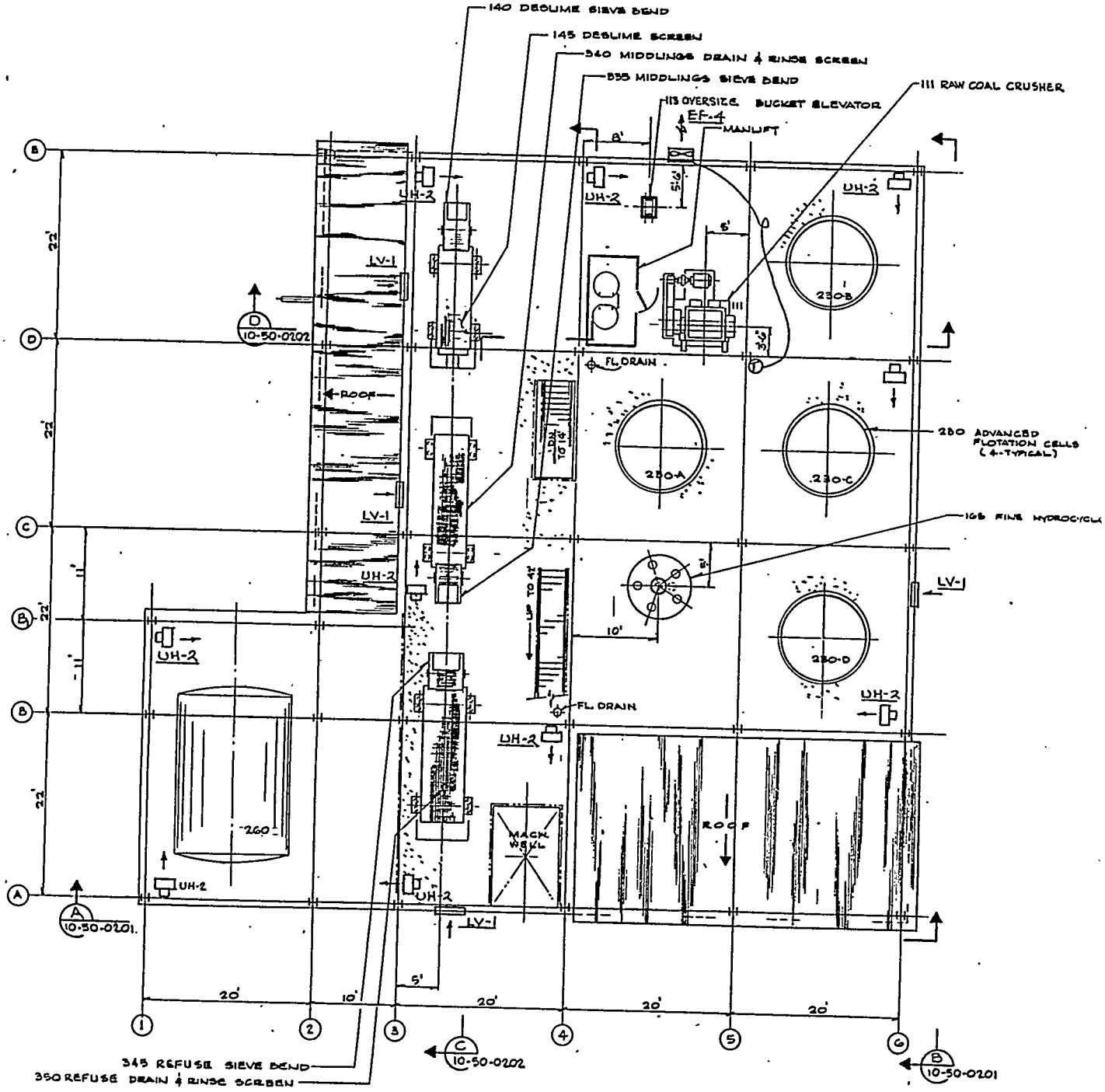
Four Gateway Center
Pittsburgh, PA 15222-1207
(412) 281-8121, TELEX: 199121

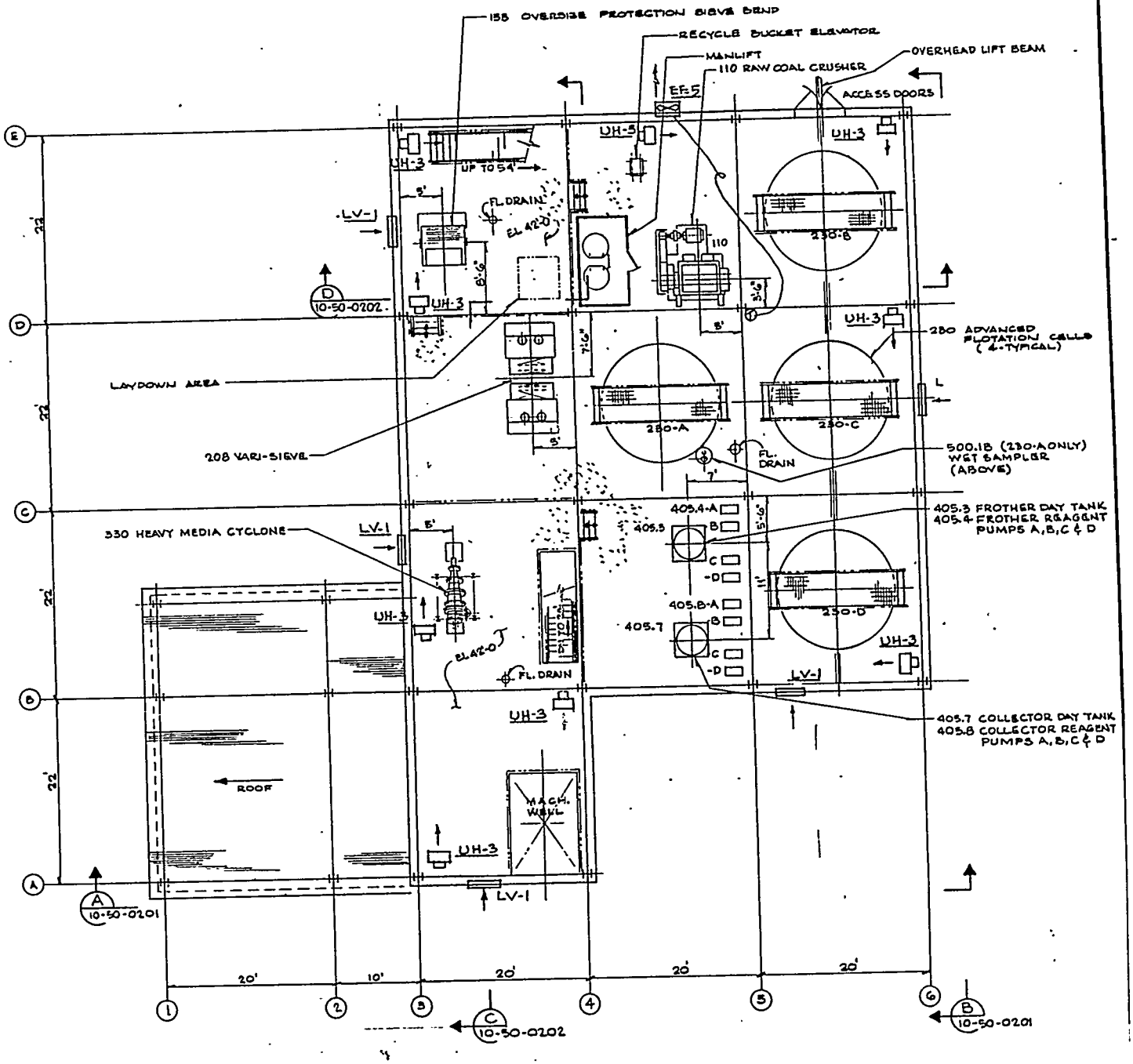
UNITED STATES DEPARTMENT OF ENERGY
ADVANCED FROTH FLOTATION PROCESS
PLAN AT ELEV. 0'-0" & 14'-0"
GENERAL ARRANGEMENT

JOB No. 88107-250-00 | DWG. No. 10-50-0203 | REVISION R-



FL. ELEV. 28'-0"

NO.	DATE	REVISION	BY	CHK.	APP.	APP.	REFERENCE DRAWINGS	NUMBER	NOTES	DESCRIPTION	COST ACCOUNT
										WORK COVERED BY THIS DRAWING CHARGED TO COST ACCOUNT ABOVE	



FL. ELEV. 40'-0" (UNLESS NOTED)

WORK THIS DWG WITH DWG 10-50-0201
10-50-0202
10-50-0203
10-50-0205

CONSTRUCTION APPROVAL	APPROVAL	DATE	SCALE: 1/8" = 1'-0"	DATE
			DESIGNED BY E. POCIERNICKI	4/5/94
			DRAWN BY E. POCIERNICKI / E.L. E.L.	5/10/94
			CHECKED BY	
			APPROVED BY	
			APPROVED BY	

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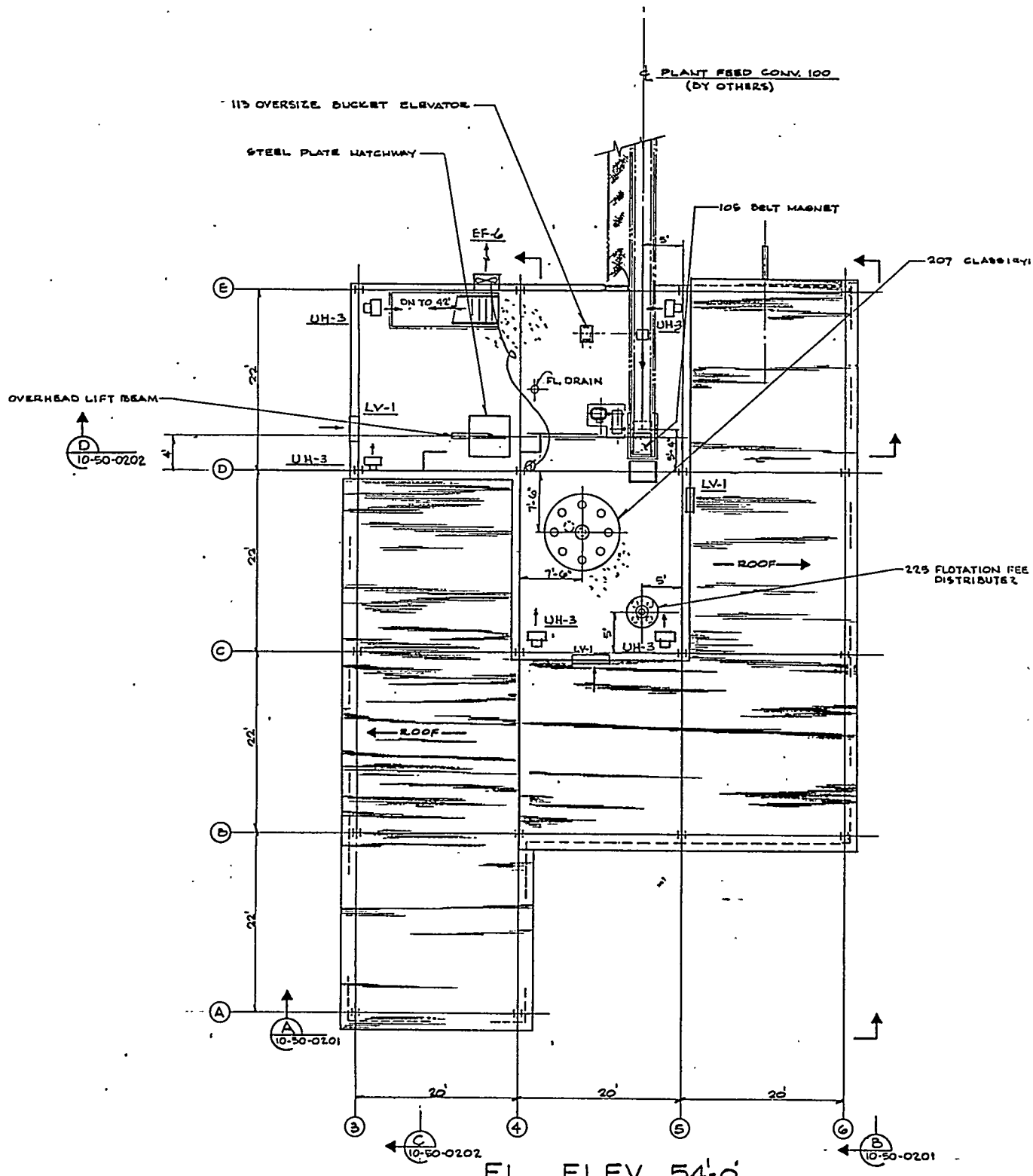
(412) 281-8121, TELEX: 199121

UNITED STATES DEPARTMENT OF ENERGY

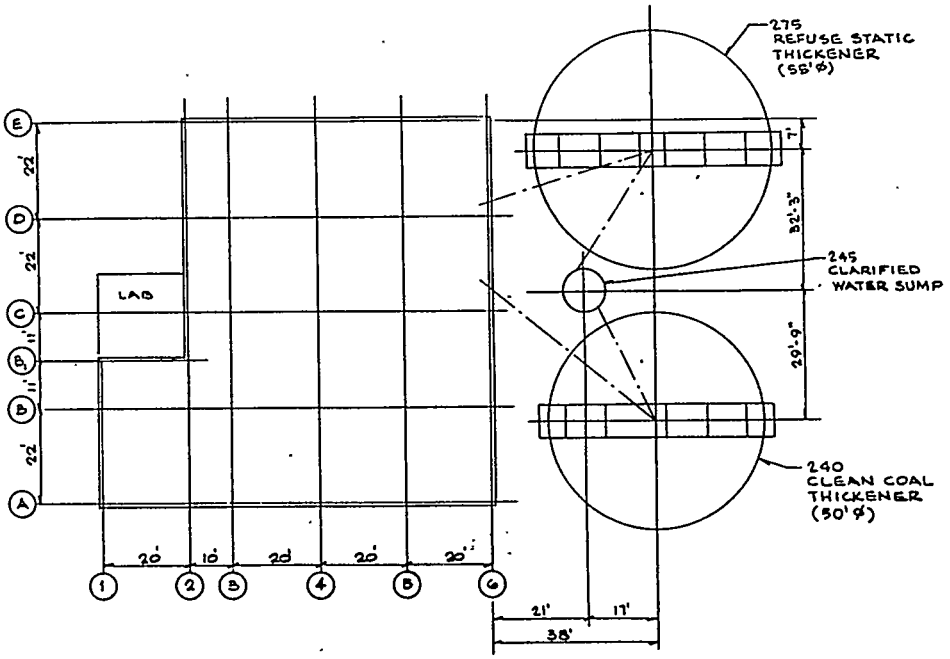
ADVANCED FROTH FLOTATION PROCESS
PLAN AT ELEV. 28'-0" & 40'-0"
GENERAL ARRANGEMENT

JOB No. 88107-250-00	DWG. No. 10-50-0204	REVISION R-



NO.	DATE	REVISION	BY	APP.	APP.	REFERENCE DRAWINGS	NUMBER	NOTES	DESCRIPTION	COST ACCOUNT
									WORK COVERED BY THIS DRAWING CHARGED TO COST ACCOUNT ABOVE	

NO CYCLONES



KEY PLAN
SCALE: 1"=20'-0"

WORK THIS DWG WITH DWG 10-50-0201
10-50-0202
10-50-0203
10-50-0204

CONSTRUCTION APPROVAL	APPROVAL	DATE	SCALE: 1/8" = 1'-0" U.N.	DATE
			DESIGNED BY B. POCIEBNICKI	4/5/94
			DRAWN BY E. POCIEBNICKI	5/10/94
			CHECKED BY	
			APPROVED BY	
			APPROVED BY	

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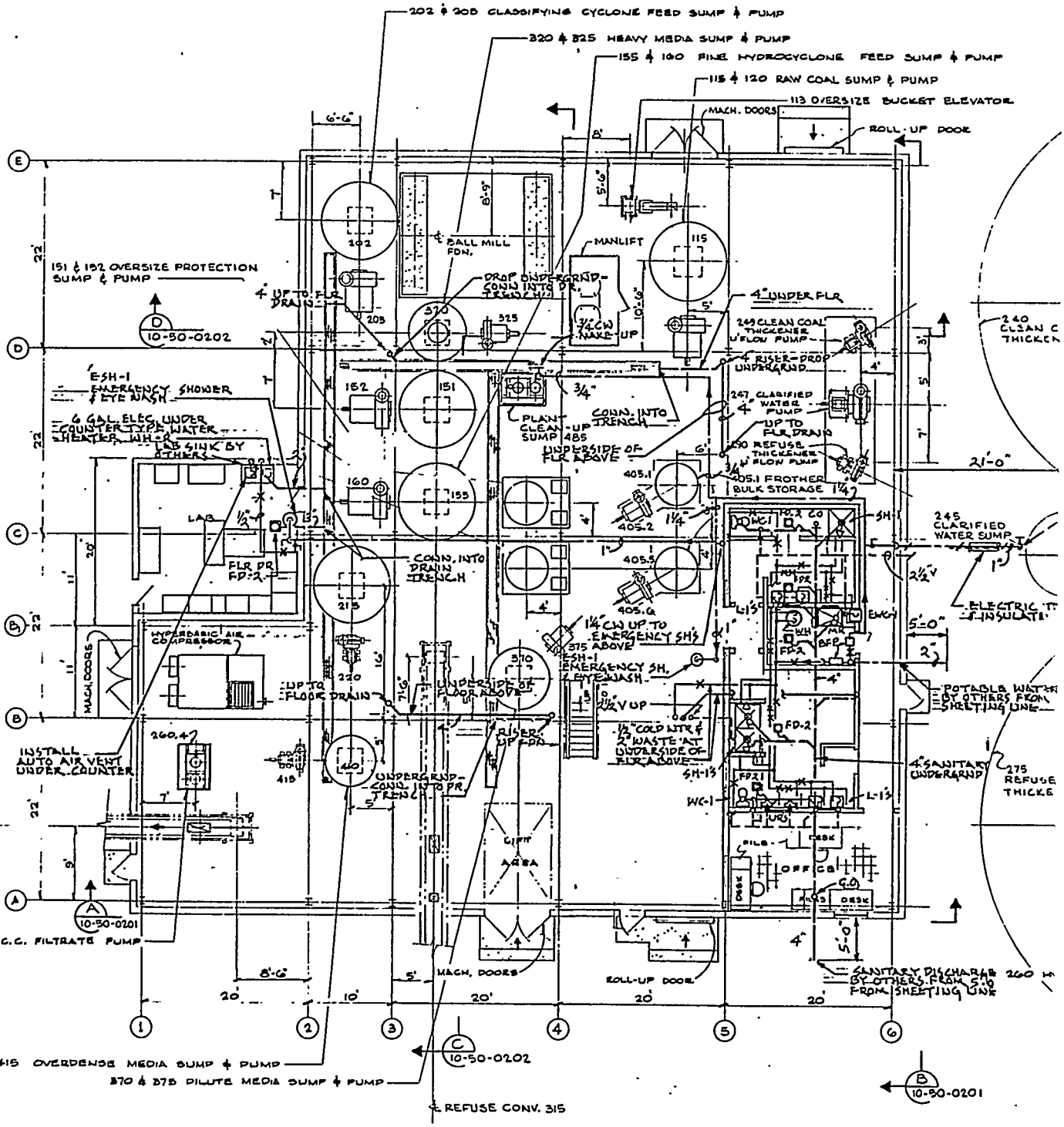
UNITED STATES DEPARTMENT OF ENERGY

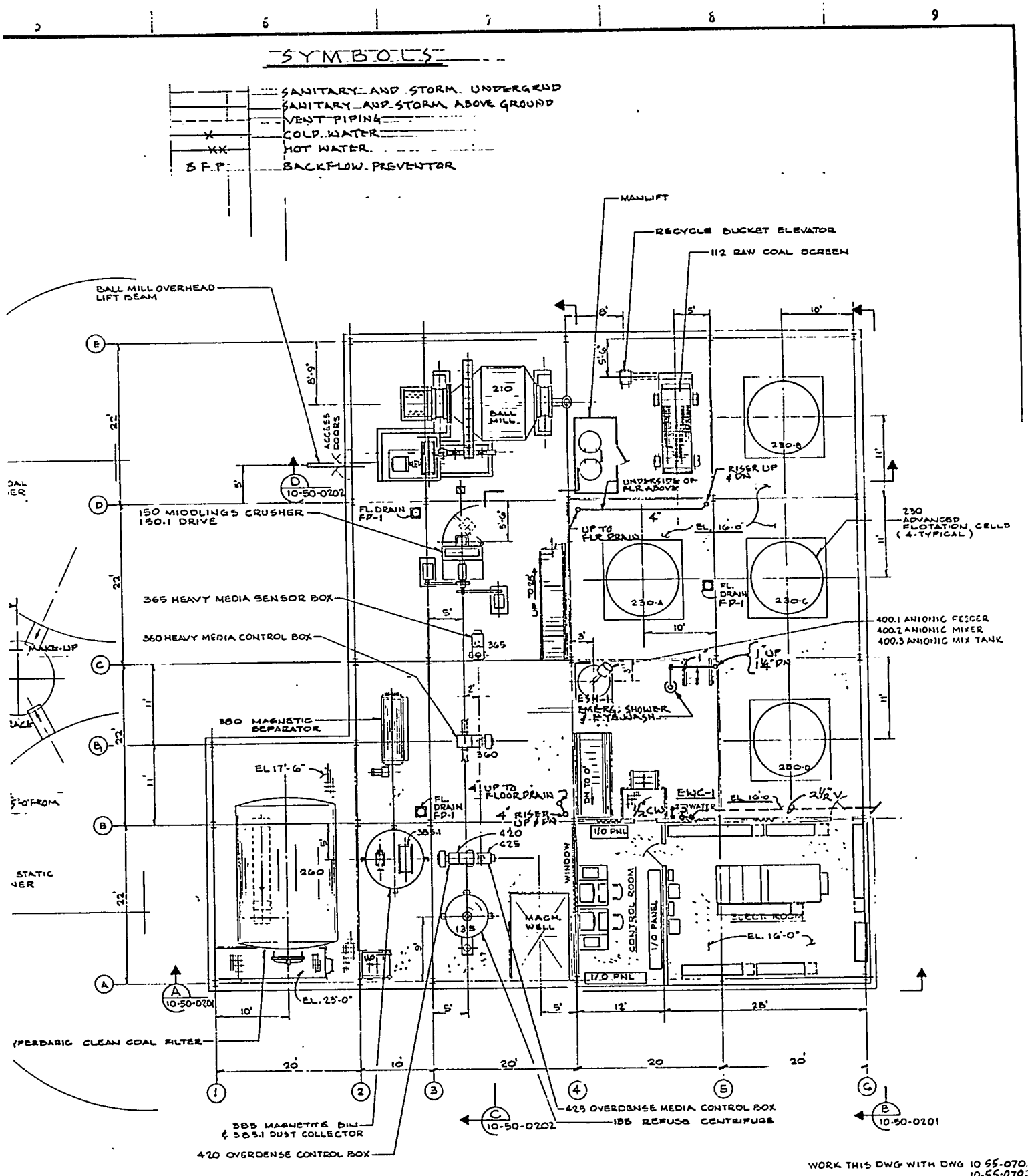
ADVANCED FROTH FLOTATION PROCESS
PLAN AT ELEV. 54'-0" & KEY PLAN
GENERAL ARRANGEMENT

JOB No. 88107-250-00 | DWG. No. 10-50-0205 | REVISION R.



GRD. FL. ELEV. 0'-0"

NO.	DATE	REVISION	BY	APP.	APP.	REFERENCE DRAWINGS	NUMBER	NOTES	DESCRIPTION	COST ADJ



CONSTRUCTION APPROVAL	APPROVAL	DATE	SCALE: 1/8" = 1'-0"	DATE
			DESIGNED BY W. L. COWHER	5/11/94
			DRAWN BY W. L. COWHER	5/26/94
			CHECKED BY	
			APPROVED BY	
			APPROVED BY	

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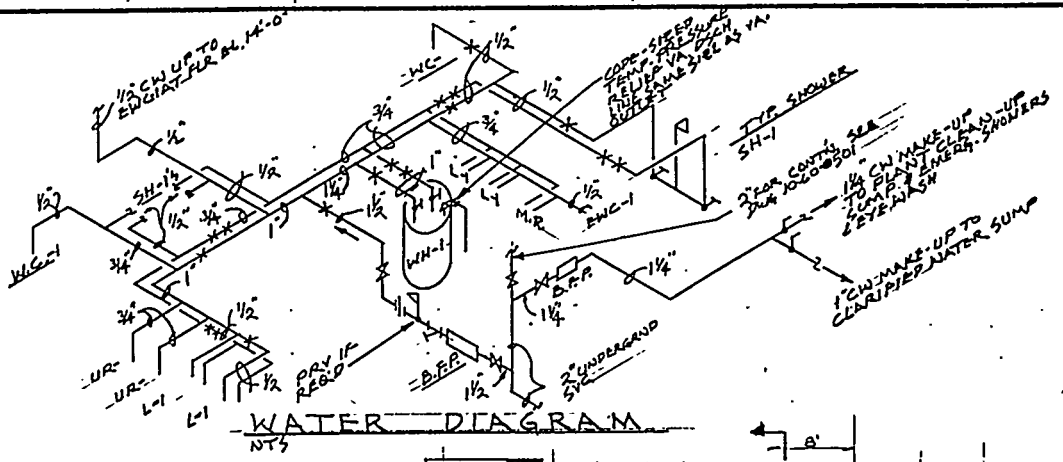
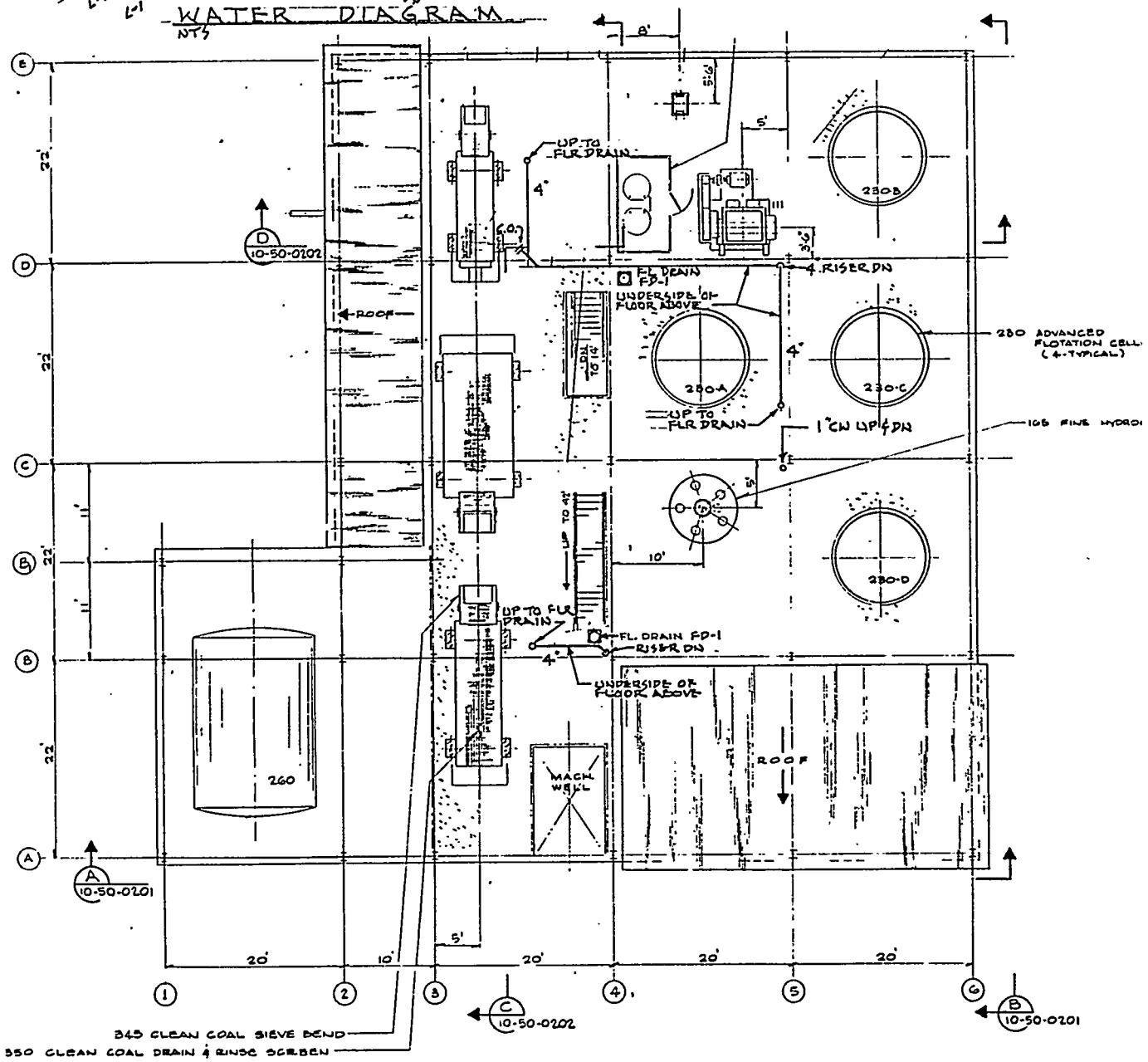
UNITED STATES DEPARTMENT OF ENERGY
ADVANCED FROTH FLOTATION PROCESS
PLAN AT ELEV. 0'-0" & 14'-0"
PLUMBING PLAN

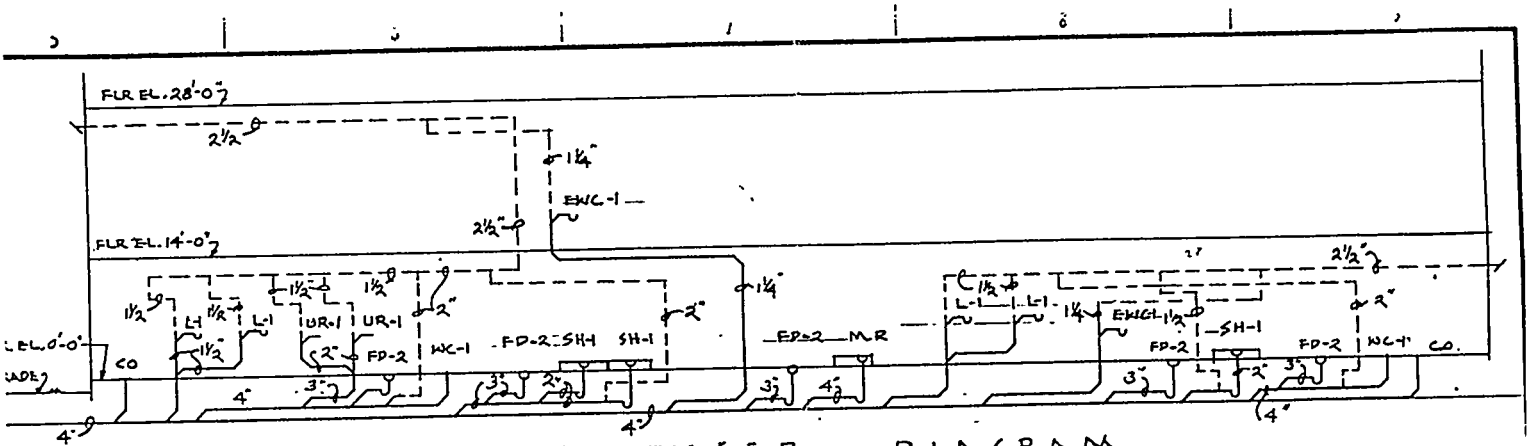
JOB No. 88107-250-00 | DWG. No. 10-55-0701 | REVISION R-





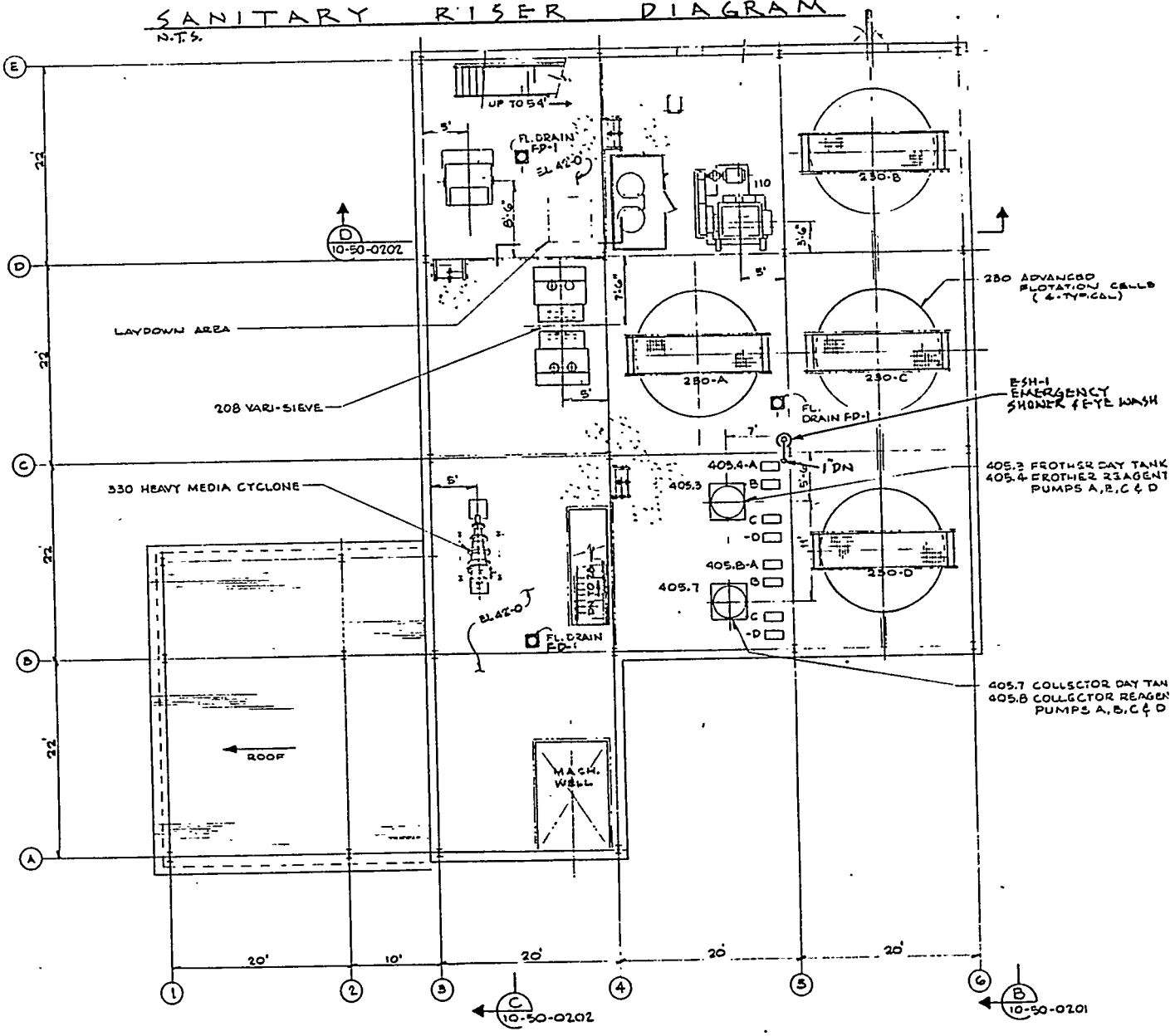
FL. ELEV. 28'-0"

NO.	DATE	REVISION	BY	CHK'D	APP.	REFERENCE DRAWINGS	NUMBER	NOTES	DESCRIPTION	COST
									WORK COVERED BY THIS CHANGED TO COST ACCOUNT	



SANITARY RISER DIAGRAM

N.T.S.



WORK THIE DWG WITH DWG 10-55-0701
10-55-0703

FL. ELEV. 40'-0" (UNLESS NOTED)

CONSTRUCTION APPROVAL	APPROVAL	DATE	SCALE: 1/8" = 1'-0"	DATE
			DESIGNED BY W. L. COWHER	5/23/94
			DRAWN BY W. L. COWHER	5/27/94
			CHECKED BY	
			APPROVED BY	
			APPROVED BY	

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ICF KAISER ENGINEERS INC.
Four Gateway Center
Pittsburgh, PA 15222-1207
(412) 281-8121, TELEX: 199121

UNITED STATES DEPARTMENT OF ENERGY

ADVANCED FROTH FLOTATION PROCESS PLAN AT ELEV. 28'-0" & 40'-0" AND PLUMBING DIAGRAMS

JOB No. 88107-250-00 | DWG. No. 10-55-0702 | REV. R-

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ELECTRIC UNIT HEATER SCHEDULE								
UNIT	KW	VOLTS	PHASE	NO. OF STAGES	BTU/HR OUTPUT	CFM AIR	MOUNTING HEIGHT	REMARKS
UH-1	10	480	3	1	34,150	650	8'-0"	Q-MARK, MODEL MUH-10-4, W/INTEGRAL T-STAT
UH-2	15	480	3	1	51,225	910	8'-0"	Q-MARK, MODEL MUH-15-4, W/INTEGRAL T-STAT
UH-3	20	480	3	1	68,300	1320	8'-0"	Q-MARK, MODEL MUH-20-4, W/INTEGRAL T-STAT

EXHAUST FAN SCHEDULE							
ITEM NO.	LOCATION	CFM	S.P.	RPM	MOTOR	DESCRIPTION	MODEL
EF-1	LOCKER ROOMS	1200	0.125	905	½ HP	120 V-1ø BELT DRIVEN CABINET FAN, W/BIRD SCREEN	GREENHECK MODEL BCF-108
EF-2	ELEV. 0'-0"	20,100	0.125	804	3 HP	480 V-3ø BELT DRIVEN SIDE WALL FAN, W/WEATHER HOOD, BACKDRAFT DAMPER, &T-STAT.	GREENHECK MODEL SPNE-36
EF-3	ELEV. 14'-0"	26,300	0.125	750	5 HP	480 V-3ø BELT DRIVEN SIDE WALL FAN, W/WEATHER HOOD, BACKDRAFT DAMPER, &T-STAT.	GREENHECK MODEL SPNE-42
EF-4	ELEV. 28'-0"	13,000	0.125	560	1 HP	480 V-3ø BELT DRIVEN SIDE WALL FAN, W/WEATHER HOOD, BACKDRAFT DAMPER, &T-STAT.	GREENHECK MODEL SPNE-36
EF-5	ELEV. 40'-0"	20,000	0.125	804	3 HP	480 V-3ø BELT DRIVEN SIDE WALL FAN, W/WEATHER HOOD, BACKDRAFT DAMPER, &T-STAT.	GREENHECK MODEL SPNE-36
EF-6	ELEV. 54'-0"	9,000	0.125	680	¾ HP	480 V-3ø BELT DRIVEN SIDE WALL FAN, W/WEATHER HOOD, BACKDRAFT DAMPER, &T-STAT.	GREENHECK MODEL SPNE-30

WALL LOUVER SCHEDULE		
ITEM NO.	SIZE	DESCRIPTION
LV-1	4'-0"X 4'-0" X 6" DEEP	GALV. LOUVERS W/SEALS, AMERICAN WARMING & VENT MODEL LF-31A-A

HV-1 ELECTRICAL ROOM

ONE FLOOR MOUNTED PACKAGED HEATING & VENTILATING UNIT RATED AT 9000 CFM, 480 V-3ø, 60 HZ., 5 HP. WITH A 16 KW, 480 V-3ø, 60 HZ, ELECTRIC HEAT STRIP. FULLY WIRED WITH DISCONNECT SWITCH AND THERMOSTAT. UNIT SHALL BE BROD & MCCLUNG MODEL CRP-22 OR APPROVED EQUAL.

HV-2 LOCKER ROOMS

ONE FLOOR MOUNTED PACKAGED HEATING & VENTILATING UNIT RATED AT 1300 CFM, 480 V-3ø, 60 HZ., 2 HP. WITH A 34 KW, 480 V-3ø, 60 HZ, ELECTRIC HEAT STRIP. FULLY WIRED WITH DISCONNECT SWITCH AND THERMOSTAT. UNIT SHALL BE BROD & MCCLUNG MODEL CRP-12 OR APPROVED EQUAL.

AC-1 OFFICE

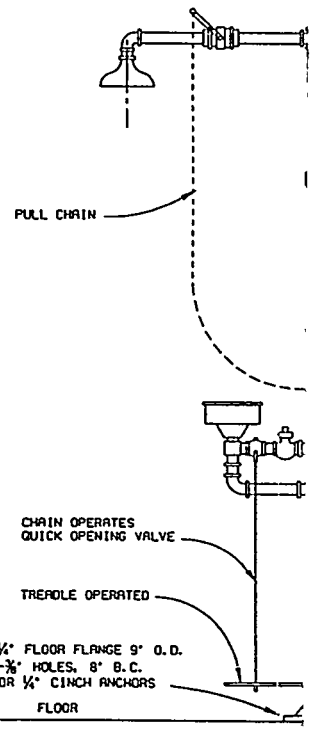
ONE THRU. WALL PACKAGED AIR CONDITIONING UNIT RATED AT 24,000 BTUH, WITH A 3 KW ELECTRIC HEAT STRIP, 480 V-3ø, 60 HZ & STARTER. UNIT SHALL BE CORRECT-AIR CORPERATION MODEL SC24 OR APPROVED EQUAL.

AC-2 CONTROL ROOM

ONE FLOOR MOUNTED PACKAGED AIR CONDITIONING UNIT RATED AT 31,000 BTUH SENSIBLE AND 46,200 BTUH TOTAL, WITH A 9KW ELECTRIC HEAT STRIP, 480V, 3ø, 60HZ, STARTER & THERMOSTAT UNIT SHALL BE ADDISON MODEL PC044 OR APPROVED EQUAL.

AC-3 LAB

ONE FLOOR MOUNTED PACKAGED AIR CONDITIONING UNIT RATED AT 31,100 BTUH SENSIBLE AND 46,200 BTUH TOTAL, WITH AN 18 KW ELECTRIC HEAT STRIP, 480 V-3ø, 60 HZ, STARTER AND THERMOSTAT. UNIT SHALL BE ADDISION MODEL PC044 OR APPROVED EQUAL.



DETAIL 1/1055070

INTERIOR SAFETY SHOWER AND EYE WASH

NO	DATE	REVISION	BY	APP	AFP	REFERENCE DRAWINGS	NUMBER	NOTES	DESCRIPTION COST A
									WORK COVERED BY THIS ACC CHARGED TO COST ACCOUNT

CONNECTION TO FIXTURES				
E	CW	HW	WASTE	VENT
	½"	—	3"/4"	2"
	½"	½"	1½"	1½"
	½"	½"	2"	1½"
-I	½"	—	1½"	1½"
	½"	½"	3 "	2"
	¾"	—	2"	1½"

SPECIFICATIONS

WATER CLOSET WC-1

FLOOR MOUNTED, SIPHON JET, VITREOUS CHINA, 18" HIGH, CLOSE-COUPLED CLOSET COMBINATION WITH ELONGATED RIM, VITREOUS CHINA CLOSET TANK WITH FITTINGS AND LEVER FLUSHING VALVE, BOLT CAPS. "AMERICAN STANDARD" CADET NO. 2108.488 OR EQUAL.

SOLID WHITE PLASTIC SEAT WITH OPEN FRONT AND COVER, BRASS BOLTS.

URINAL UR-1

EACH URINAL SHALL BE "AMERICAN STANDARD" NO. 6561.017 TRIMBROOK WHITE VITREOUS CHINA, WATER SAVER, SIPHON JET WITH ¾" TOP SPUD, FLUSHING RIM, EXTENDED STALL SIDE, OUTLET CONNECTION THREADED 2" INSIDE, AND WALL HANGERS WITH FLUSH VALVE

LAVATORY L-1

LAVATORY SHALL BE "AMERICAN STANDARD" MODEL "AQUALYN" 0476.028.20" X 18" WITH CONCEALED ARMS, FLAT SLAB VITREOUS CHINA WITH FRONT OVERFLOW. FAUCET HOLES ON 4" CENTER. PROVIDE 4" CENTERSET FAUCET WITH VALVES WITH RENEWABLE SEATS. FITTINGS SHALL INCLUDE ½" MALE THREADED INLETS, COUPLING NUTS, 4 ½" SPOUT WITH AERATOR WITH 2.5 GPM FLOW RESTRICTOR, LESS POP-UP DRAIN.

FLOOR DRAIN FD-1

12" HEAVY DUTY DRAIN. DRAIN SHALL BE DUCO CAST IRON BODY AND FLASHING COLLAR WITH NICKEL BRONZE ADJUSTABLE STRAINER HEAD. BOTTOM OUTLET. "ZURN" Z-521 SERIES.

FLOOR DRAIN FD-2

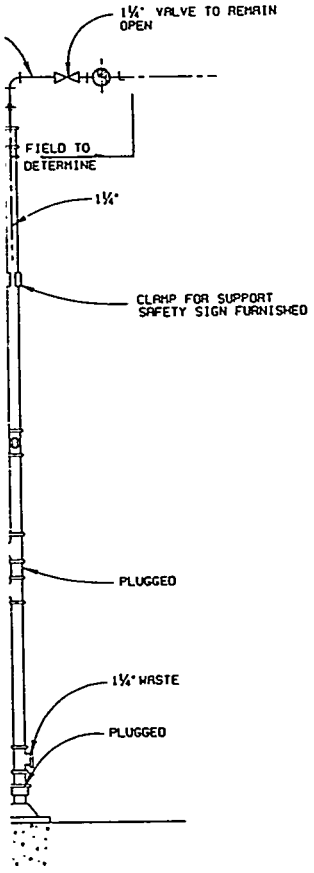
10" MEDIUM DUTY DRAIN. DRAIN SHALL BE DUCO CAST IRON BODY AND FLASHING COLLAR WITH POLISHED BRONZE ADJUSTABLE STRAINER HEAD. "ZURN" Z8-525 SERIES.

ELECTRIC WATER HEATER WH-1

HEATER SHALL BE RATED AT 9 KW, 240V, 1 PHASE, 60 CYCLE. HEATER SHALL HAVE A MAXIMUM PRESSURE OF 150 PSI AND A NOMINAL STORAGE TANK CAPACITY OF 40 GAL.. ALL INTERNAL SURFACES OF THE HEATER EXPOSED TO WATER SHALL BE GLASS LINED. ELECTRIC HEATING ELEMENT SHALL BE ZINC PLATED COPPER SHEATH, SCREW-IN DESIGN. HEATER SHALL HAVE 10-YEAR LIMITED WARRANTY. WATER HEATER SHALL BE LOCHINVAR MODEL ESA-040 OR APPROVED EQUAL.

ELECTRIC WATER HEATER WH-2

HEATER SHALL BE RATED AT 1.5 KW, 120V, 1 PHASE, 60 CYCLE. HEATER SHALL HAVE A MAXIMUM PRESSURE OF 150 PSI AND A NOMINAL STORAGE TANK CAPACITY OF 6 GAL. ALL INTERNAL SURFACES OF THE HEATER EXPOSED TO WATER SHALL BE GLASS LINED. ELECTRIC HEATING ELEMENT SHALL BE ZINC PLATED COPPER SHEATH, SCREW-IN DESIGN. HEATER SHALL HAVE 10-YEAR LIMITED WARRANTY. UNDER-COUNTER TYPE. LOCHINVAR MODEL JRC-600E OR APPROVED EQUAL.



SHOWER SH-1

CABINET SHALL BE SINGLE ACCESS, FRONT OPENING WITH A ONE PIECE, 6" HIGH TERRAZZO FLOOR. NOMINAL DIMENSIONS ARE 36" X 36" X 82". CABINET TO BE FURNISHED WITH PRESSURE-EQUALIZING VALVE WITH SHOWER HEAD, ARM AND FLANGE. STAINLESS STEEL CURTAIN ROD WITH CHROMIUM-PLATED BRASS BRACKETS, CURTAIN AND CHROMIUM-PLATED BRASS SOAP DISH. SHOWER HEAD RATED AT 4 GPM. FIAT PRODUCTS, INC., COMMANDER MODEL 86 OR APPROVED EQUAL.

MOP RECEPTOR M.R.

THE UNIT SHALL HAVE 10" HIGH WALLS WITH NOT LESS THAN 1" WIDE SHOULDERS AND AN INTEGRATED MOLDED SHELL 10⅜" WIDE. THE FACTORY INSTALLED DRAIN BODY SHALL BE STAINLESS STEEL WITH LEAD CAULKED JOINT TO ACCEPT A 2" PIPE WITH OPTIONAL FLAT STRAINER. UNIT SHALL BE 36"X24"X10"HIGH UNIT SHALL BE MOLDED-STONE MSD-3624, FIAT PRODUCTS, INC. OR APPROVED EQUAL.

EMERGENCY SHOWER AND EYE WASH ESH-1

EMERGENCY SHOWER AND EYE WASHES TO BE ALL STAINLESS STEEL WITH FOOT OPERATED EYE-WASH. FREE-STANDING, SELF-CLEANING, NON-CLOGGING EYE AND FACE WASH WITH QUICK OPENING, FULL-FLOW VALVES RATED AT 22 GPM. VALVES SHALL BE SELF CLOSING TYPE. "HAWS" MODEL 8300 SERIES OR APPROVED EQUAL.

ELECTRIC WATER COOLER EWC-1

ELECTRIC WATER COOLER SHALL BE SELF-CONTAINED, WALL HUNG AND MECHANICALLY REFRIGERATED ELECTRIC WATER COOLER AND SHALL CONFORM TO ARI-1010. SHALL USE ONE OF THE HALOGENATED HYDROCARBONS AS A REFRIGERANT, AND SHALL HAVE A CAPACITY TO DELIVER A MINIMUM OF 9.2 GPH OF 50 DEGREE F WATER WHEN SUPPLIED WITH 80 DEGREE F INLET WATER AND A 90 DEGREE F ROOM TEMPERATURE. WATER COOLER SHALL BE 120V, 1 PHASE. UNIT SHALL BE "OASIS" ON-A-WALL COOLER MODEL OPL8FCM OR APPROVED EQUAL.

)1, 0702

WORK THIS DWG WITH DWGS 10550701, & 10550702

	CONSTRUCTION APPROVAL	APPROVAL	DATE	SCALE: NONE	DATE
				DESIGNED BY: W. L. COWHER	06/01/9
				DRAWN BY: W. L. COWHER	06/10/9
				CHECKED BY:	
				APPROVED BY:	
:COUNT				APPROVED BY:	
OUNT					
BOVE					

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PITTSBURGH, PA 15222-1207
(412) 497-2000

UNITED STATES DEPARTMENT OF ENERGY
ADVANCED FROTH FLOATATION
H. V. A. C. AND PLUMBING SCHEDULES & DETAILS

JOB NO. 88107-250	DWG. NO. 10550703	REVISION R-

/user5/cad/88107250/10550703.dgnwher

MANUAL VALVES

- ANGLE VALVE
- BALL VALVE
- BUTTERFLY VALVE
- CHECK VALVE
- DIAPHRAM VALVE
- GATE VALVE
- GLOBE VALVE
- NEEDLE VALVE
- PLUG VALVE
- ROTARY VALVE
- 3-WAY VALVE
- 4-WAY VALVE
- KNIFE GATE VALVE
- PINCH VALVE

NOTE: VALVES SHOWN SOLID ARE CLOSED

CONTROL VALVES

- DIAPHRAM ACTUATOR
- DIAPHRAM ACTUATOR W/POSITIONER (IA)
- ELECTRIC MOTOR ACTUATOR (M)
- HYDRAULIC ACTUATOR (H)
- PNEUMATIC ACTUATOR (P)
- PNEUMATIC CYLINDER ACTUATOR
- REGULATOR W/EXTERNAL TAP
- SELF CONTAINED REGULATOR
- 2-WAY SOLENOID (S)
- 3-WAY SOLENOID (S)
- 4-WAY SOLENOID (S)
- PNEUMATIC KNIFE GATE (P)
- PNEUMATIC PINCH (P)

FC INDICATES "FAIL CLOSED"
FL INDICATES "FAIL LAST"
FO INDICATES "FAIL OPEN"

SAFETY RELIEFS

- PRESSURE SAFETY VALVE' (PSV)
- RUPTURE DISK (PRESSURE)
- VACUUM SAFETY VALVE (PSV)
- VACUUM & PRESSURE SAFETY VALVE

PIPING

- UTILITY PIPING
- PROCESS PIPING
- CHUTEWORK
- LINE BREAK;PIPING OR INSTR.
- INSULATED PIPING (COLD CONSERVATION) (CC)
- INSULATED PIPING (HEAT CONSERVATION) (HC)
- INSULATED PIPING (PERSONNEL PROTECTION) (PP)
- INSULATED & ELECTRIC TRACED PIPING (ET)
- INSULATED & SOLVENT TRACED (LT)
- INSULATED & STEAM TRACED PIPING (ST)
- INSULATED & JACKETED PIPING
- INSTRUMENT AIR SUPPLY & FILTER/REGULATOR (IA)
- SIGHT GLASS
- TRAP (T)
- AIR ELIMINATOR (AE)
- POP DRAIN (D)
- SAMPLE POINT (SP)
- VACUUM BREAKER (VB)
- BLIND FLANGE/FLANGES
- THREADED CAP
- DIAPHRAGM SEAL
- DRAIN
- EDUCTOR
- EXPANSION JOINT
- FLEXIBLE CONNECTION
- HOSE CONNECTION
- REDUCER
- SLIP BLIND
- TIE-IN
- VENT TO ATMOSPHERE
- "Y" STRAINER
- FLAME ARRESTOR

INSTRUMENT SIGNALS

- CAPILLARY TUBING
- ELECTRICAL SIGNAL
- HYDRAULIC
- PNEUMATIC TUBING
- SOFTWARE
- ELECTROMAGNETIC OR NUCLEAR

INSTRUMENTS

- PANEL MOUNTED INSTRUMENT
- REAR PANEL MOUNTED INSTRUMENT
- LOCALLY MOUNTED INSTRUMENT
- INSTRUMENT FURNISHED W/EQUIPMENT
- DISTRIBUTED CONTROL DISPLAYED ON CRT
- DISTRIBUTED CONTROL BLIND FUNCTION
- DISTRIBUTED CONTROL MANUAL BACKUP
- DISTRIBUTED CONTROL H: HIGH ALARM L: LOW ALARM
- LEVEL GAUGE BOARD (WITH SEAL) (LI)
- LEVEL GAUGE BOARD (WITHOUT SEAL) (LI)
- HAND OPERATED SWITCH (HS)
- LEVEL SIGHT GAUGE (LG)
- ONE INSTRUMENT W/MULTIPLE FUNCTIONS
- SELECTOR SWITCH (SS)
- ORIFICE PLATE (FE)
- RESTRICTING ORIFICE (RO)
- VORTEX SHEDDING
- FLOW TRANSMITTER (FT)
- ROTAMETER/PURGE METER (FI)
- TARGET FLOW METER (FT)

P&ID SHEET #2 OF 2	10-60-0202
P&ID SHEET #1 OF 2	10-60-0201

DESCRIPTION | COST ACCOUNT

INSTRUMENTS

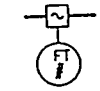
PITOT TUBE (OR ANNUBAR)

TURBINE OR PROPELLER FLOW SENSOR

MAGNETIC FLOWMETER (SENSOR ELEMENT)

WEIR

POSITIVE DISPLACEMENT FLOW TOTALIZING INDICATOR



SONIC FLOW TRANSMITTER (DOPPLER OR TRANSIT TIME)

FLOW STRAIGHTENING VANE

TEMPERATURE ELEMENT

TEMPERATURE ELEMENT FILLED SYSTEM

VENTURI

INTERLOCK

INTERLOCK (SOFTWARE OR ELECTRICAL)

LOGIC FUNCTION
S – SUM

TRANSDUCER FUNCTION
R – RESISTANCE
I – CURRENT
P – PNEUMATIC
MV – MILLIVOLTS

ANALOG INPUT

ANALOG OUTPUT

DIGITAL INPUT

DIGITAL OUTPUT

ABBREVIATIONS

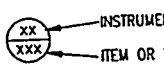
e	ENERGIZED
de	DE-ENERGIZED
FC	FAIL CLOSE
FO	FAIL OPEN
NC	NORMALLY CLOSED
NO	NORMALLY OPEN
PV	PROCESS VARIABLE
RSP	REMOTE SETPOINT (CASCADE)
M/A	MANUAL – AUTOMATIC
FLP	FAIL LAST POSITION
S40	SCHEDULE 40 PIPE THK.
S80	SCHEDULE 80 PIPE THK.
XS	EXTRA STRONG PIPE THK.
CT	0.0625" TUBING WALL THK.
A	PIPING SPEC. – CS; S40
F	FLEXIBLE HOSE
B	TUBING SPEC. – COPPER

LINE CODE

1"–CW–110–S40–A
- 1" – LINE SIZE
- CW – FLUID SYMBOL
- 110 – LINE NUMBER
- S40 – PIPING SCHEDULE
- A – PIPING SPECIFICATION

FLUID SYMBOLS

PREFIX	SERVICE		COMMENTS
BW	BLACK WATER	1"/FT.	
CC	CLEAN COAL	2"/FT.	
CW	CLARIFIED WATER	1/16"/FT.	
DM	DILUTE MEDIA	2"/FT.	
F	FLOCCULENT	—	
FW	FRESH WATER	1/16"/FT.	
HM	HEAVY MEDIA	2"/FT.	
IA	INSTRUMENT AIR	—	
M	MIDDLINGS	2"/FT.	
PA	PLANT AIR	—	
R	REFUSE	1"/FT.	
RC	RAW COAL	3"/FT.	
RT	REAGENT	—	
			NOTE:
			THIS COLUMN IS MINIMUM
			GRAVITY LINE SLOPES.



INSTRUMENT FUNCTION IDENTIFICATION SYMBOLS

	1st LETTER	2nd LETTER	3rd LETTER	4th LETTER	LAST LETTER
A	ANALYZER	ALARM	ALARM	ALARM	ALARM
B	BURNER (FLAME)				
C	CONTROL (LOOP)	CONTROLLER	CONTROLLER	CONTROLLER	CONTROLLER
D	DENSITY	DIFFERENTIAL			DRIVE OPERATOR
E	VOLTAGE				ELEMENT
F	FLOW	RATIO	FLOW	FLOW	
G	GAUGE	GAUGE			GLASS
H	HAND (MANUAL)		HIGH	HIGH	HIGH
I	AMPERES	INDICATOR			INDICATOR
J	POWER				MTR. PB & LGT.
K	TIME (COUNT)				
L	LEVEL	LEVEL	LOW	LOW	LOW
M	MOISTURE				METER
N	FLOAT SWITCH				
O	OPERATIONAL				
P	PRESSURE	PRESSURE	PRESSURE		PNEUMATIC
Q	SETTLING RATE	INTEGRATE	INTEGRATE	INTEGRATE	INTEGRATE
R	RECIRCULATION	RECORDER	RECORDER	RECORDER	RECORDER
S	SPEED, SOLENOID	SWITCH	SWITCH	SWITCH	SWITCH
T	TEMPERATURE				TRANSMITTER
U	TURBIDITY	MULTIVARIABLE			MULTIVARIABLE
V	VIBRATION	VALVE	VALVE	VALVE	VALVE
W	WEIGHT				WELL
X	TORQUE				TRANSDUCER
Y	LIMIT				TRANSDUCER
Z	POSITION				COMPUTER
pH	pH				

CONSTRUCTION APPROVAL	APPROVAL	DATE

SCALE: NONE	DATE
DESIGNED BY B. FERRIS	4/94
DRAWN BY M P MOROVICH	4/25/94
CHECKED BY	
APPROVED BY	
APPROVED BY	

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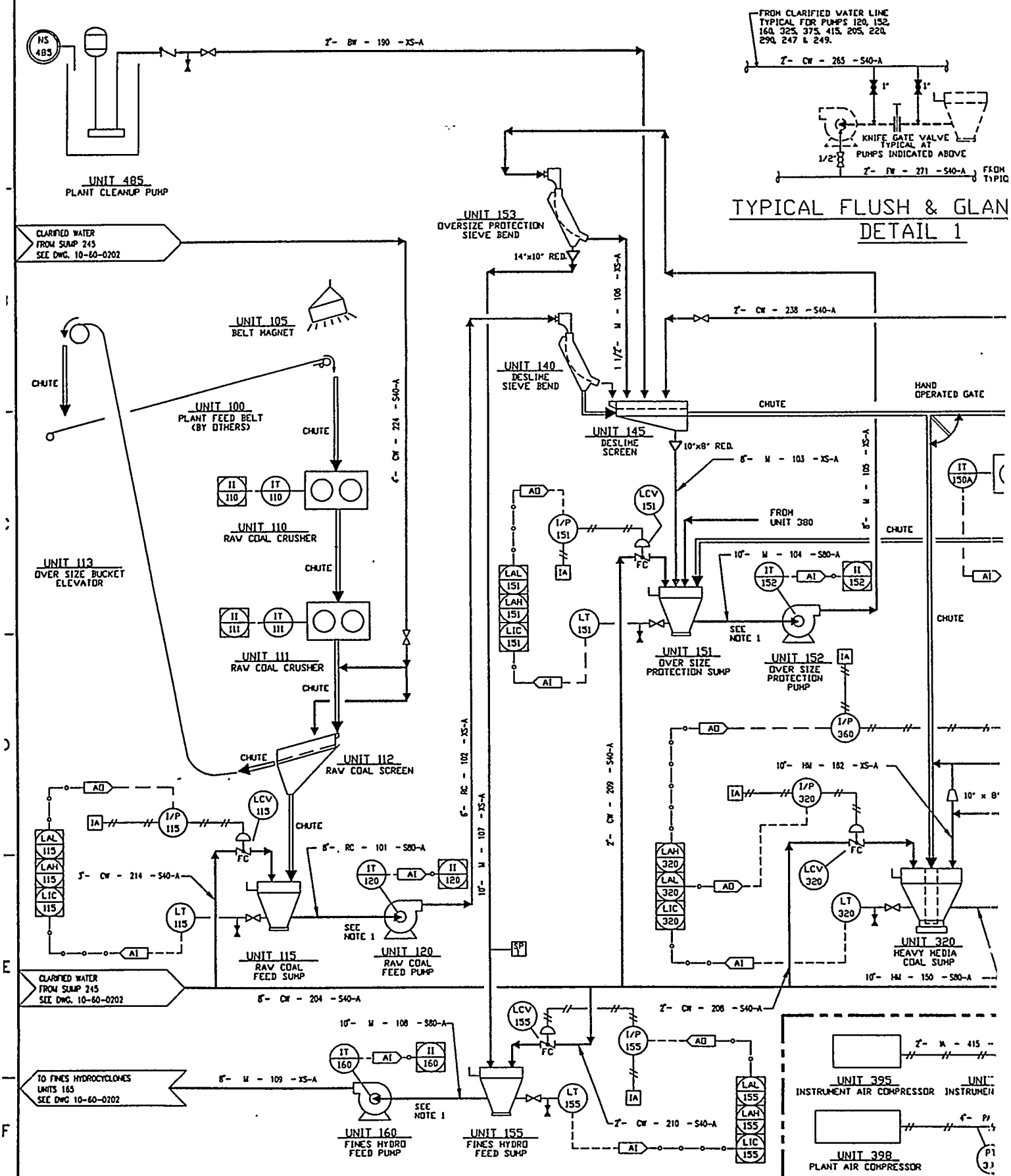
UNITED STATES DEPARTMENT OF ENERGY
ADVANCED FROTH FLOTATION PROCESS
P & ID SYMBOLS & LEGEND

JOB No. 88107–250	DWG. No. 10–60–0200	REVISION

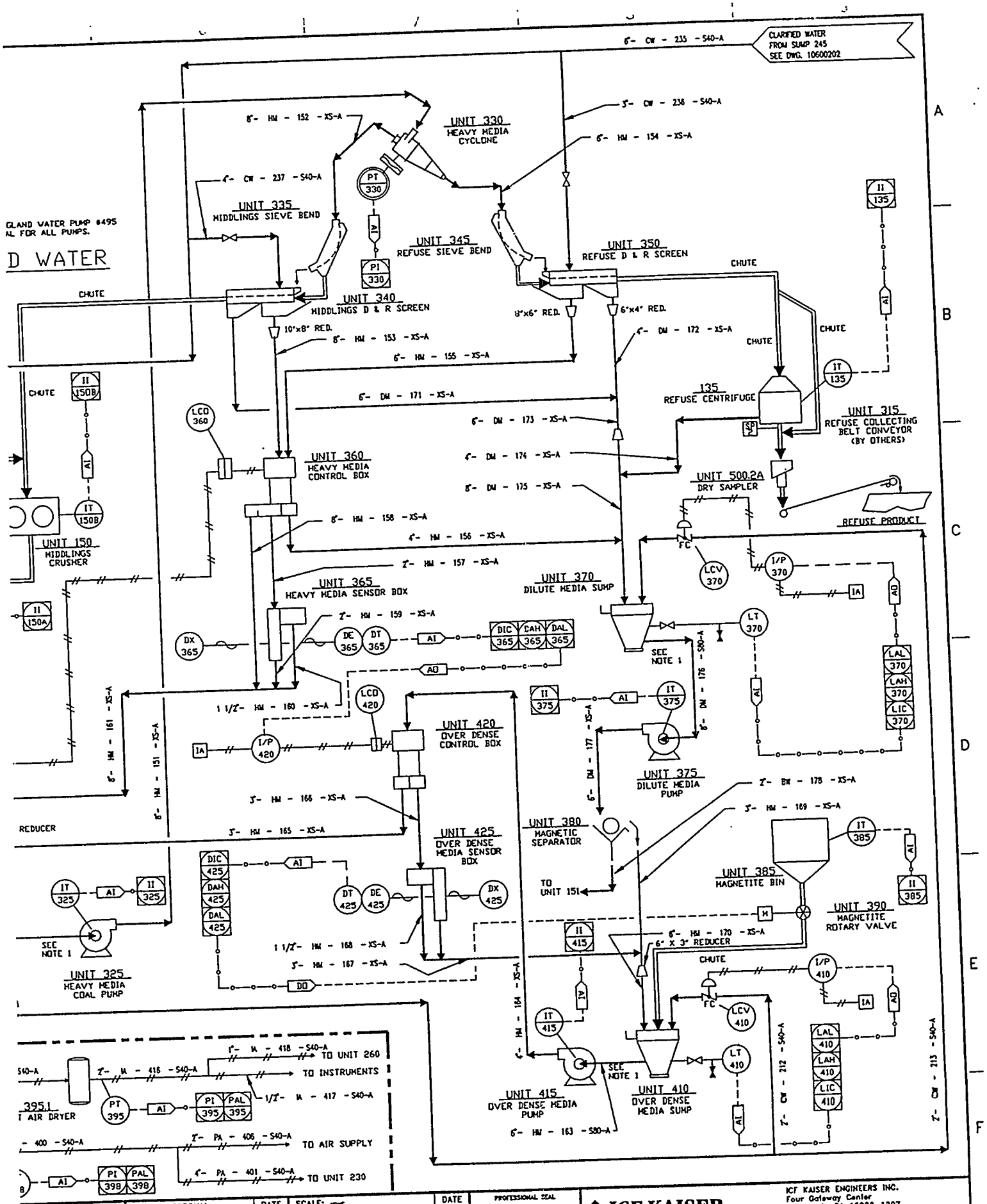


P&ID SYMBOLS & LEGEND	10-60-0200	
P&ID SHEET #2 OF 2	10-60-0202	

NOTE:

1. FOR PUMP SUCTION PIPING AND PUMP GLAND WATER PIPING SEE DETAIL 1 ON THIS DWG.

DESCRIPTION | COST ACCOUNT



CONSTRUCTION APPROVAL

APPROVAL	DATE	SCALE: NONE	DATE
		DESIGNED BY R. FERRIE	4/94
		DRAWN BY M P MCKOWEN	4/28/94
		CHECKED BY	
		APPROVED BY	
		APPROVED BY	

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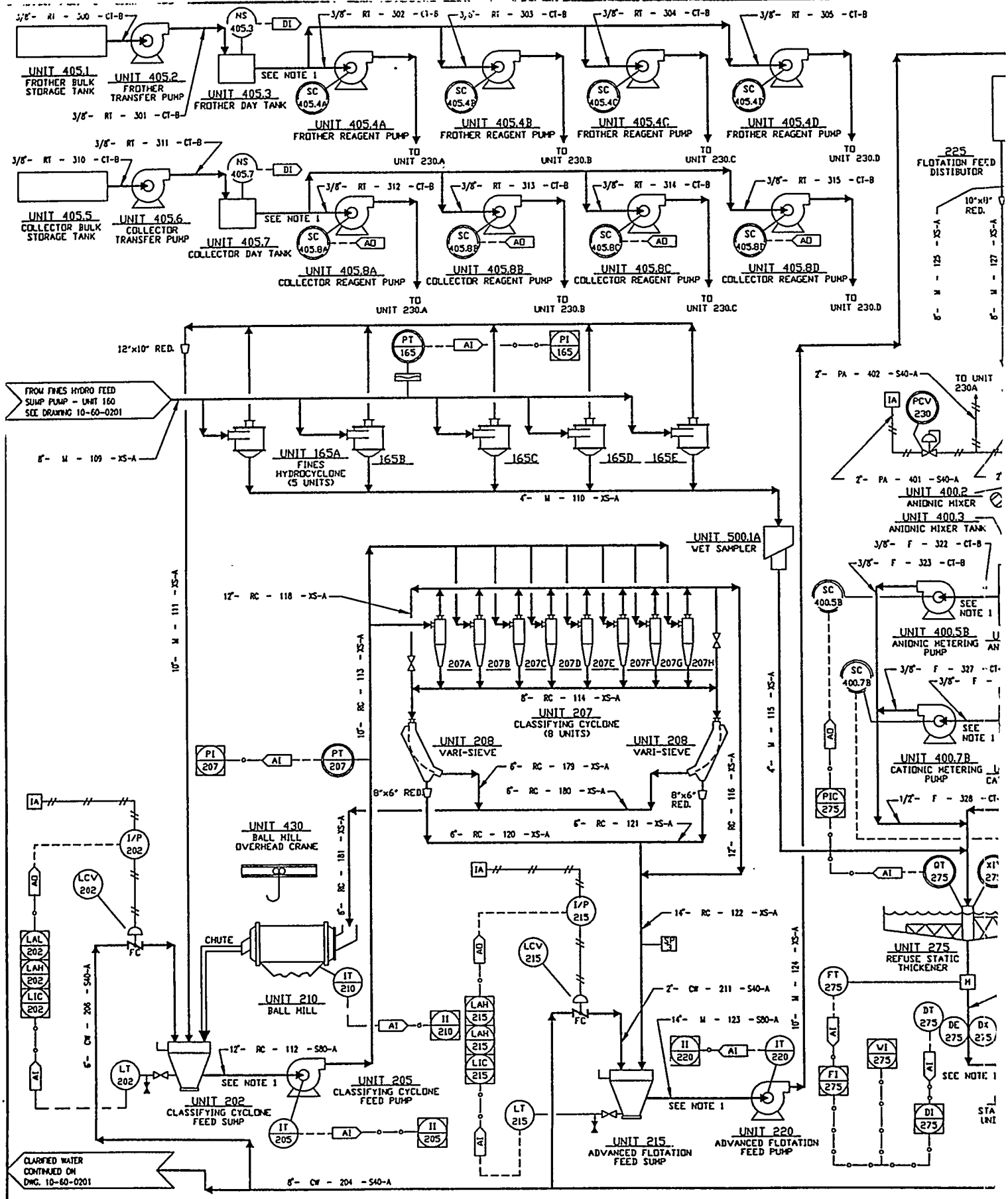
Pittsburgh, PA 15222-1207
(412) 497-2000, FAX (412) 497-2212

UNITED STATES DEPARTMENT OF ENERGY
ADVANCED FROTH FLOTATION PROCESS
PIPING & INSTRUMENTATION DIAGRAM
SHEET 1 OF 2

JOB No. 88107-250

DWG. No. 10-60-0201

REVISION

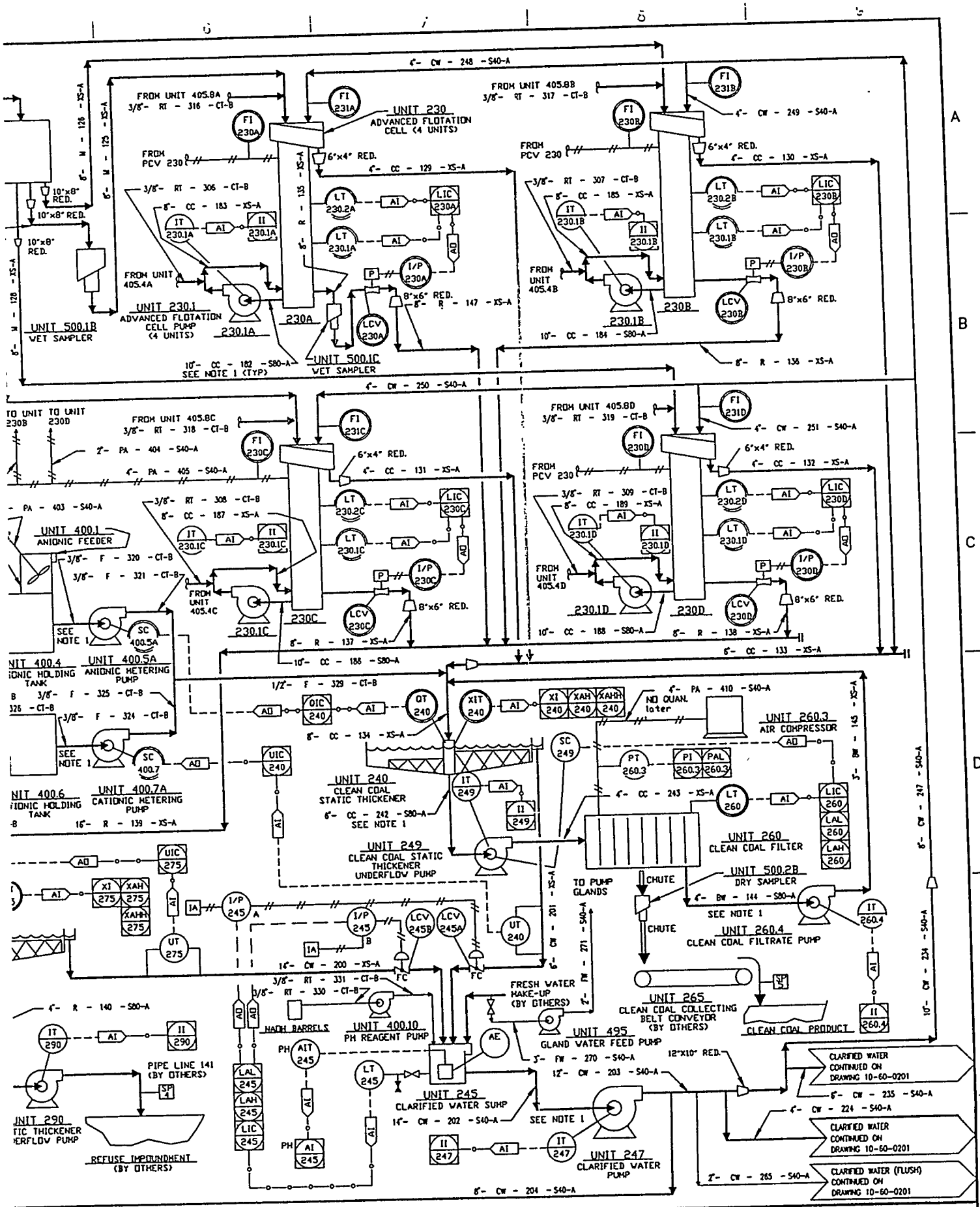


NOTE:

1. FOR PUMP SUCTION PIPING AND PUMP GLAND WATER PIPING SEE DETAIL 1 ON DRAWING 10-60-0201.

P&ID SYMBOLS & LEGEND	10-60-0200
P&ID SHEET #1 OF 2	10-60-0201

DESCRIPTION | COST ACCOUNT



CONSTRUCTION APPROVAL	APPROVAL	DATE	SCALE:	DATE
			DESIGNED BY B. FENNS	4/94
			DRAWN BY M P MOROVICH	4/12/94
			CHECKED BY	
			APPROVED BY	
			APPROVED BY	

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(412) 497-2000, FAX (412) 497-2212

UNITED STATES DEPARTMENT OF ENERGY
ADVANCED FROTH FLOTATION PROCESS
PIPING & INSTRUMENTATION DIAGRAM
SHEET 2 OF 2

JOB No. 88107-250 | DWG. No. 10-60-0202 | REVISION

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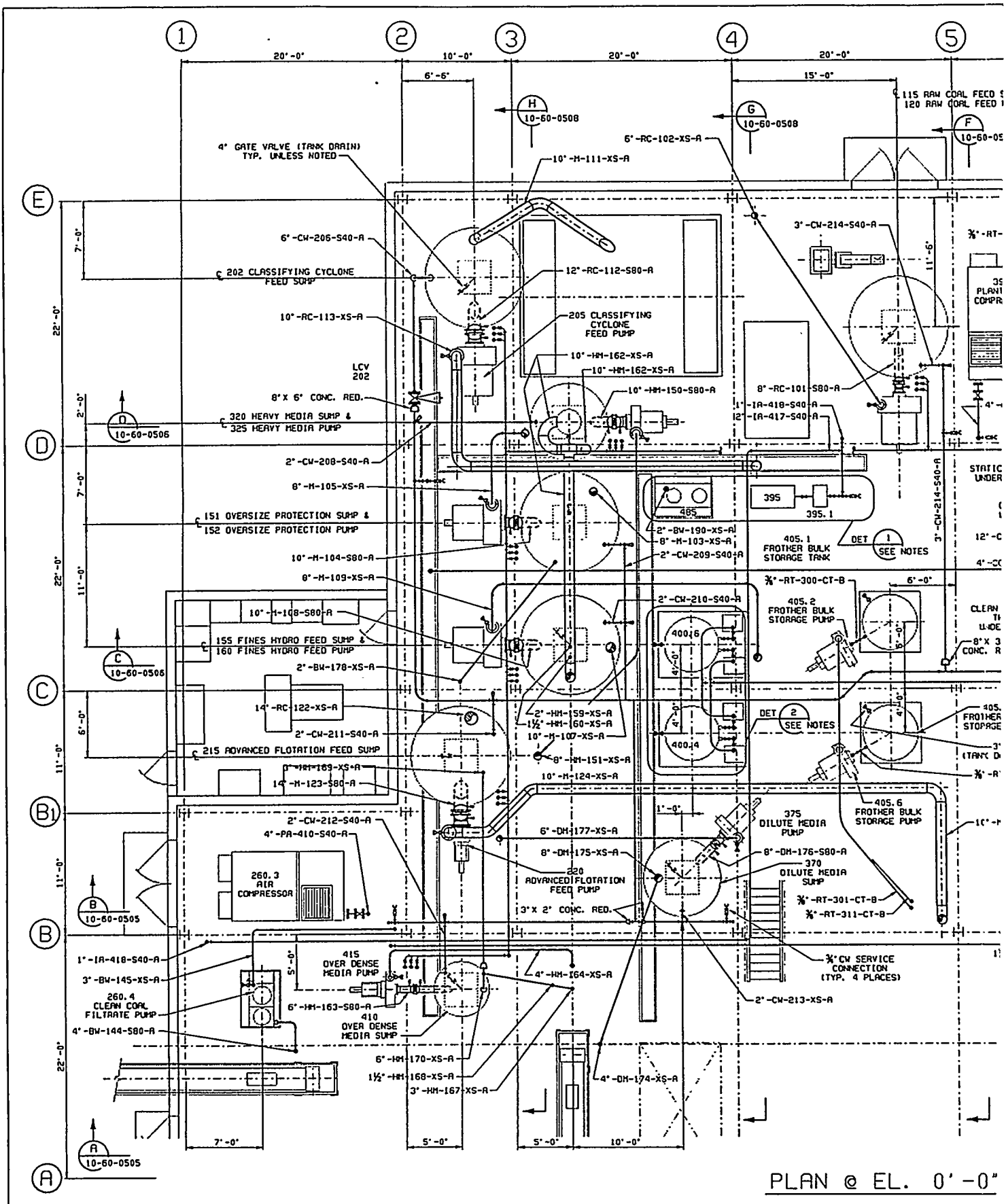
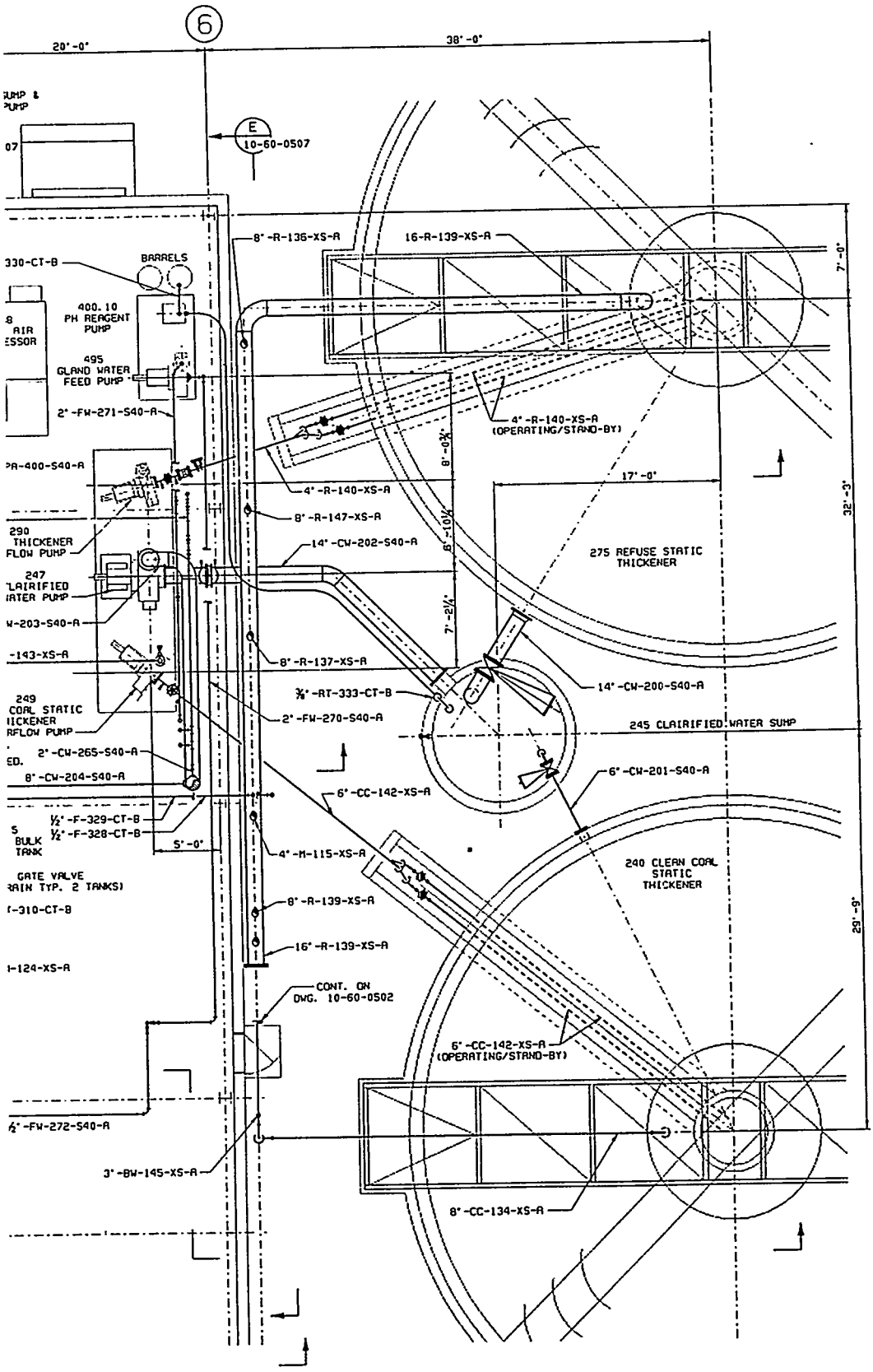


PLAN @ EL. 0'-0"

NO	DATE	REVISION	BY	CK	APP	APP	REFERENCE DRAWINGS	NUMBER	NOTES	DESCRIPTION COST
										WORK COVERED BY THIS A CHARGED TO COST ACCOUN



NOTES:

1. SEE PIPING SPECIFICATION NO. 88107-99601101.
2. WORK THIS DRAWING WITH DRAWINGS 10-60-0502 THRU 10-60-0508.

CONSTRUCTION APPROVAL	APPROVAL	DATE	SCALE: 3/16" = 1'-0"	DATE
			DESIGNED BY: J. R. LARKIN	6/8/94
			DRAWN BY: J. R. LARKIN	6/8/94
			CHECKED BY:	
			APPROVED BY:	
			APPROVED BY:	

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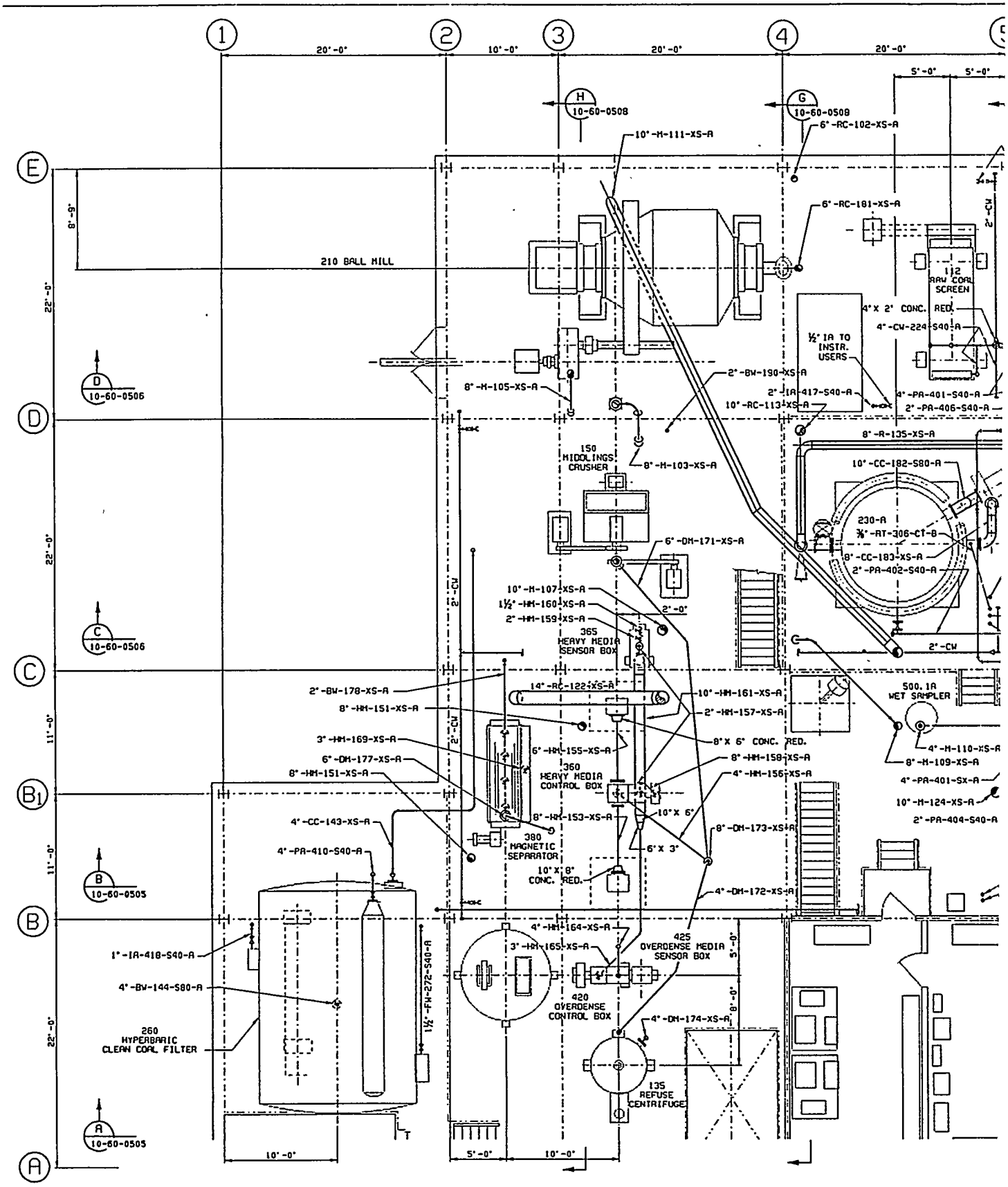
UNITED STATES DEPARTMENT OF ENERGY
ADVANCED FROTH FLOTATION PROCESS
PLAN AT ELEV. 0'-0"
PIPING ARRANGEMENT

JOB NO. 88107-250	DWG. NO. 10-60-0501	REV R-

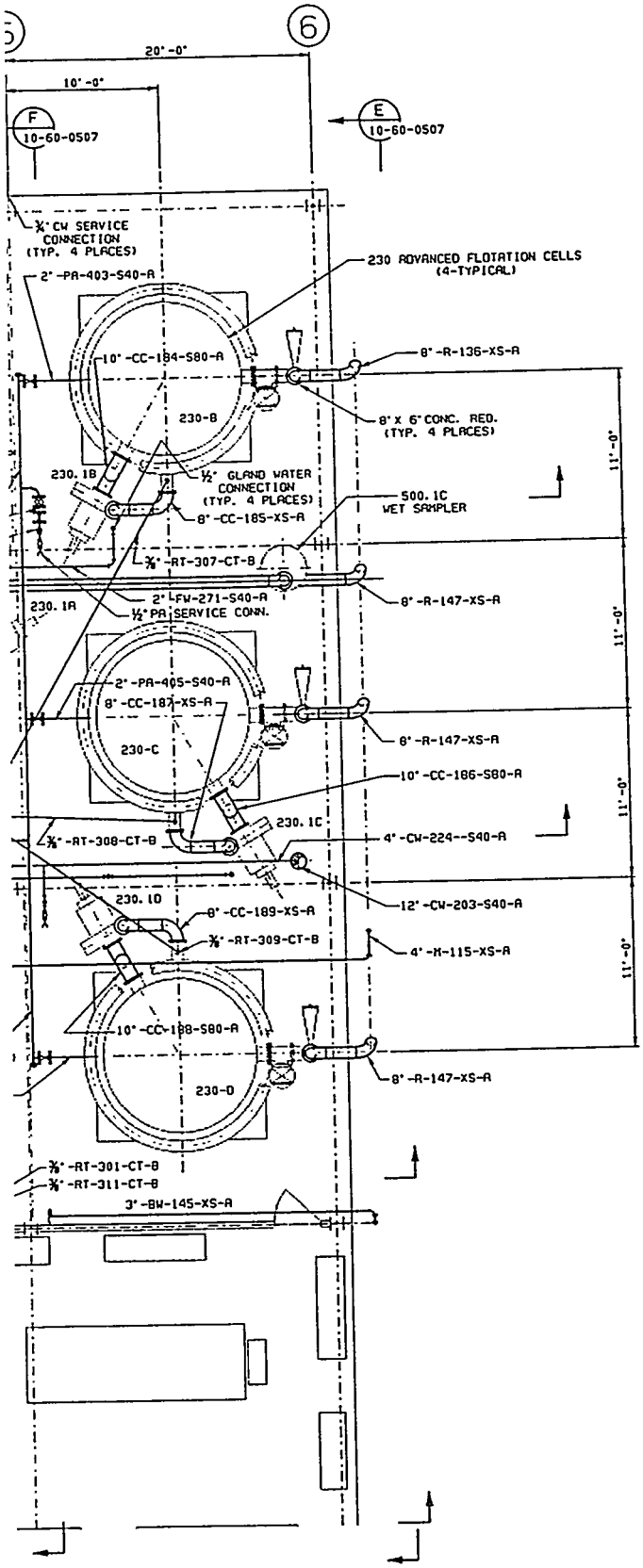
ACCOUNT
ACCOUNT
ABOVE

J:\prj\88107250\10600501.dgn rebar
19-JUL-1994 08



PLAN @ EL. 14'-0"

NO	DATE	REVISION	BY	CH	APP	APP	REFERENCE DRAWINGS	NUMBER	NOTES	DESCRIPTION COST
										WORK COVERED BY THIS A CHARGED TO COST ACCOUN



CONSTRUCTION APPROVAL	APPROVAL	DATE	SCALE: ⅜" = 1'-0"	DATE
			DESIGNED BY: J. R. LARKIN	6/8/94
			DRAWN BY: J. R. LARKIN	6/8/94
			CHECKED BY:	
			APPROVED BY:	
			APPROVED BY:	

ACCOUNT
ACCOUNT ABOVE

INFORMATION CONFIDENTIAL: ALL PLANS, DRAWINGS, SPECIFICATIONS AND/OR INFORMATION FURNISHED HEREWITH ARE AND SHALL REMAIN THE PROPERTY OF ICF KAISER ENGINEERS INC. AND SHALL BE HELD CONFIDENTIAL AND SHALL NOT BE USED FOR ANY PURPOSE NOT PROVIDED FOR IN AGREEMENTS WITH ICF KAISER ENGINEERS INC.

PROFESSIONAL SEAL

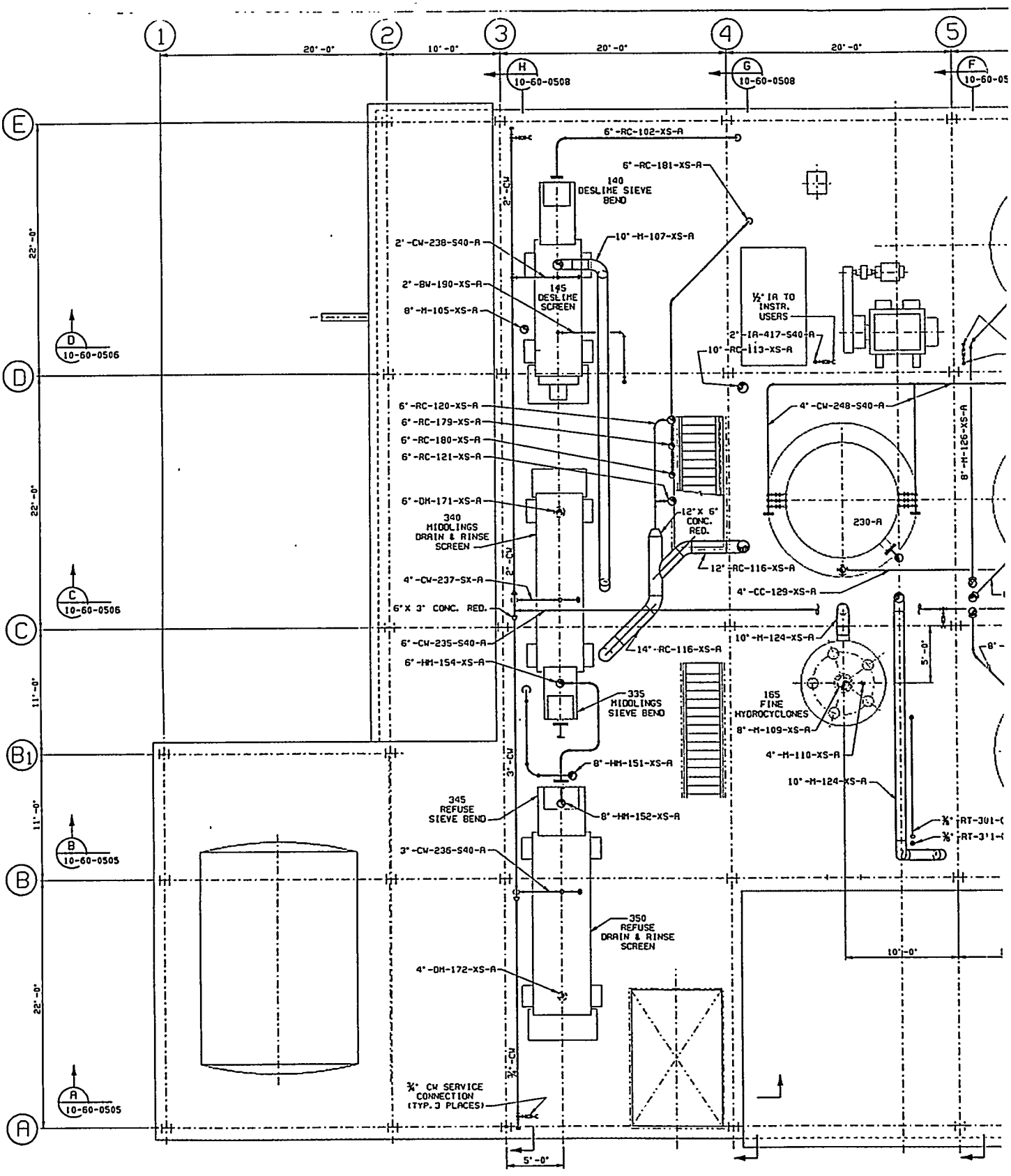
ICF KAISER

ICF KAISER ENGINEERS, INC.
FOUR GATEWAY CENTER
PITTSBURGH, PA 15222-1207
(412) 497-2000

UNITED STATES DEPARTMENT OF ENERGY
ADVANCED FROTH FLOTATION PROCESS
PLAN AT ELEV. 14'-0"
PIPING ARRANGEMENT

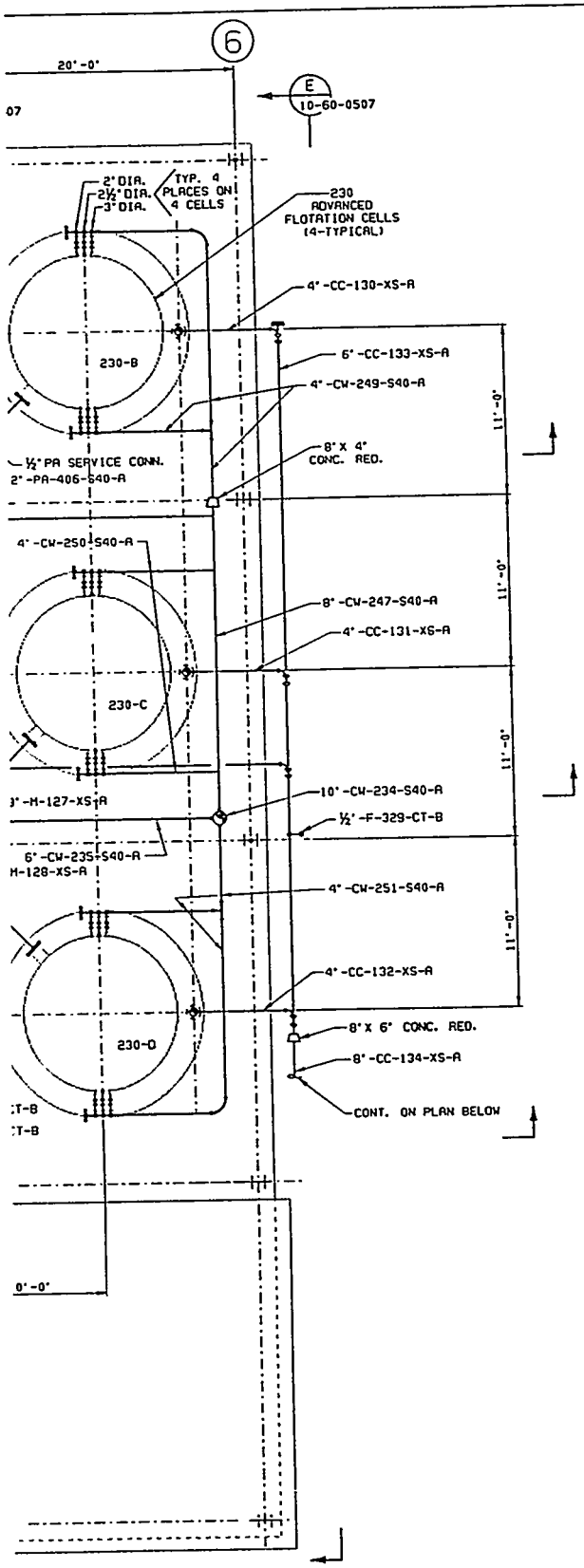
JOB NO. 88107-250	DWG. NO. 10-60-0502	REVISED R-

J:\prj\88107250\10600502.dgn rebar
19-JUL-1994 09:0



PLAN @ EL. 28'-0"

NO	DATE	REVISION	BY	CK	APP	REFERENCE DRAWINGS	NUMBER	NOTES	DESCRIPTION / COST
									WORK COVERED BY THIS A CHARGED TO COST ACCOUN



CONSTRUCTION APPROVAL	APPROVAL	DATE	SCALE: 3/16" = 1'-0"	DATE
			DESIGNED BY: J. R. LARKIN	6/8/94
			DRAWN BY: J. R. LARKIN	6/8/94
			CHECKED BY:	
			APPROVED BY:	
			APPROVED BY:	

ACCOUNT

ACCOUNT ABOVE

INFORMATION CONFIDENTIAL: ALL PLANS, DRAWINGS, SPECIFICATIONS AND/OR INFORMATION FURNISHED HEREWITH ARE AND SHALL REMAIN THE PROPERTY OF ICF KAISER ENGINEERS INC. AND SHALL BE HELD CONFIDENTIAL AND SHALL NOT BE USED FOR ANY PURPOSE NOT PROVIDED FOR IN AGREEMENTS WITH ICF KAISER ENGINEERS INC.

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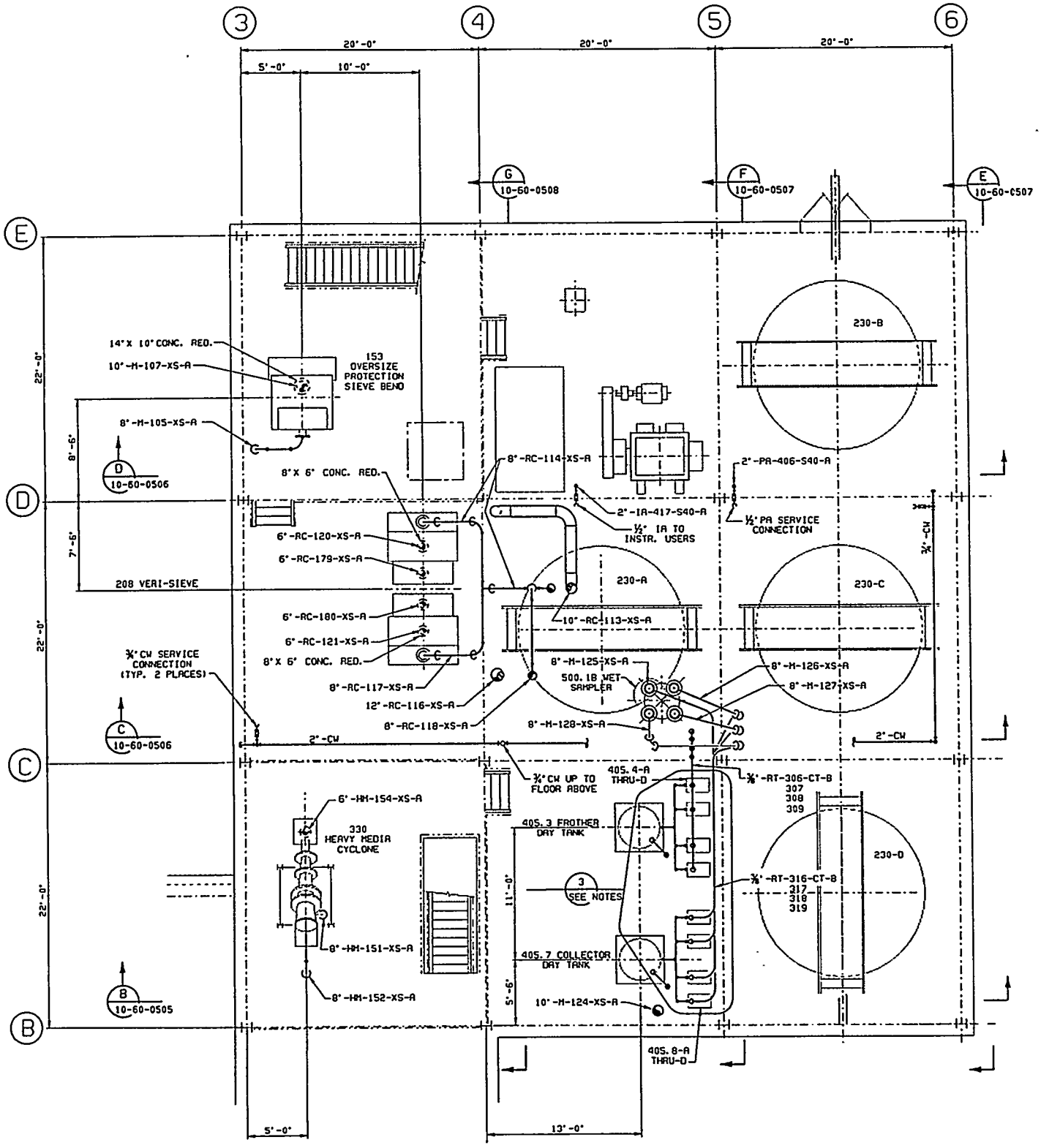
ICF KAISER ENGINEERS, INC.
FOUR GATEWAY CENTER
PITTSBURGH, PA 15222-1208
(412) 497-2000

UNITED STATES DEPARTMENT OF ENERGY
ADVANCED FROTH FLOTATION PROCESS
PLAN AT ELEV. 28'-0"
PIPING ARRANGEMENT

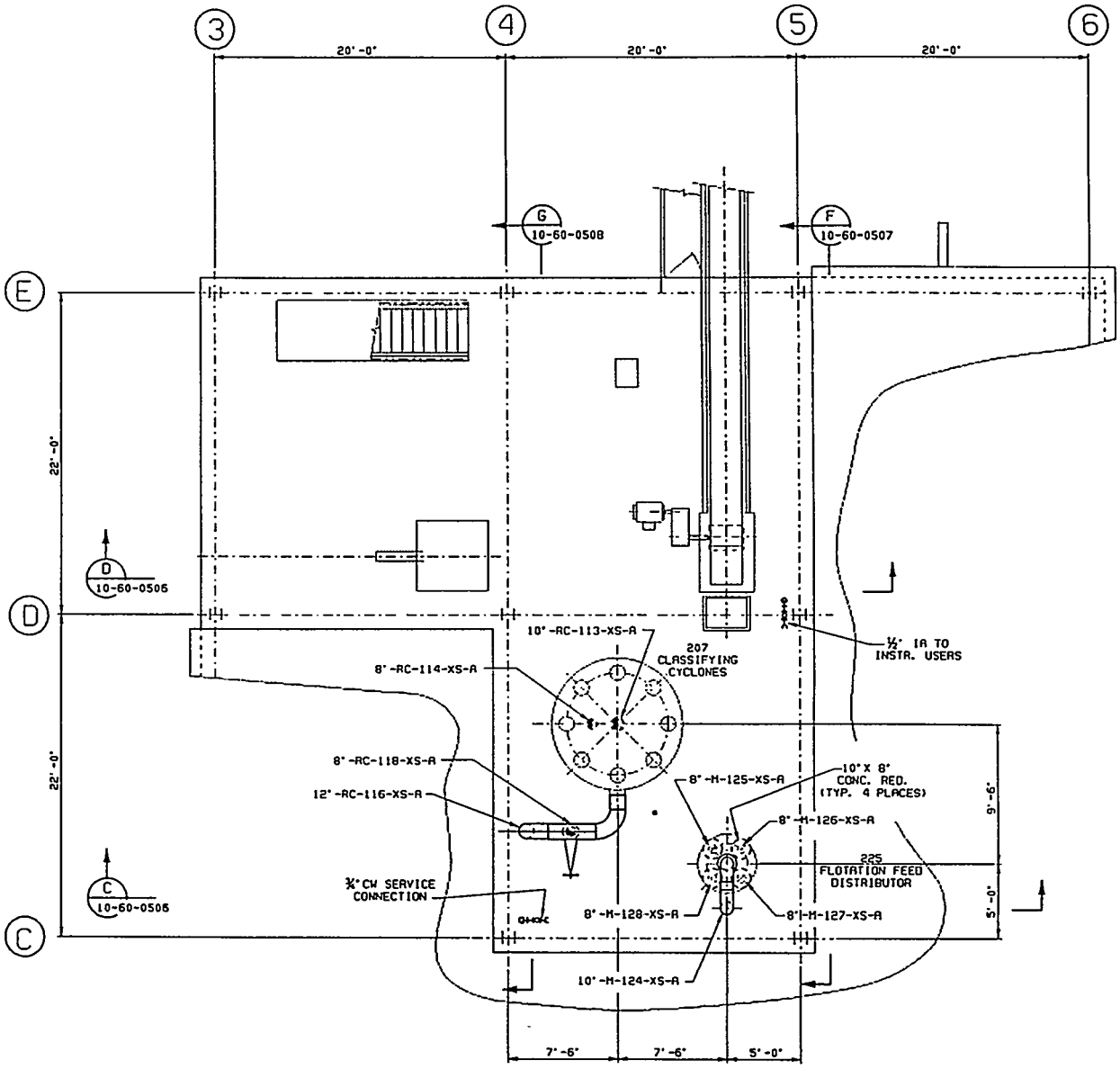
JOB NO. 88107-250	DWG. NO. 10-60-0503	R-

J:\prj\88107250\10600503.dgn rebar 15-JUN-1994 10:



PLAN @ EL. 40'-0"

NO	DATE	REVISION	BY	APP	APP	REFERENCE DRAWINGS	NUMBER	NOTES	DESCRIPTION COST A WORK COVERED BY THIS ACC CHARGED TO COST ACCOUNT



PLAN @ EL. 54'-0'

CONSTRUCTION APPROVAL	APPROVAL	DATE	SCALE: 3/16" = 1'-0"	DATE	PROFESSIONAL SEAL
			DESIGNED BY: J. R. LARKIN	5/8/94	
			DRAWN BY: J. R. LARKIN	5/8/94	
			CHECKED BY:		
			APPROVED BY:		
			APPROVED BY:		

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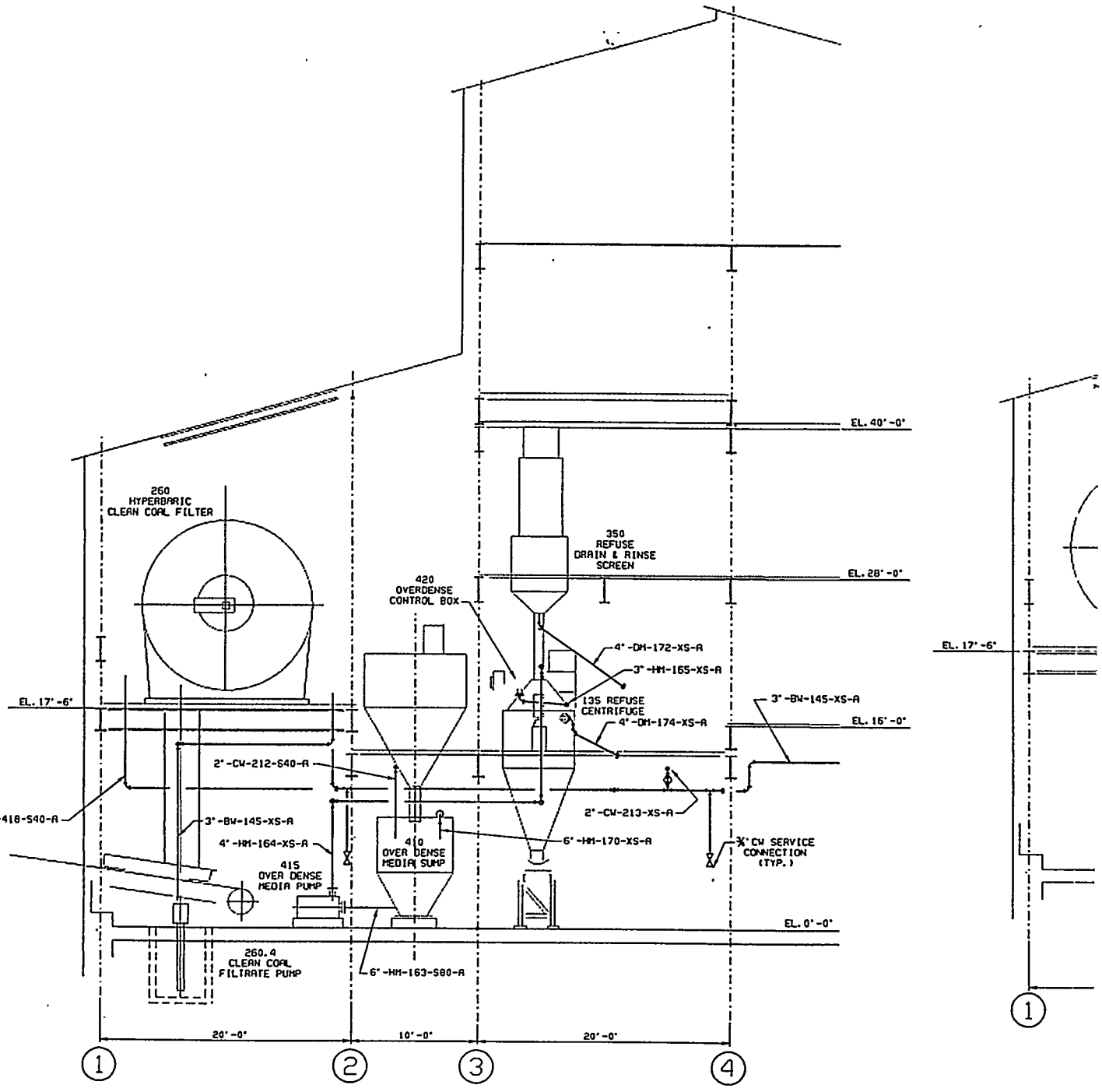
FOUR GATEWAY CENTER
PITTSBURGH, PA 15222-1207
(412) 497-2000

UNITED STATES DEPARTMENT OF ENERGY
ADVANCED FROTH FLOTATION PROCESS
PLAN AT ELEV. 40'-0" AND ELEV. 54'-0"
PIPING ARRANGEMENT

JOB NO. 88107-250	DWG. NO. 10-60-0504	R-

J:\prj\88107250\10600504.dgn reber

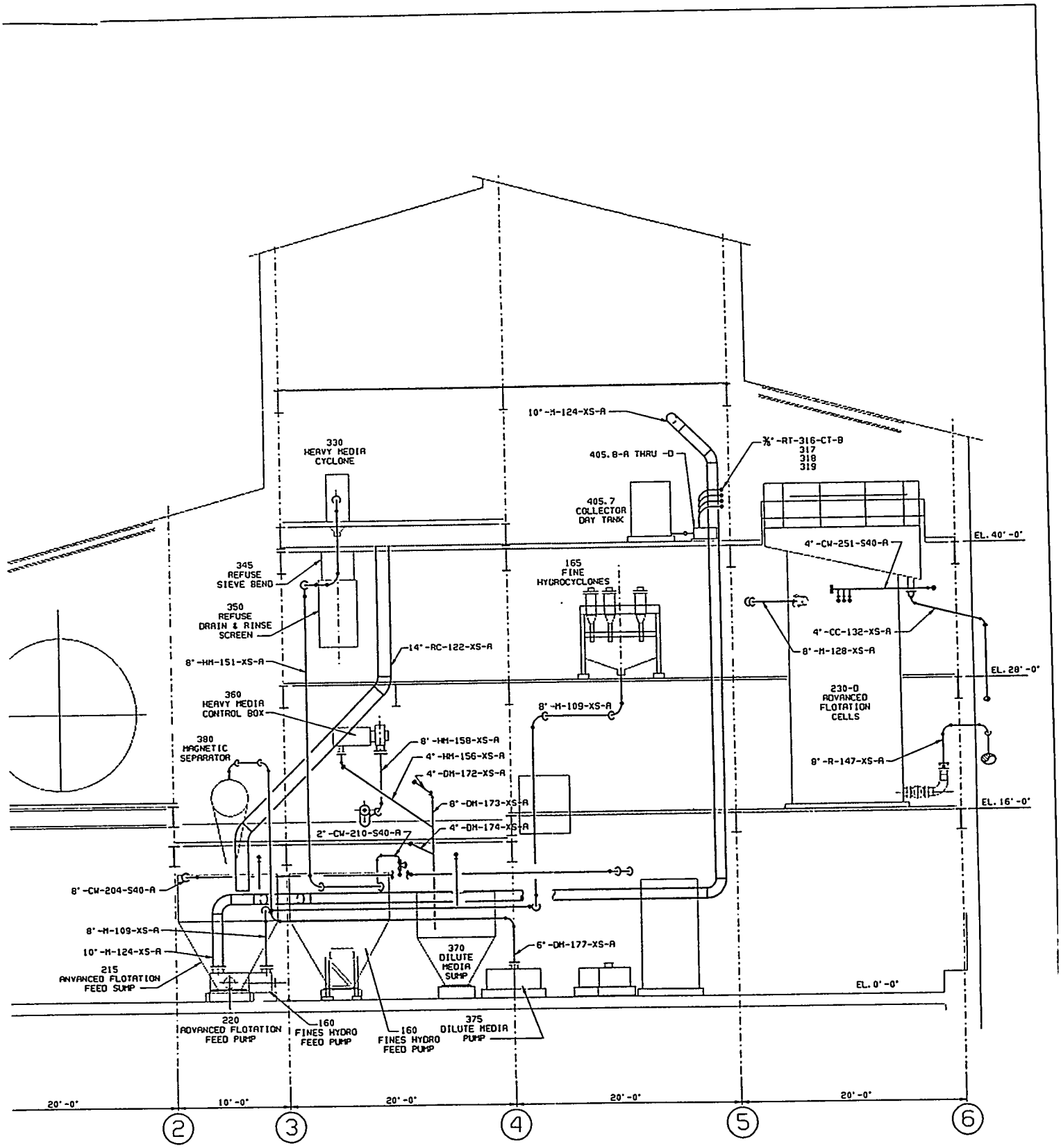


SECTION (A)

@ COLUMN A

10-60-0501 THRU 10-60-0504

NO	DATE	REVISION	BY	CHK	APP	APP	REFERENCE DRAWINGS	NUMBER	NOTES	DESCRIPTION COST A
										WORK COVERED BY THIS ACC CHARGED TO COST ACCOUNT



SECTION B
@ COLUMN B
10-60-0501 THRU 10-60-0504

CONSTRUCTION APPROVAL	APPROVAL	DATE	SCALE: ⅜"=1'-0"	DATE
			DESIGNED BY: L. HARRIS	7/1/94
			DRAWN BY: L. HARRIS	7/1/94
			CHECKED BY:	
			APPROVED BY:	
			APPROVED BY:	

PROFESSIONAL SEAL

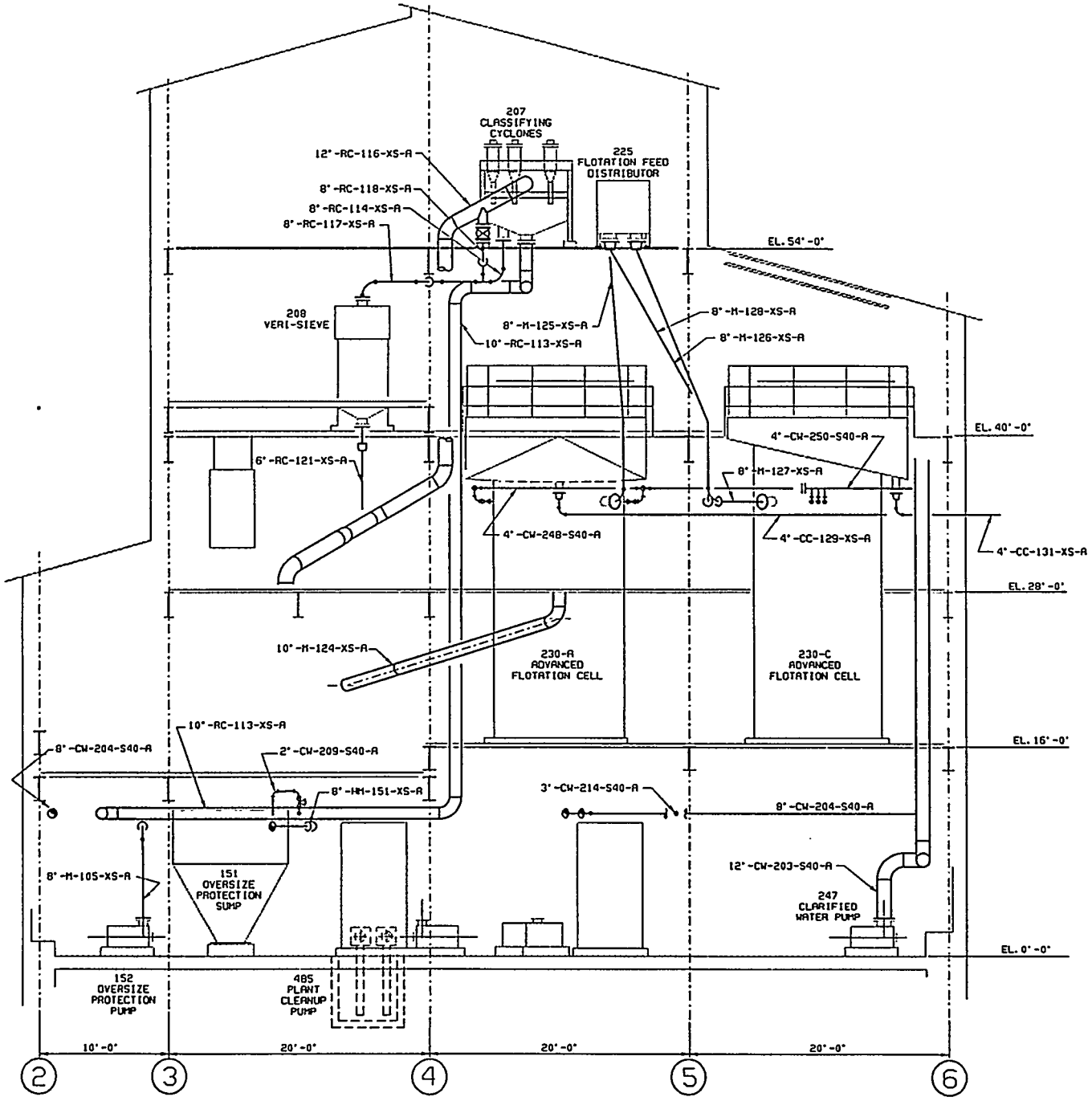
ICF KAISER

ICF KAISER ENGINEERS, INC.
FOUR GATEWAY CENTER
PITTSBURGH, PA 15222-1207
(412) 497-2000

UNITED STATES DEPARTMENT OF ENERGY
ADVANCED FROTH FLOTATION PROCESS
SECTIONS A & B
PIPING ARRANGEMENT

JOB NO. 88107-250 | DWG. NO. 10-60-0505 | REVISION R-

INFORMATION CONFIDENTIAL: ALL PLANS, DRAWINGS, SPECIFICATIONS AND/OR INFORMATION FURNISHED HEREWITH ARE AND SHALL REMAIN THE PROPERTY OF ICF KAISER ENGINEERS INC. AND SHALL BE HELD CONFIDENTIAL AND SHALL NOT BE USED FOR ANY PURPOSE NOT PROVIDED FOR IN AGREEMENTS WITH ICF KAISER ENGINEERS INC.

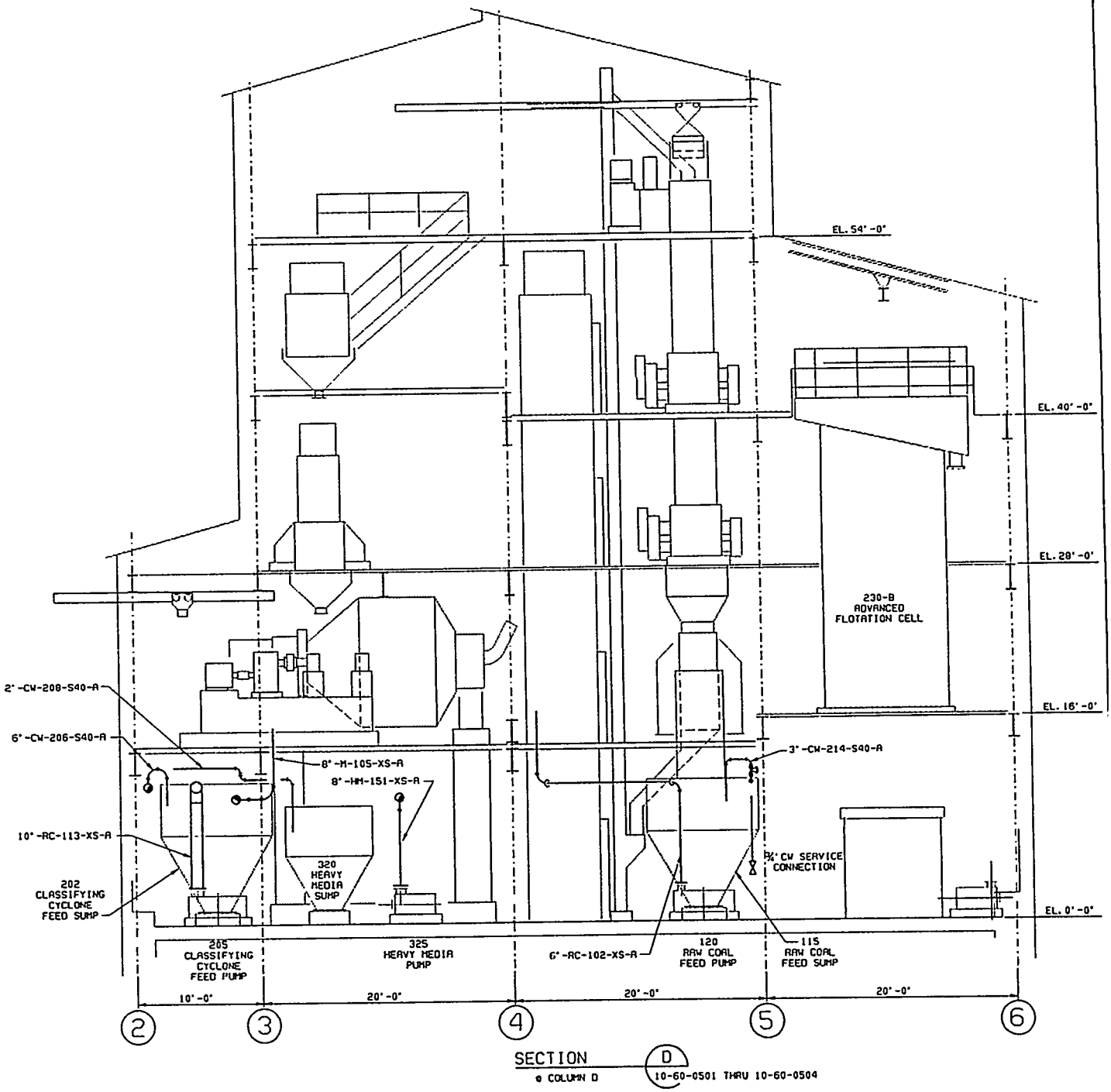


SECTION C

@ COLUMN C

10-60-0501 THRU 10-60-0504

NO	DATE	REVISION	BY	CHK	APP	APP	REFERENCE DRAWINGS	NUMBER	NOTES	DESCRIPTION COST A WORK COVERED BY THIS AC CHARGED TO COST ACCOUNT



SECTION D
@ COLUMN D
10-60-0501 THRU 10-60-0504

CONSTRUCTION APPROVAL	APPROVAL	DATE	SCALE: 3/16" = 1'-0"	DATE
			DESIGNED BY: L. HARRIS	7/1/94
			DRAWN BY: L. HARRIS	7/1/94
			CHECKED BY:	
			APPROVED BY:	
			APPROVED BY:	

PROFESSIONAL SEAL

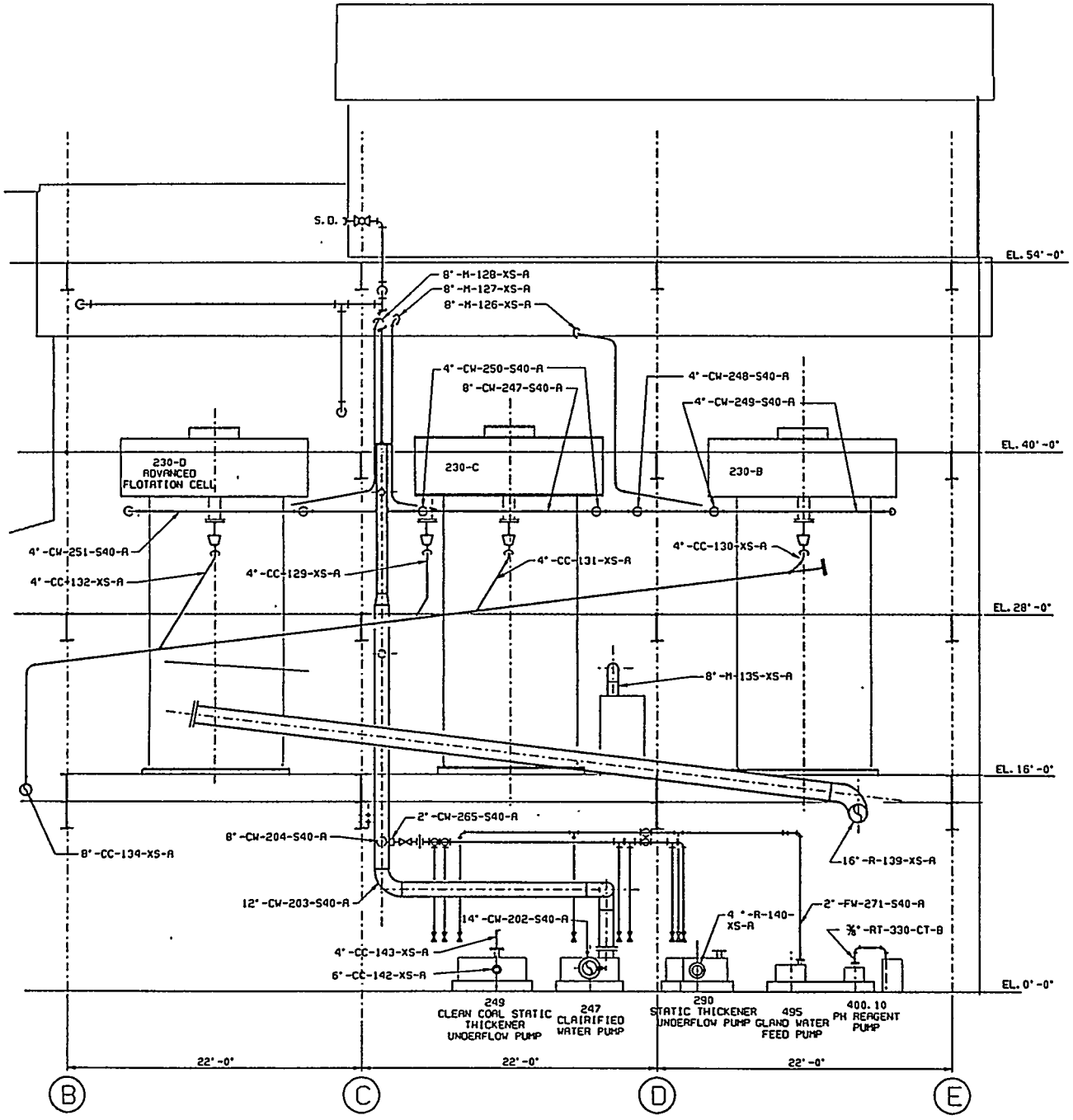
INFORMATION CONTAINED IN ALL PLANS, DRAWINGS, SPECIFICATIONS AND/OR INFORMATION FURNISHED HEREWITH ARE AND SHALL REMAIN THE PROPERTY OF ICF KAISER ENGINEERS INC. AND SHALL BE HELD CONFIDENTIAL AND SHALL NOT BE USED FOR ANY PURPOSE NOT PROVIDED FOR IN AGREEMENTS WITH ICF KAISER ENGINEERS INC.

ICF KAISER
ICF KAISER ENGINEERS, INC.
FOUR GATEWAY CENTER
PITTSBURGH, PA 15222-1687
(412) 497 2000

UNITED STATES DEPARTMENT OF ENERGY
ADVANCED FROTH FLOTATION PROCESS
SECTIONS C & D
PIPING ARRANGEMENT

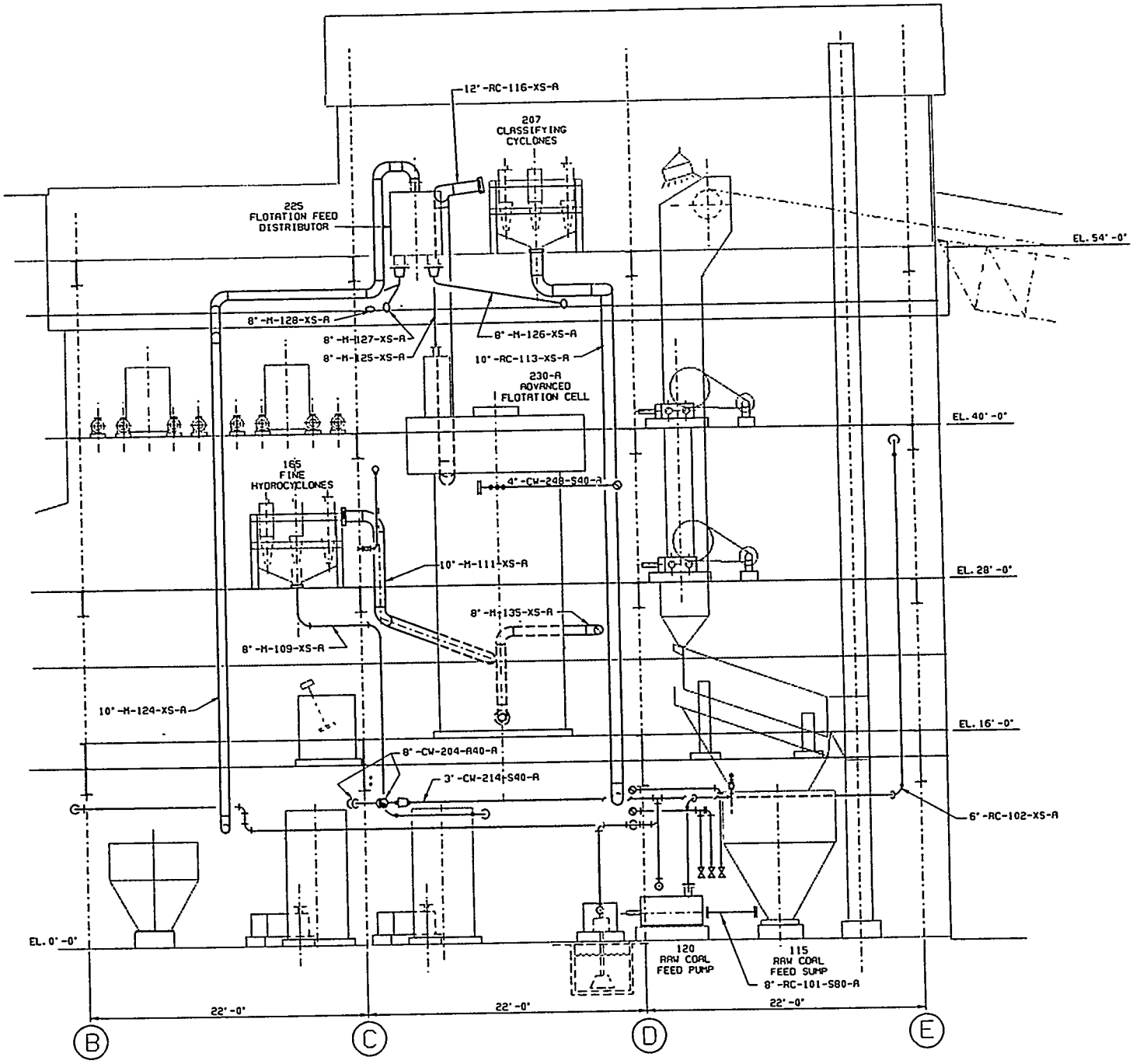
JOB NO. 88107-250	DWG. NO. 10-60-0506	REVISION R-

J:\prj\88107250\10600506.dgn rebar



SECTION E
@ COLUMN 6
10-60-0501 THRU 10-60-0504

NO	DATE	REVISION	BY	CH	APP	APP	REFERENCE DRAWINGS	NUMBER	NOTES	DESCRIPTION COST
										WORK COVERED BY THIS A CHARGED TO COST ACCOUN



SECTION F
@ COLUMN 6
10-60-0501 THRU 10-60-0504

CONSTRUCTION APPROVAL	APPROVAL	DATE	SCALE: 3/16" = 1'-0"	DATE
			DESIGNED BY: D. GROSS	7/1/94
			DRAWN BY: D. GROSS	7/1/94
			CHECKED BY:	
			APPROVED BY:	
			APPROVED BY:	

ACCOUNT
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INFORMATION CONFIDENTIAL: ALL PLANS, DRAWINGS, SPECIFICATIONS AND/OR INFORMATION FURNISHED HEREWITH ARE AND SHALL REMAIN THE PROPERTY OF ICF KAISER ENGINEERS, INC. AND SHALL BE HELD CONFIDENTIAL AND SHALL NOT BE USED FOR ANY PURPOSE NOT PROVIDED FOR IN AGREEMENTS WITH ICF KAISER ENGINEERS, INC.

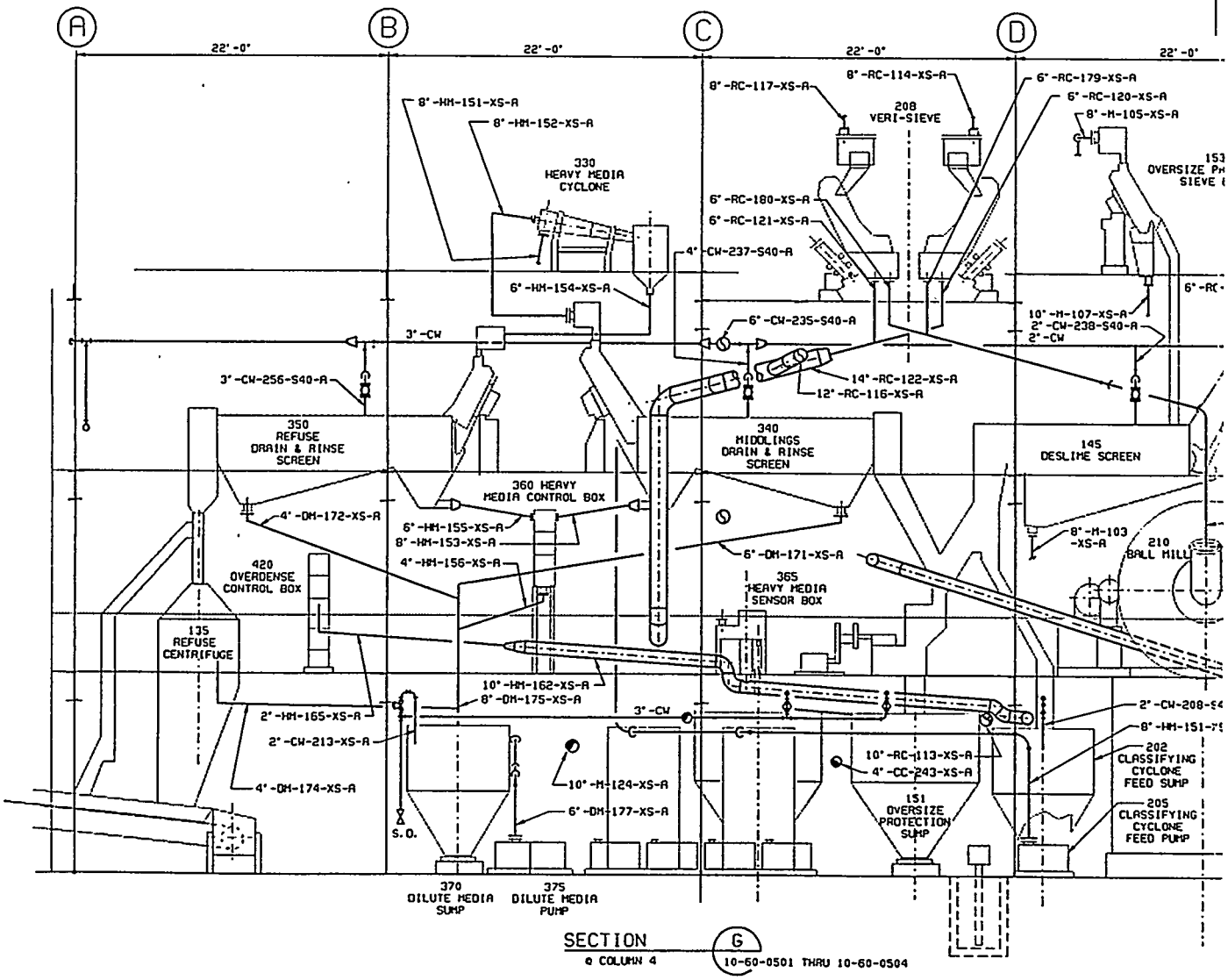
PROFESSIONAL SEAL

ICF KAISER

ICF KAISER ENGINEERS, INC.
FOUR GATEWAY CENTER
PITTSBURGH, PA 15222-1207
(412) 497-2000

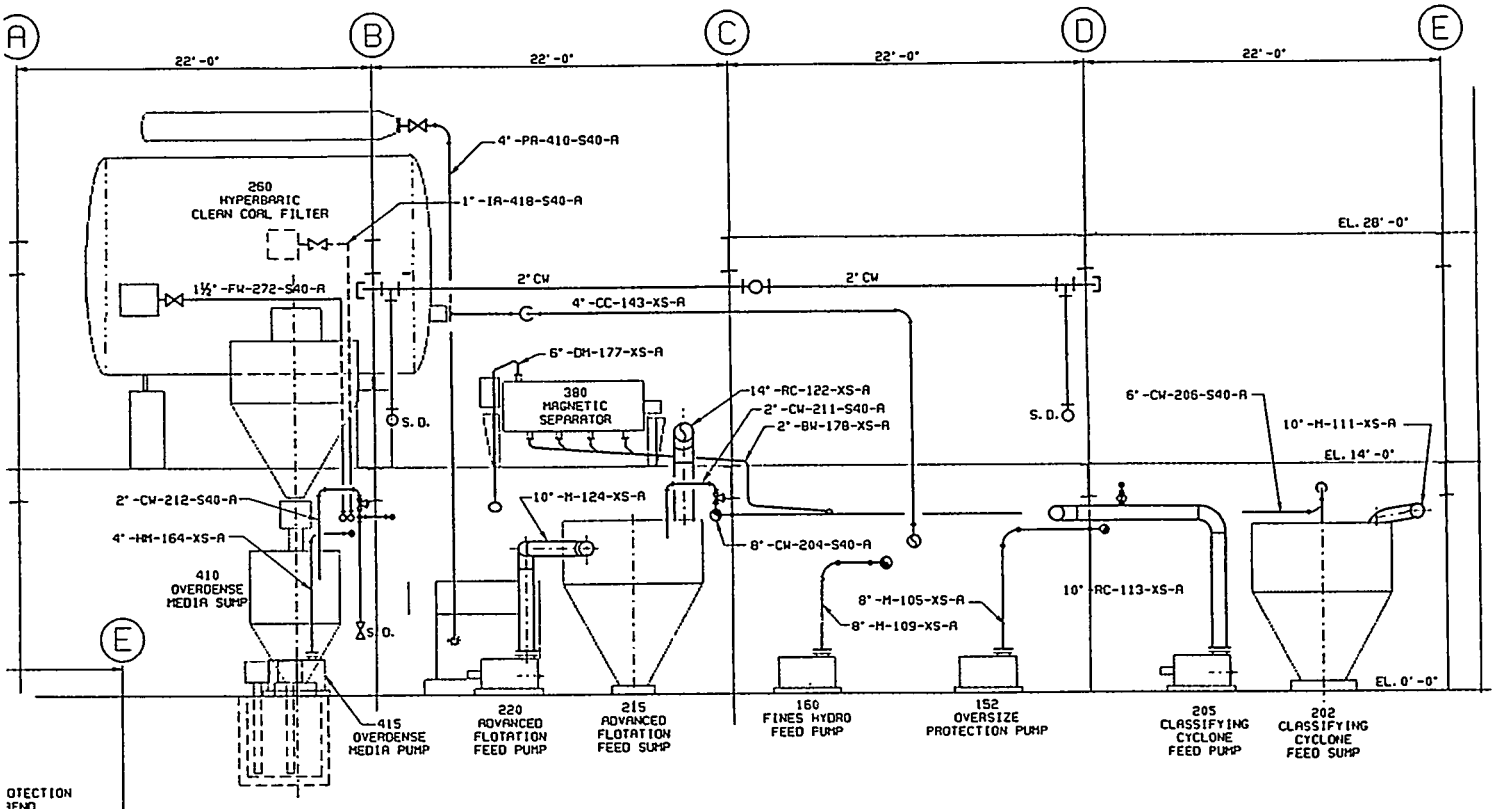
UNITED STATES DEPARTMENT OF ENERGY
ADVANCED FROTH FLOTATION PROCESS
SECTIONS E & F
PIPING ARRANGEMENT

JOB NO. 88107-250 | DWG. NO. 10-60-0507 | REVISION R-

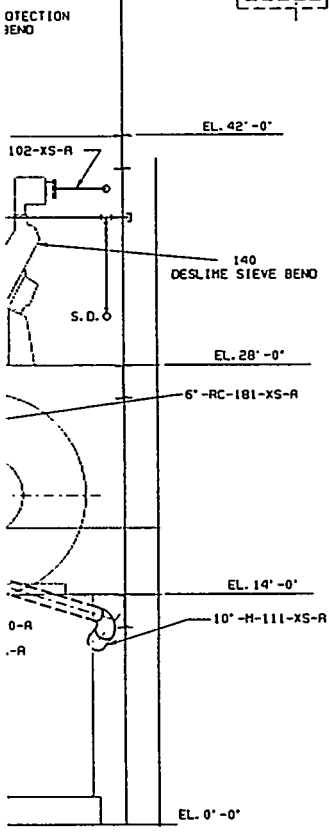


SECTION G
@ COLUMN 4
10-60-0501 THRU 10-60-0504

NO	DATE	REVISION	BY	APP	APP	REFERENCE DRAWINGS	NUMBER	NOTES	DESCRIPTION COST
									WORK COVERED BY THIS I CHARGED TO COST ACCOU



SECTION H
@ COLUMN 3
10-60-0501 THRU 10-60-0504



CONSTRUCTION APPROVAL	APPROVAL	DATE	SCALE: 3/8" = 1'-0"	DATE
			DESIGNED BY: D. GROSS	7/1/94
			DRAWN BY: D. GROSS	7/1/94
			CHECKED BY:	
			APPROVED BY:	
			APPROVED BY:	

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FOUR GATEWAY CENTER
PITTSBURGH, PA 15222-1207
(412) 497-2000

UNITED STATES DEPARTMENT OF ENERGY
ADVANCED FROTH FLOTATION PROCESS
SECTIONS G & H
PIPING ARRANGEMENT

JOB NO. 88107-250 | DWG. NO. 10-60-0508 | REV. R-

ACCOUNT
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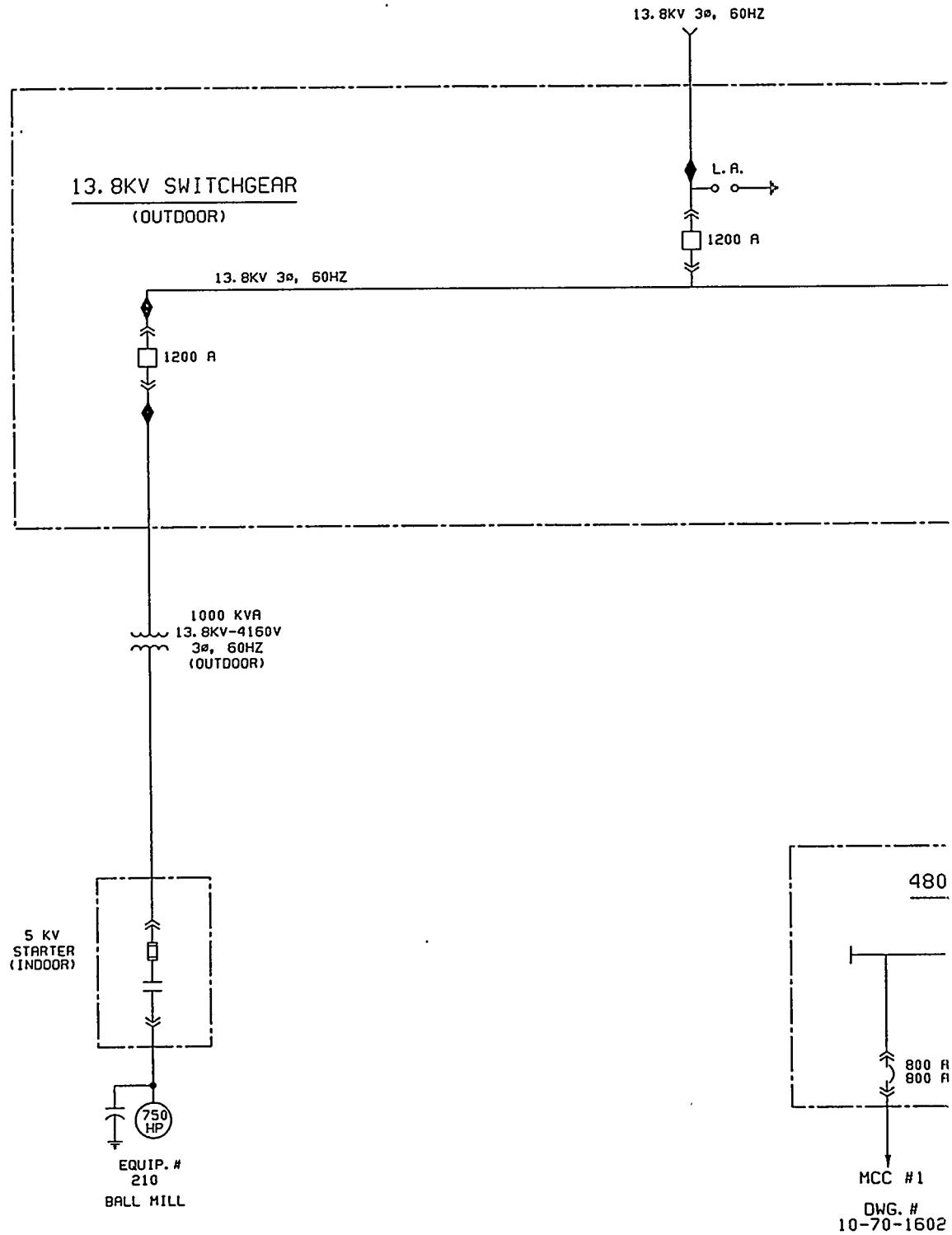
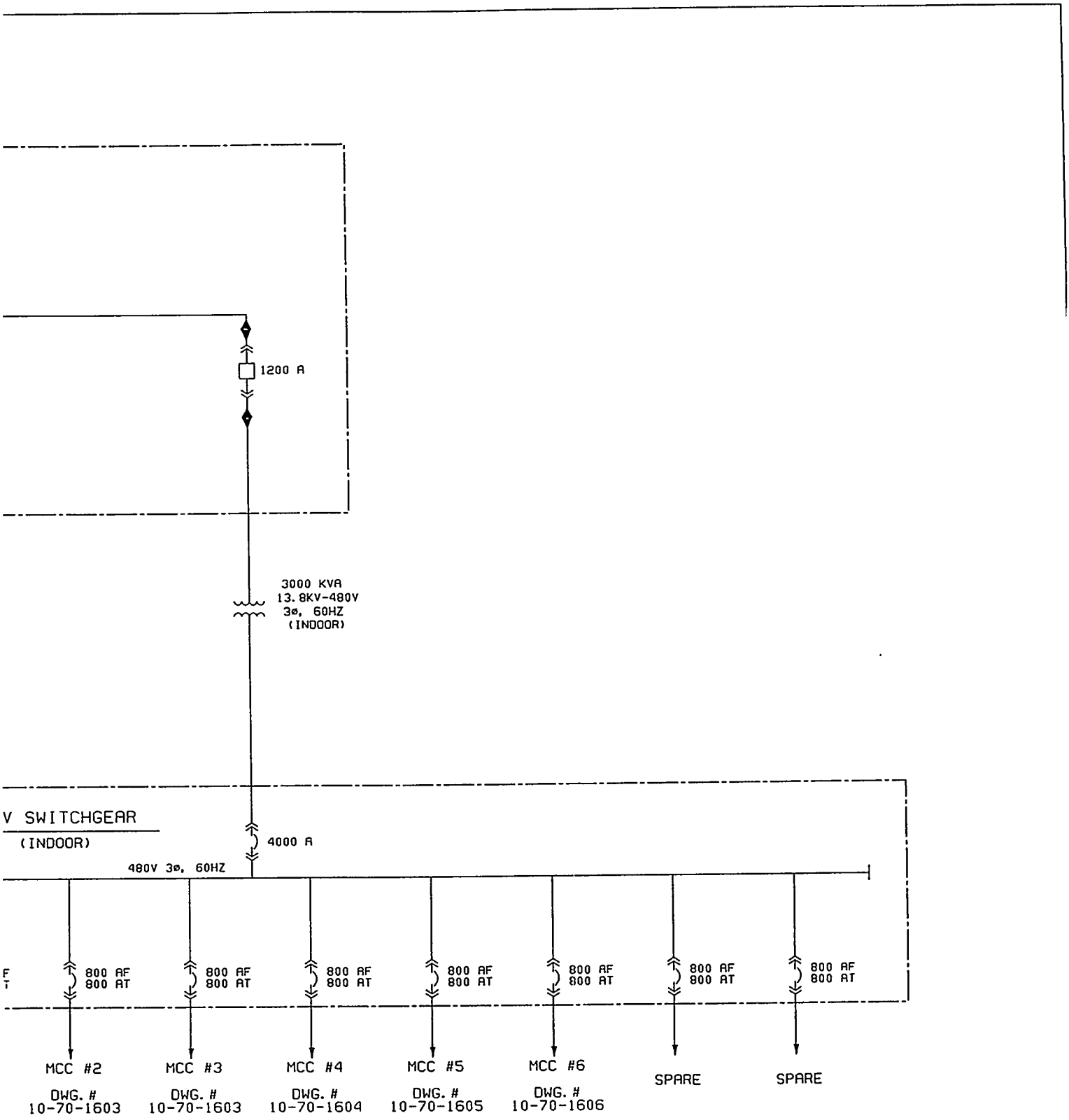
19-AUG-1994 08:5



NO	DATE	REVISION	BY	CHK	APP	APP	REFERENCE DRAWINGS	NUMBER	NOTES	DESCRIPTION



CONSTRUCTION APPROVAL	APPROVAL	DATE	SCALE: NONE	DATE
			DESIGNED BY: R. BURTNETT	6/1/94
			DRAWN BY: D.M. KISELICA	6/2/94
			CHECKED BY:	
			APPROVED BY:	
			APPROVED BY:	

PROFESSIONAL SEAL

ICF KAISER

UNITED STATES DEPARTMENT OF ENERGY
ADVANCED FROTH FLOATATION

ELECTRICAL POWER DISTRIBUTION
SINGLE LINE DIAGRAM

JOB NO. 88107-250	DWG. NO. 10-70-1601	R-

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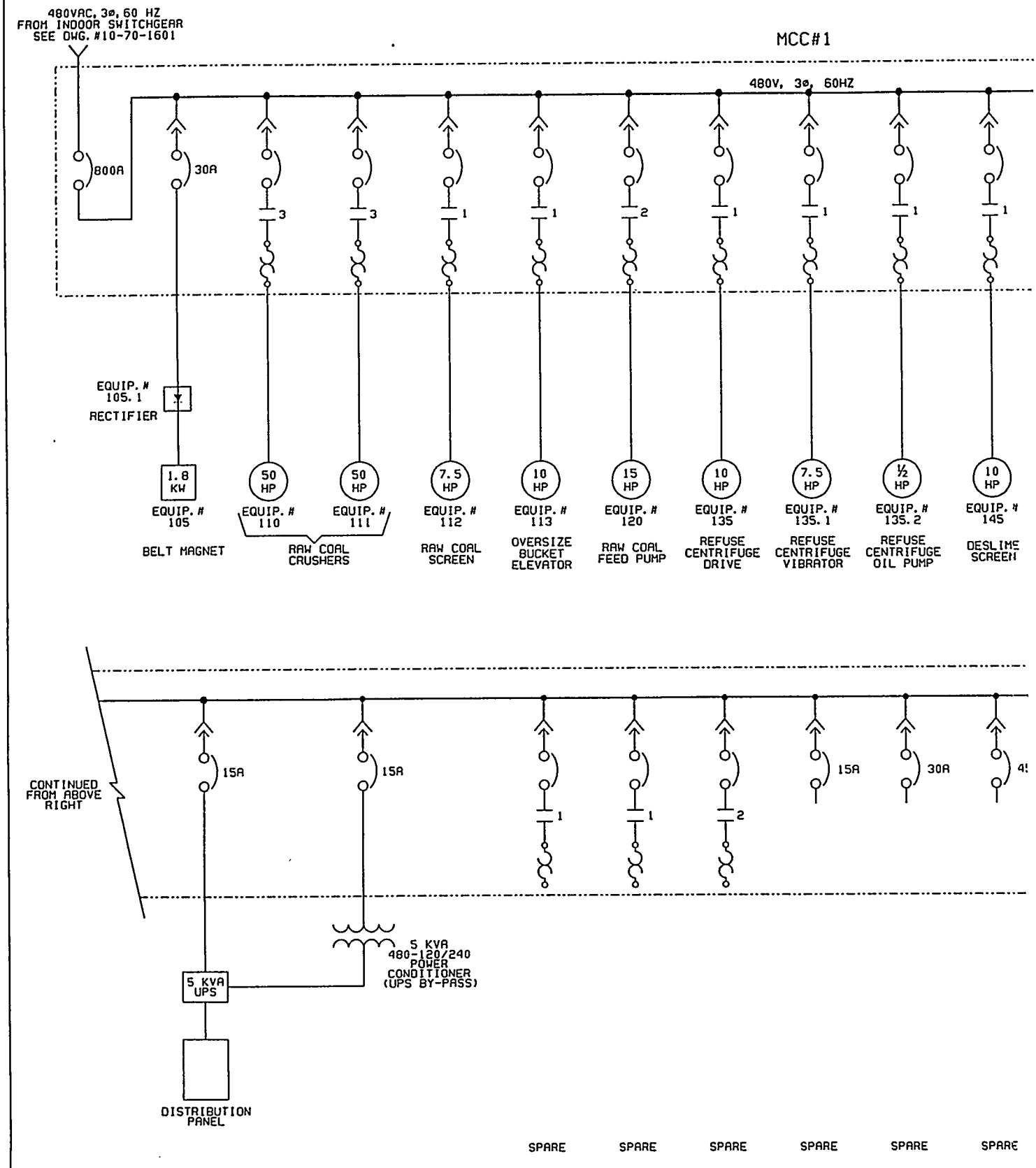
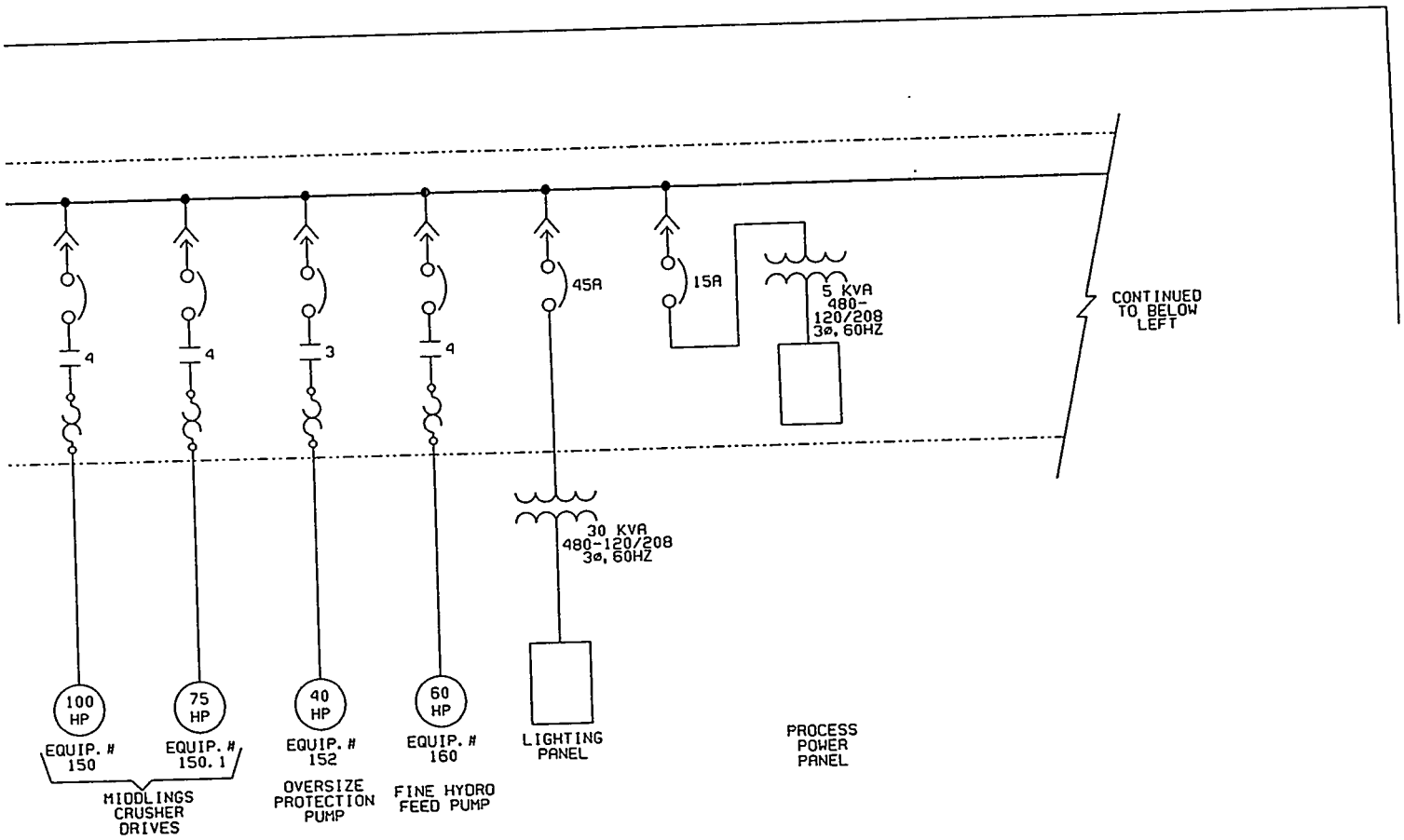
I:\pc1\88107250\10701601.dgn wap13



NO	DATE	REVISION	BY	CH	APP	APP	REFERENCE DRAWINGS	NUMBER	NOTES	DESCRIPTION COST
										WORK COVERED BY THIS I CHARGED TO COST ACCOUN



5A

CONSTRUCTION APPROVAL	APPROVAL	DATE	SCALE: NONE	DATE
			DESIGNED BY: R. BURTNETT	6/1/94
			DRAWN BY: D.M. KISELICA	6/2/94
			CHECKED BY:	
			APPROVED BY:	
			APPROVED BY:	

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FOUR GATEWAY CENTER
PITTSBURGH, PA 15222 1287
(412) 497-2000

UNITED STATES DEPARTMENT OF ENERGY
ADVANCED FROTH FLOATATION

MOTOR CONTROL CENTER #1
SINGLE LINE DIAGRAM

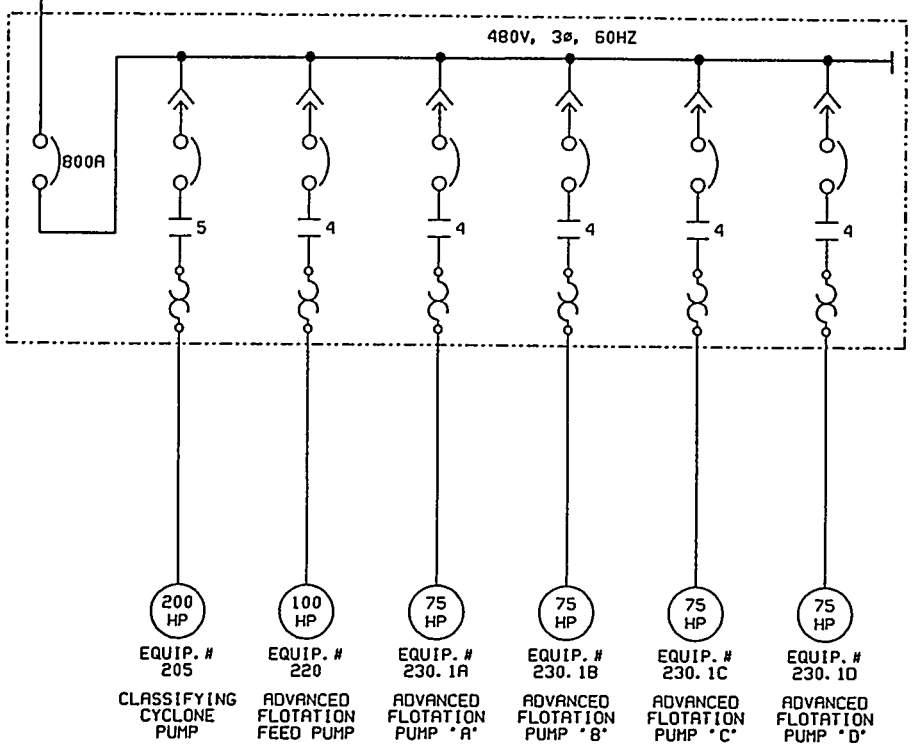
JOB NO. 88107-250	DWG. NO. 10-70-1602	REVISED R-

ACCOUNT
ACCOUNT
T ABOVE

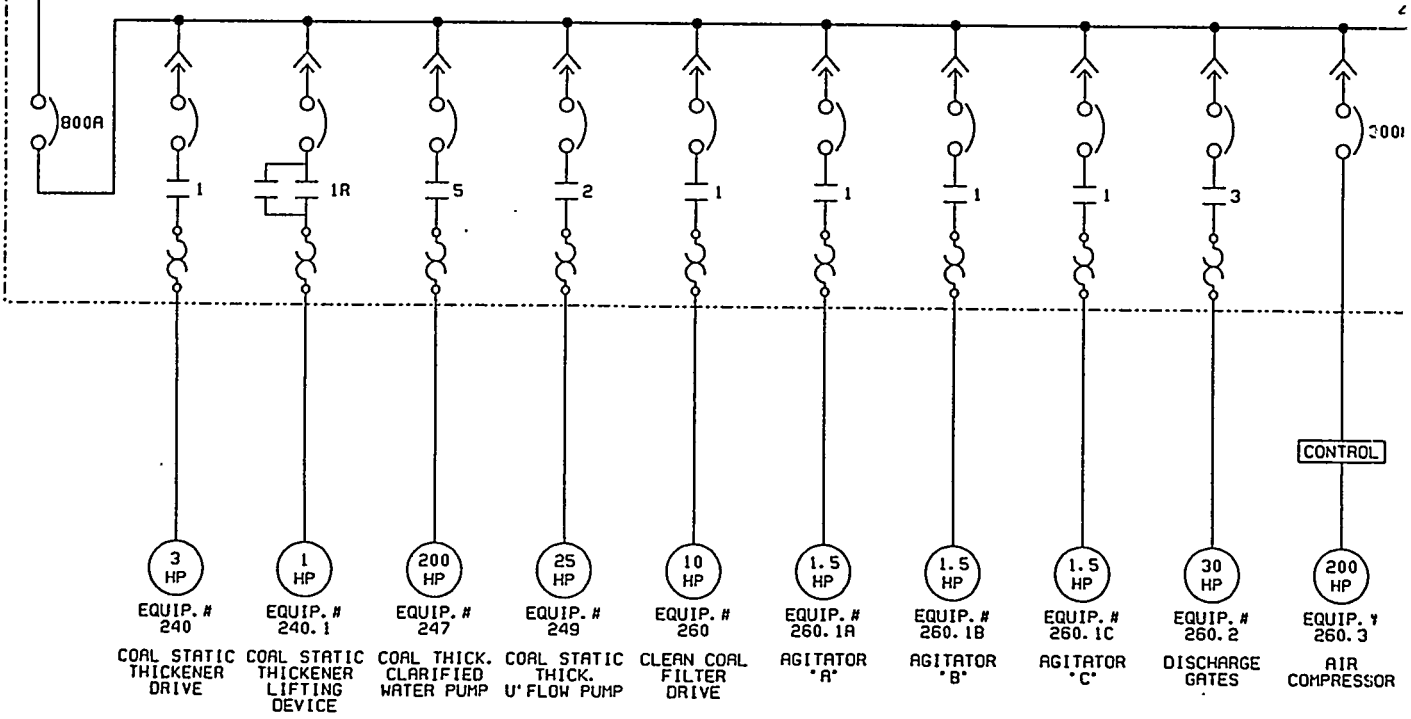
J:\pr_j\88107250\10701602.dgn epl3

480VAC, 3ø, 60 HZ
FROM INDOOR SWITCHGEAR
SEE DWG. #10-70-1601

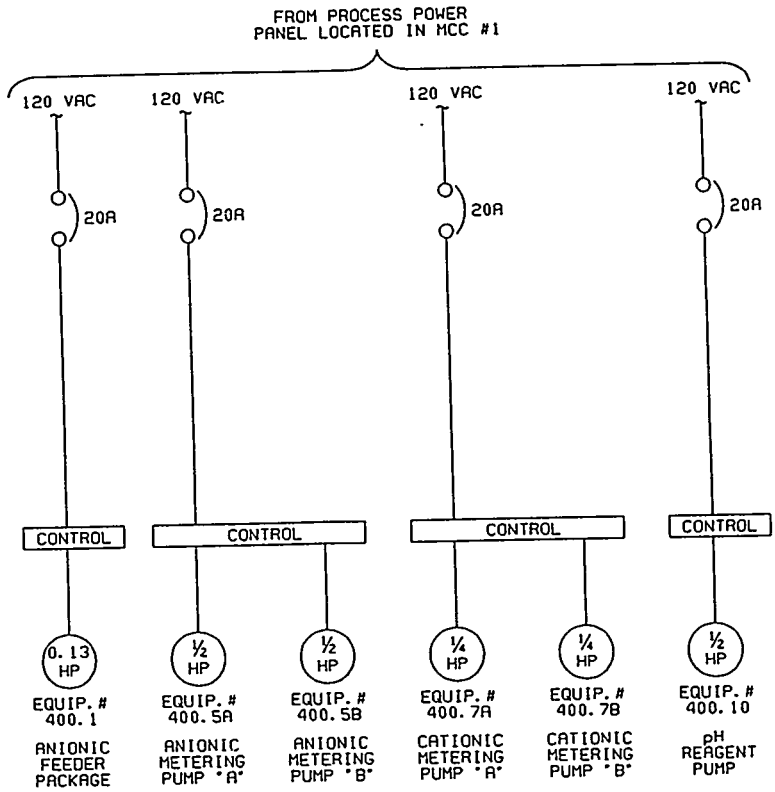
MCC#2

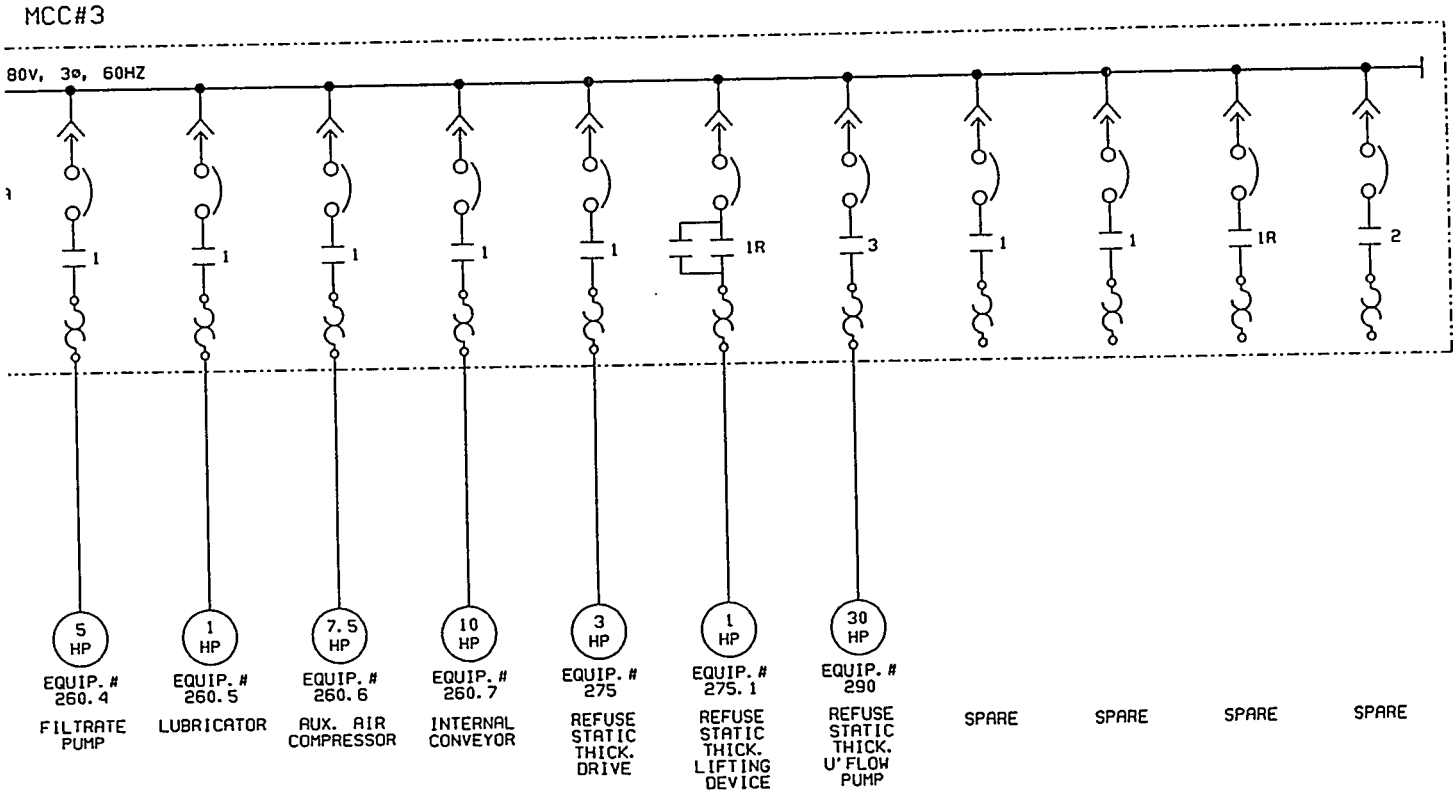


480VAC, 3ø, 60 HZ
FROM INDOOR SWITCHGEAR
SEE DWG. #10-70-1601



NO	DATE	REVISION	BY/CH	APP	APP	REFERENCE DRAWINGS	NUMBER	NOTES	DESCRIPTION COST F
									WORK COVERED BY THIS AC CHARGED TO COST ACCOUNT





CONSTRUCTION APPROVAL	APPROVAL	DATE	SCALE: NONE	DATE	PROFESSIONAL SEAL
			DESIGNED BY: R. BURTNETT	6/1/94	
			DRAWN BY: D.M. KISELICA	6/3/94	
			CHECKED BY:		
			APPROVED BY:		
			APPROVED BY:		

ACCOUNT
COUNT ABOVE

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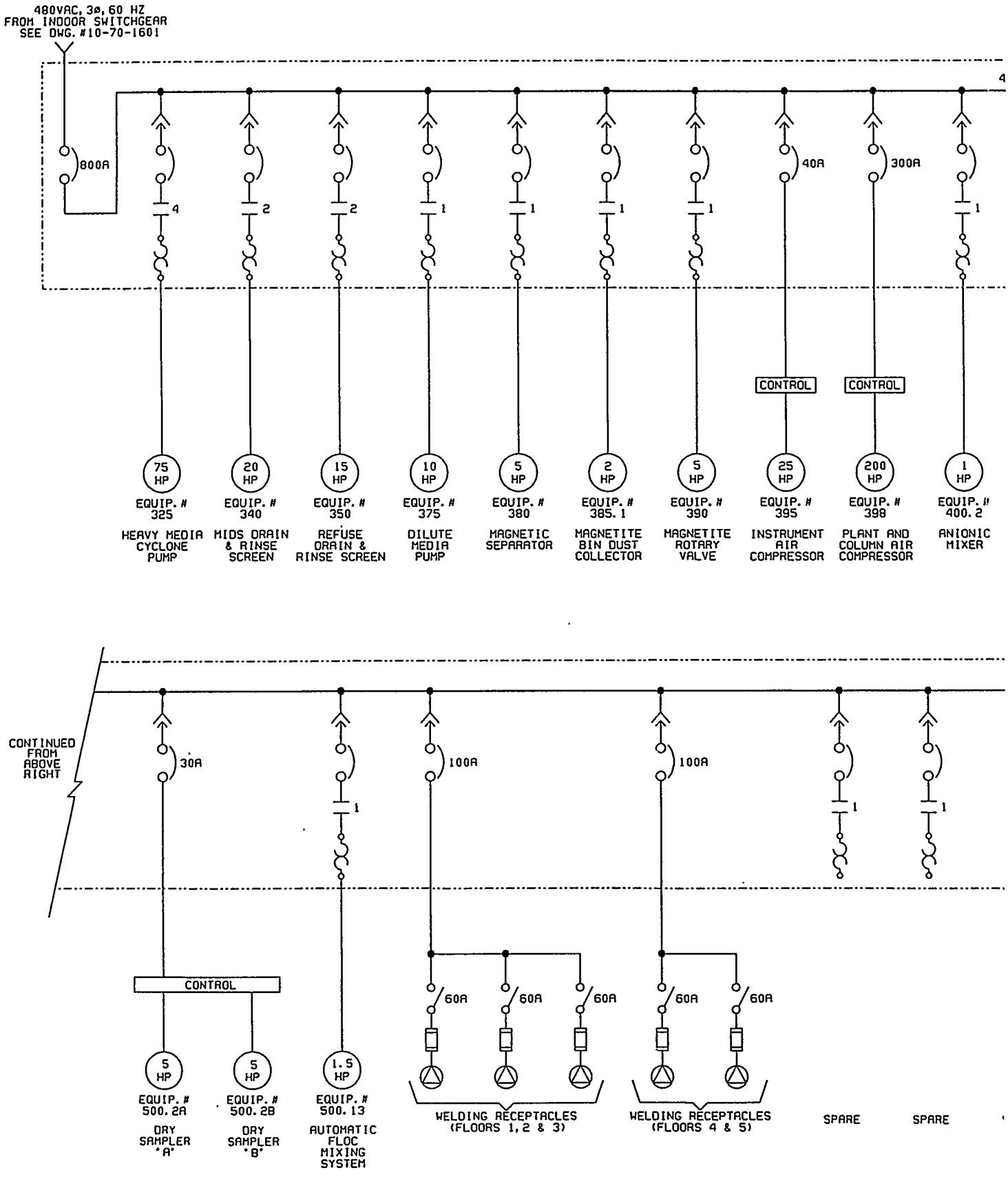
ICF KAISER ENGINEERS, INC.
FOUR GATEWAY CENTER
PITTSBURGH, PA 15222-1207
(412) 562-2000

UNITED STATES DEPARTMENT OF ENERGY
ADVANCED FROTH FLOATATION

MOTOR CONTROL CENTER #2, #3 & MISC. 120VAC
SINGLE LINE DIAGRAM

JOB NO. 88107-250	DWG. NO. 10-70-1603	REVISION R-

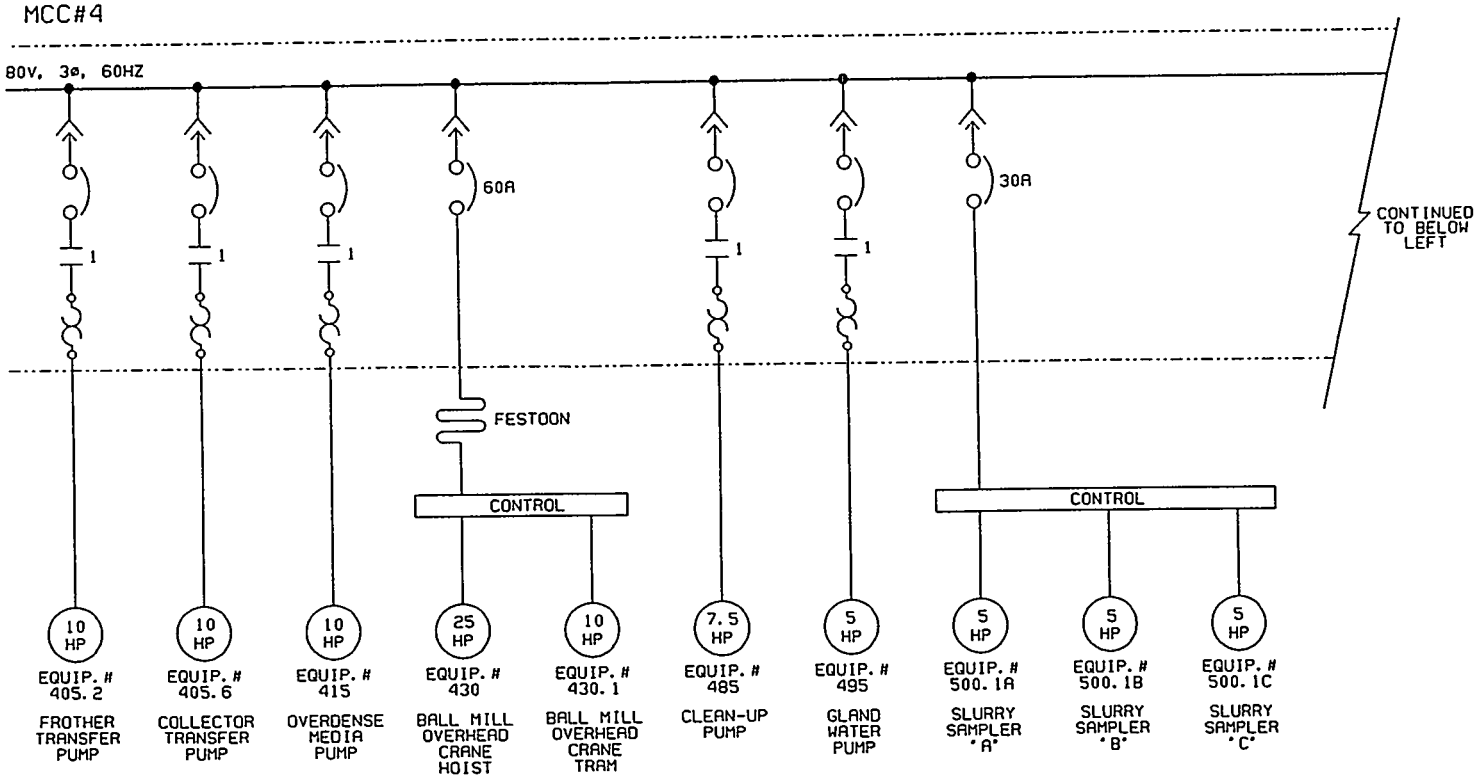
I:\acad\88107250\10701603.dgn - mpl3

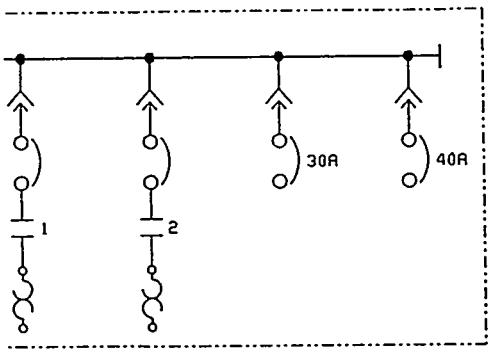


NO	DATE	REVISION	BY	APP	APP	REFERENCE DRAWINGS	NUMBER	NOTES	DESCRIPTION COST A WORK COVERED BY THIS ACC CHARGED TO COST ACCOUNT

MCC#4

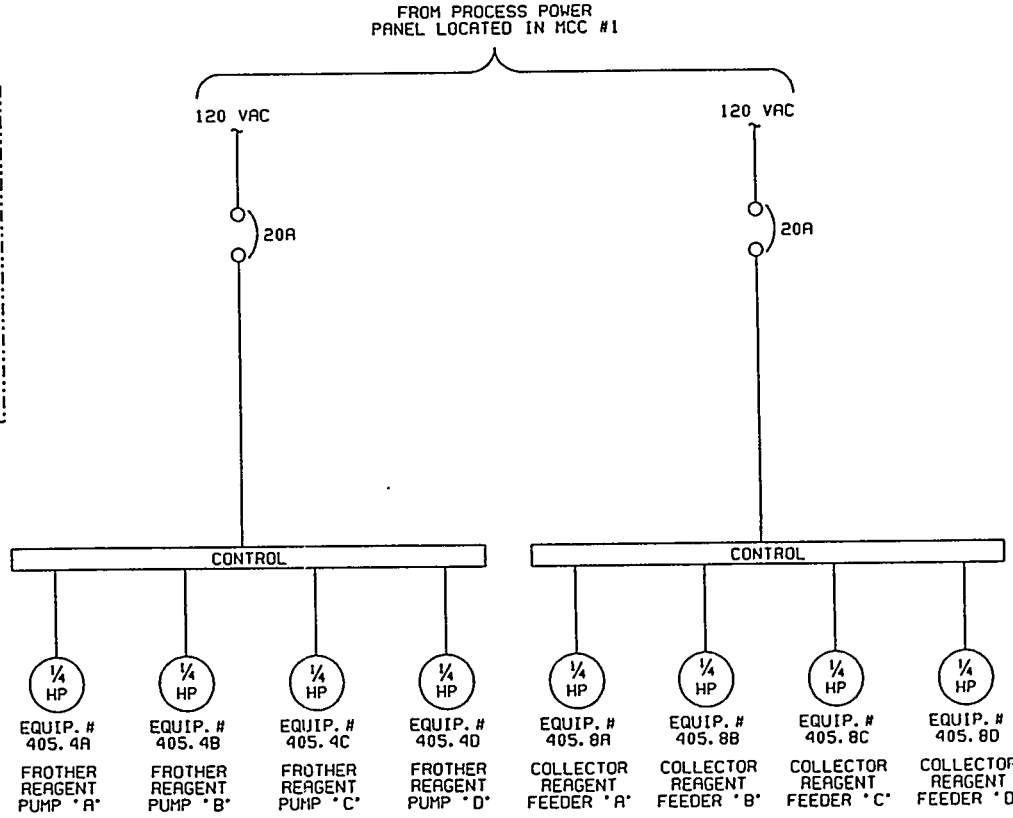
480V, 3ø, 60HZ





SPARE SPARE SPARE SPARE

FROM PROCESS POWER PANEL LOCATED IN MCC #1



CONSTRUCTION APPROVAL	APPROVAL	DATE	SCALE: NONE	DATE
			DESIGNED BY: R. BURTNETT	6/1/94
			DRAWN BY: D.M. KISELICA	6/3/94
			CHECKED BY:	
			APPROVED BY:	
			APPROVED BY:	

PROFESSIONAL SEAL

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ICF KAISER

ICF KAISER ENGINEERS, INC.
FOUR GATEWAY CENTER
PITTSBURGH, PA 15222-1207
(412) 497 2600

UNITED STATES DEPARTMENT OF ENERGY
ADVANCED FROTH FLOATATION

MOTOR CONTROL CENTER #4 & MISC. 120VAC SINGLE LINE DIAGRAM

JOB NO. 88107-250	DWG. NO. 10-70-1604	REVISION: R-

480VAC, 3ø, 60 HZ
FROM INDOOR SWITCHGEAR
SEE DWG. #10-70-1601

MCC#

480V, 3ø

600A

20A | 20A | 20A | 20A | 20A | 20A | 20A | 30A | 30A | 30A

CONTROL | CONTROL | CONTROL | CONTROL | CONTROL | CONTROL | CONTROL | CONTROL | CONTROL | CONTROL

10 KW | 10 KW | 10 KW | 10 KW | 10 KW | 10 KW | 10 KW | 20 KW | 20 KW | 20 KW

UH-1A | UH-1B | UH-1C | UH-1D | UH-1E | UH-1F | UH-1G | UH-3A | UH-3B | UH-3C

UNIT HEATERS @ EL. 0'-0"

CONTINUED FROM ABOVE RIGHT

30A | 30A | 30A | 40A | 40A

CONTROL | CONTROL | CONTROL | CONTROL

20 KW

UH-3N

UNIT HEATER @ EL. 54'-0"

1/3 HP | 5 HP | 3 KW — FAN | COMP. | HTR.

AC-1 OFFICE HVAC UNIT

1/3 HP | 5 HP | 3 KW — FAN | COMP. | HTR.

AC-2 CONTROL ROOM HVAC UNIT

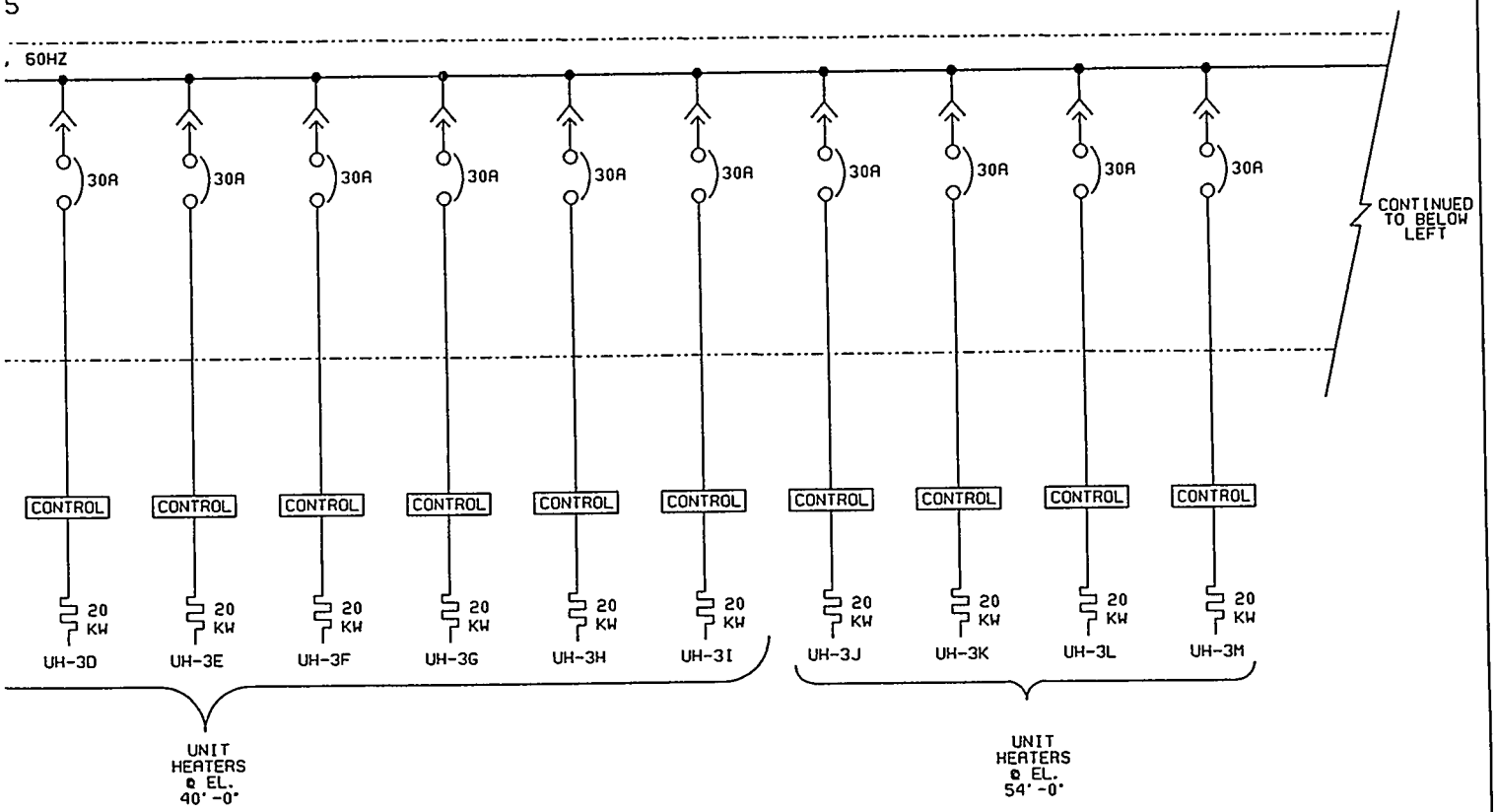
½ HP | 7.5 HP | 18 KW — FAN | COMP. | HTR.

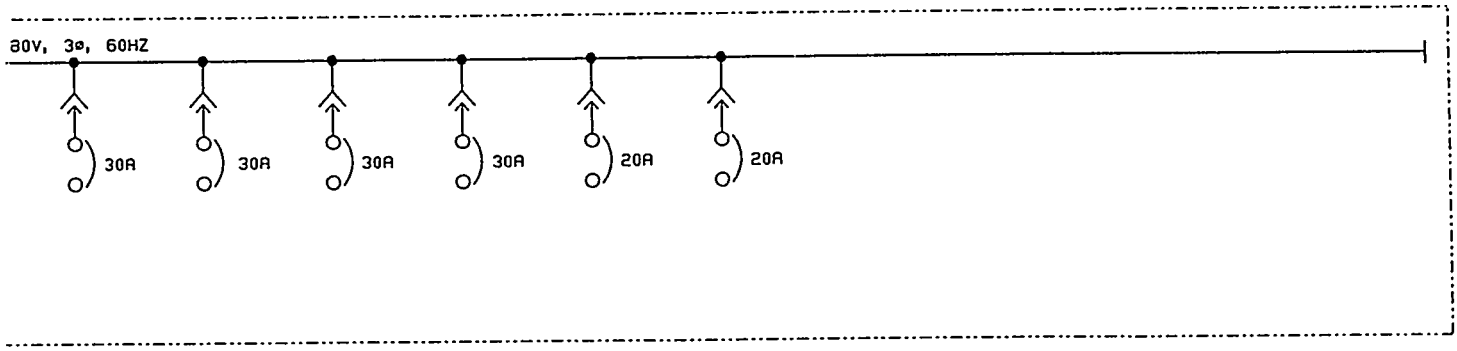
AC-3 LAB HVAC UNIT

SPARE

NO	DATE	REVISION	BY	CHK	APP	REFERENCE DRAWINGS	NUMBER	NOTES	DESCRIPTION COST
									WORK COVERED BY THIS AC CHARGED TO COST ACCOUNT

5





SPARE SPARE SPARE SPARE SPARE SPARE

CONSTRUCTION APPROVAL	APPROVAL	DATE	SCALE: NONE	DATE	PROFESSIONAL SEAL	ICF KAISER	ICF KAISER ENGINEERS, INC.
			DESIGNED BY: R. BURNETT	6/1/94		UNITED STATES DEPARTMENT OF ENERGY ADVANCED FROTH FLOATATION	
			DRAWN BY: D.M. KISELICA	6/10/94		MOTOR CONTROL CENTER #5 SINGLE LINE DIAGRAM	
			CHECKED BY:				
			APPROVED BY:				
			APPROVED BY:				
ACCOUNT COUNT ABOVE	INFORMATION CONFIDENTIAL: ALL PLANS, DRAWINGS, SPECIFICATIONS AND/OR INFORMATION FURNISHED HEREWITH ARE AND SHALL REMAIN THE PROPERTY OF ICF KAISER ENGINEERS, INC. AND SHALL BE HELD CONFIDENTIAL AND SHALL NOT BE USED FOR ANY PURPOSE NOT PROVIDED FOR IN AGREEMENTS WITH ICF KAISER ENGINEERS, INC.					JOB NO. 88107-250	DWG. NO. 10-70-1605 REVISION R-

J:\prj\88107250\10701605.dgn esbol

480VAC, 3ø, 60 HZ
FROM INDOOR SWITCHGEAR
SEE DWG. #10-70-1601

MCC#

480V, 3ø

600A

30A

CONTROL

15 KW

UH-2A
UH-2B
UH-2C
UH-2D
UH-2E
UH-2F
UH-2G
UH-2H
UH-2I
UH-2J

UNIT HEATERS @ EL. 14'-0"

CONTINUED FROM ABOVE RIGHT

1

40A

	HP	
EF-1	½	BLDG. EXHAUST FAN #1 @ LOCKER ROOMS
EF-2	3	BLDG. EXHAUST FAN #2 @ EL. 0'-0"
EF-3	5	BLDG. EXHAUST FAN #3 @ EL. 14'-0"
EF-4	1	BLDG. EXHAUST FAN #4 @ EL. 28'-0"
EF-5	3	BLDG. EXHAUST FAN #5 @ EL. 40'-0"
EF-6	¾	BLDG. EXHAUST FAN #6 @ EL. 54'-0"

CONTROL

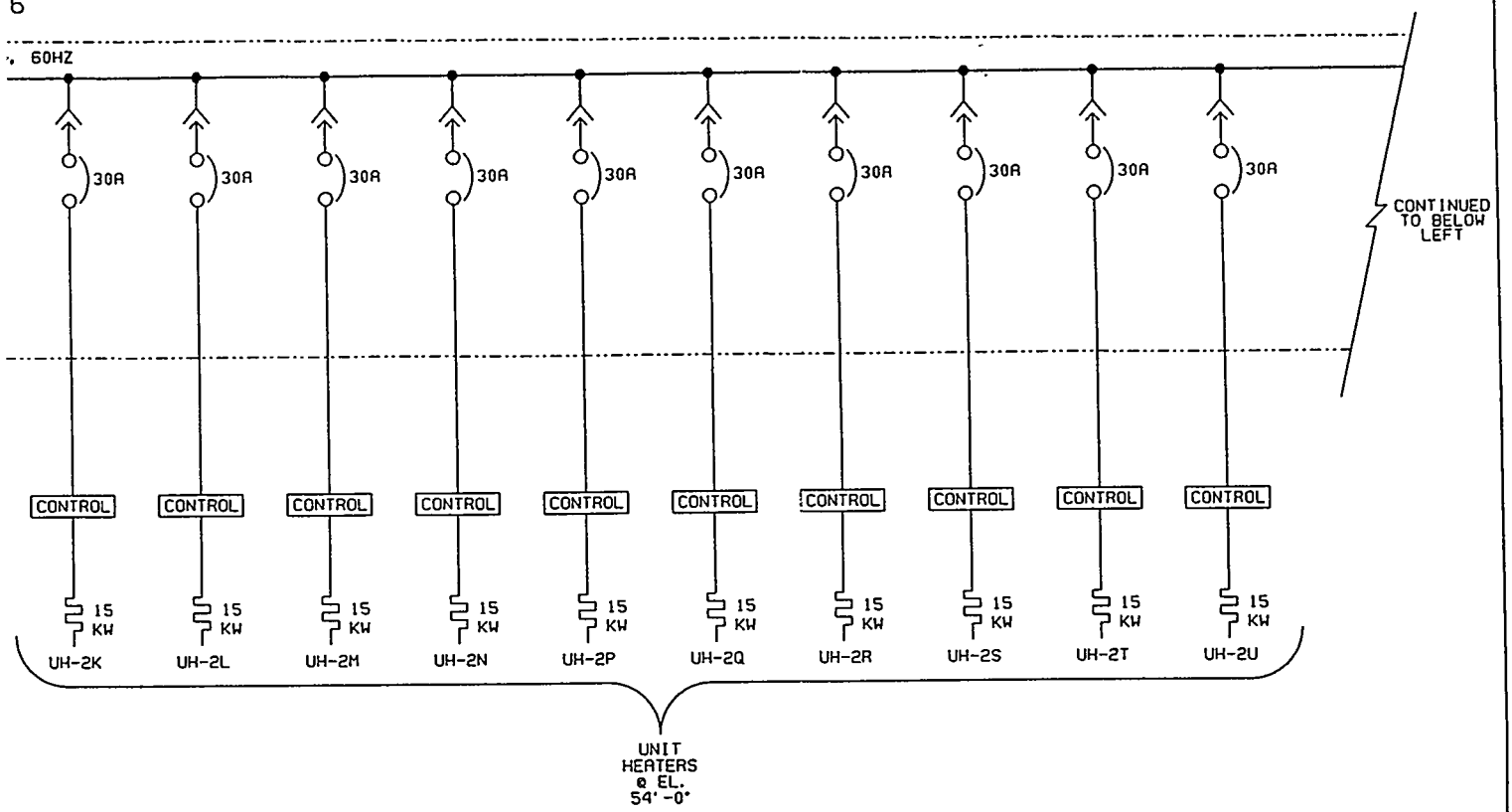
5 HP FAN

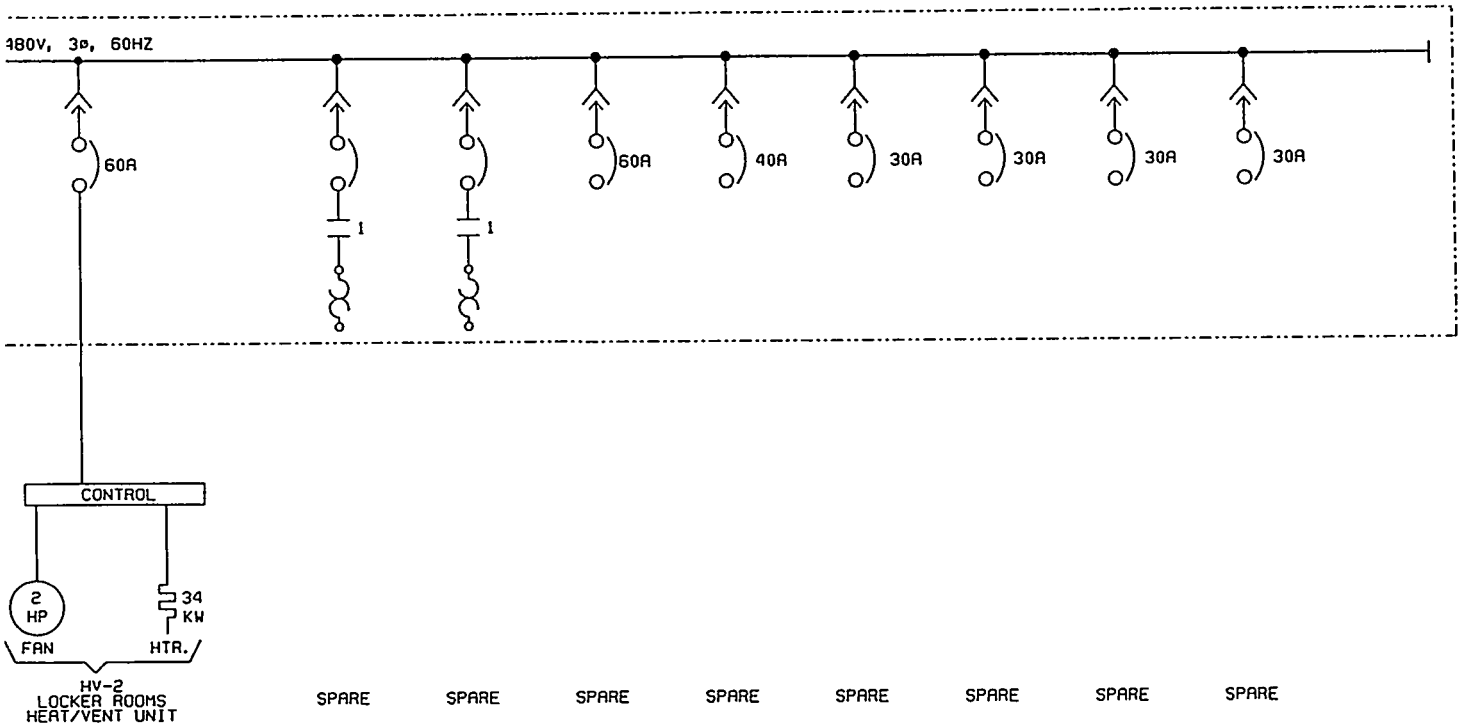
16 KW HTR.

HV-1
ELECTRICAL ROOM
HEAT/VENT UNIT

NO	DATE	REVISION	BY	APP	APP	REFERENCE DRAWINGS	NUMBER	NOTES	DESCRIPTION	COST
									WORK COVERED BY THIS A CHARGED TO COST ACCOUN	

6





CONSTRUCTION APPROVAL	APPROVAL	DATE	SCALE: NONE	DATE
			DESIGNED BY: R. BURTNETT	6/1/94
			DRAWN BY: D.M. KISELICA	6/10/94
			CHECKED BY:	
			APPROVED BY:	
			APPROVED BY:	

PROFESSIONAL SEAL

ICF KAISER

ICF KAISER ENGINEERS, INC. FOUR GATEWAY CENTER PITTSBURGH, PA 15222-1207 (412) 497-7000

UNITED STATES DEPARTMENT OF ENERGY
ADVANCED FROTH FLOATATION

MOTOR CONTROL CENTER #6
SINGLE LINE DIAGRAM

JOB NO. 88107-250 | DWG. NO. 10-70-1606 | REVISION R-

ACCOUNT
ACCOUNT ABOVE

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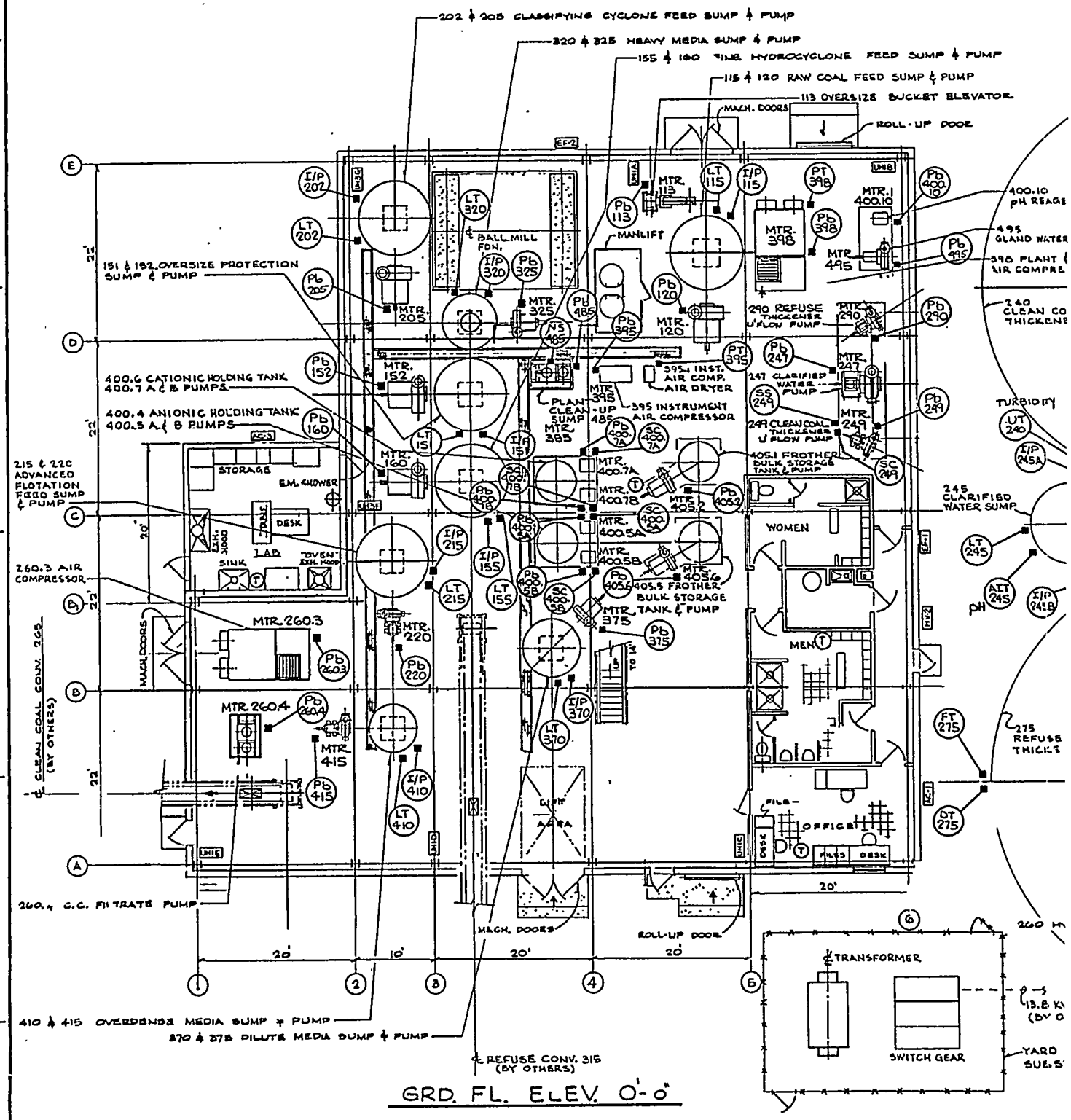
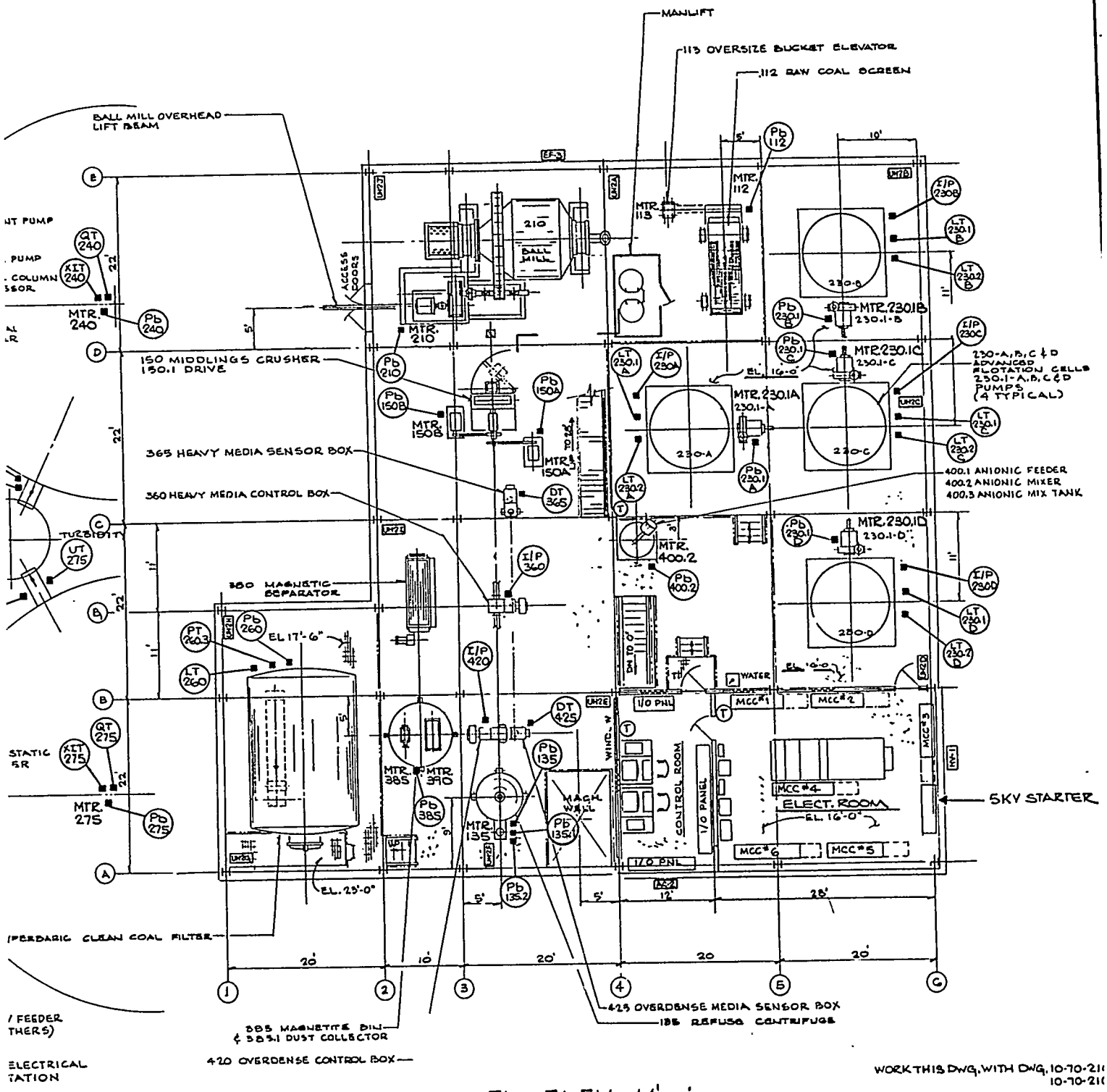
j:\prj\88107250\10701606.dgn sabal



NO.	DATE	REVISION	BY	APP.	APP.	REFERENCE DRAWINGS	NUMBER	NOTES	DESCRIPTION	COST AC
									WORK COVERED BY THIS DR. CHARGED TO COST ACCOUNT	



FL. ELEV. 14'-0" (UNLESS NOTED)

CONSTRUCTION APPROVAL	APPROVAL	DATE	SCALE: 1/8" = 1'-0"	DATE	PROFESSIONAL SEAL
			DESIGNED BY K. MOOTS	6/15/94	
			DRAWN BY K. MOOTS	9/16/94	
			CHECKED BY		
			APPROVED BY		
			APPROVED BY		

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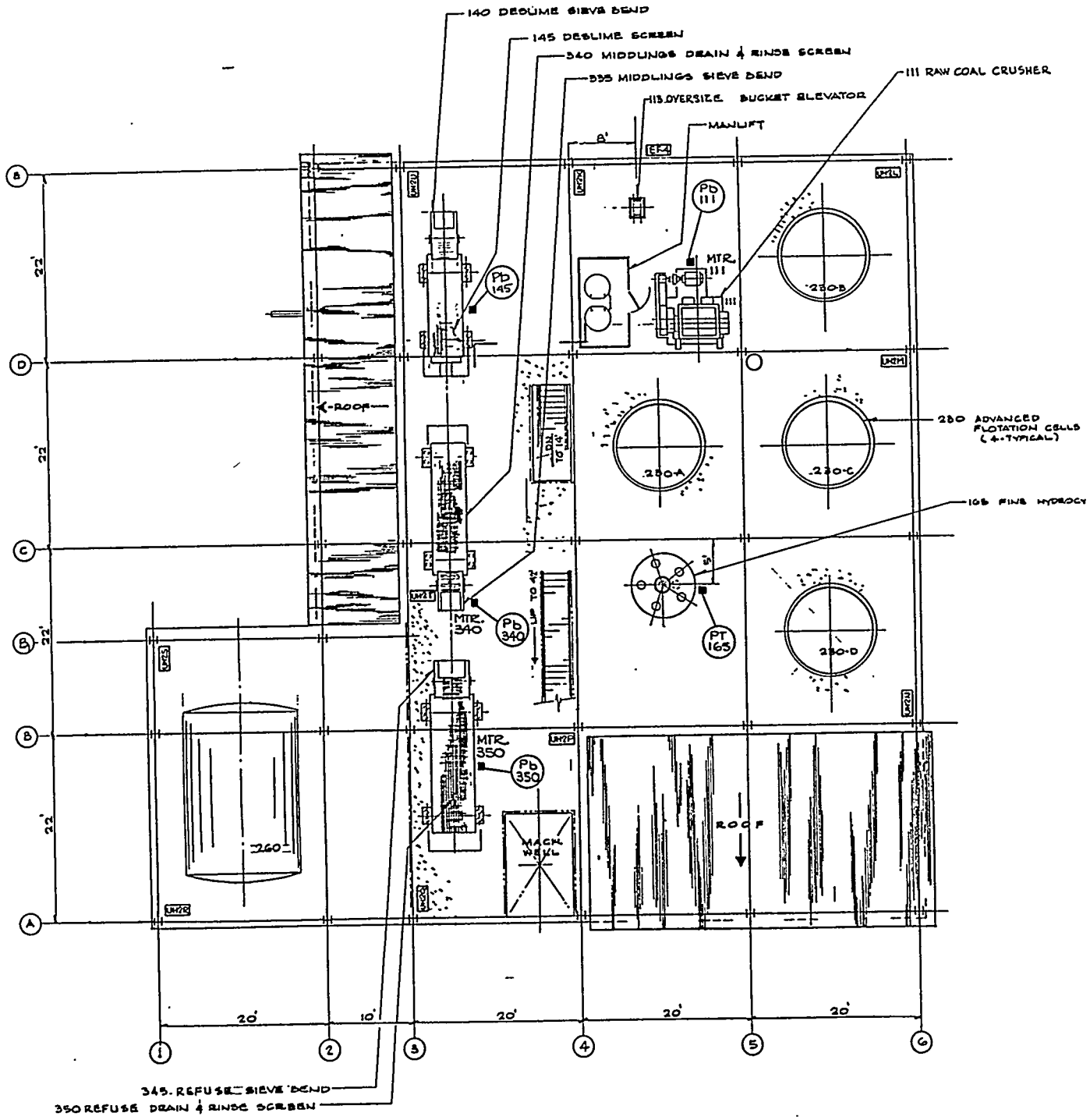
ICF KAISER ENGINEERS
ICF KAISER ENGINEERS INC.
Four Gateway Center
Pittsburgh, PA 15222-1207
(412) 281-8121, TELEX: 199121

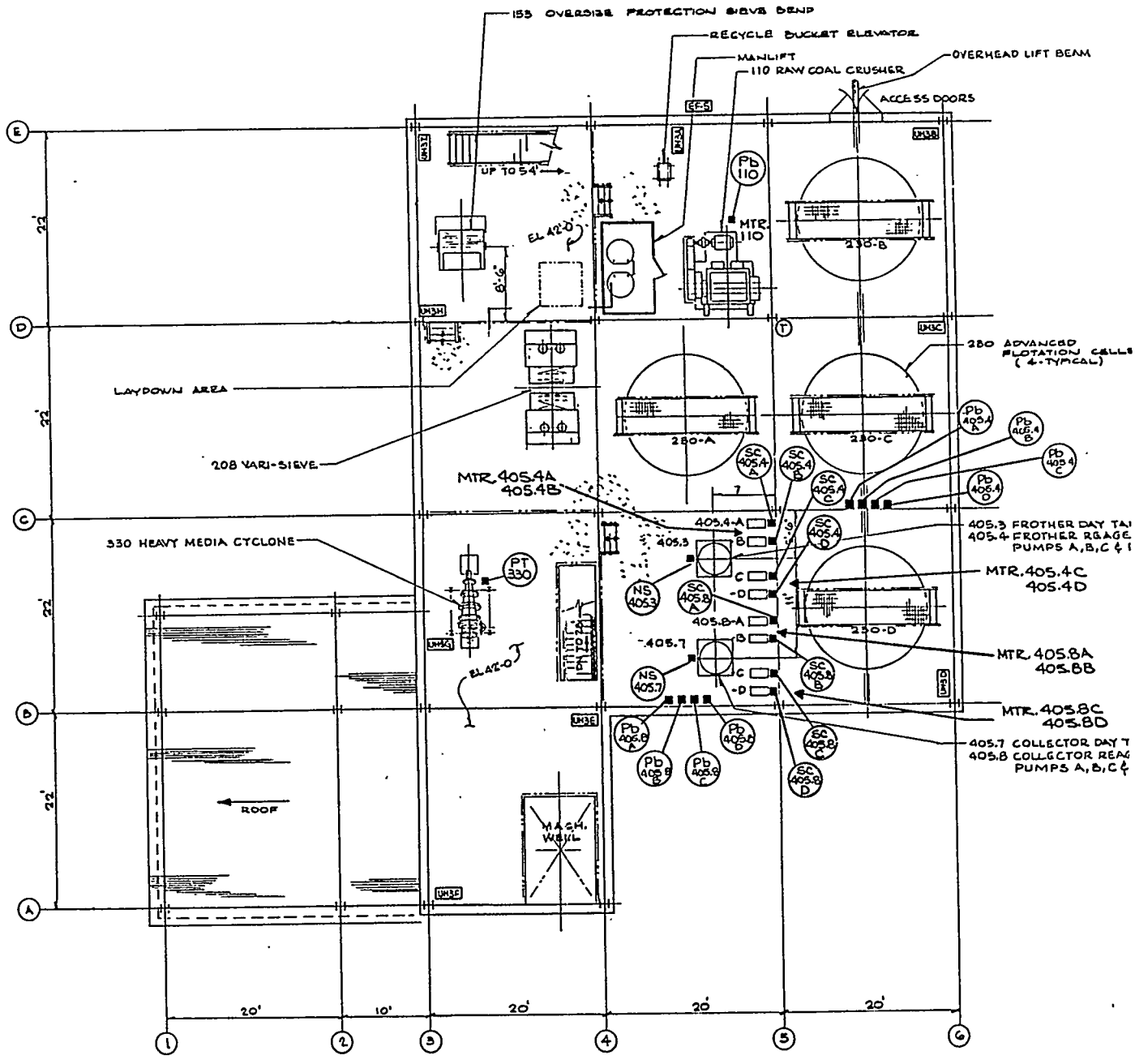
UNITED STATES DEPARTMENT OF ENERGY
ADVANCED FROTH FLOTATION PROCESS
PLAN AT ELEV. 0'-0" & 14'-0"
POWER, CONTROL & INSTR. LOCATION PLAN

JOB No. 88107-250-00 | DWG. No. 10-70-2101 | REV. R-



FL. ELEV. 28'-0"

NO.	DATE	REVISION	BY	APP.	APP.	REFERENCE DRAWINGS	NUMBER	NOTES	DESCRIPTION	COST AC
									WORK COVERED BY THIS DR CHARGED TO COST ACCOUNT	



WORK THIS DWG. WITH DWG. 10-70-2101
10-70-2103

FL. ELEV. 40'-0" (UNLESS NOTED)

CONSTRUCTION APPROVAL	APPROVAL	DATE	SCALE: 1/8" = 1'-0"	DATE
			DESIGNED BY K.MOOTS	6/15/94
			DRAWN BY K.MOOTS	6/17/94
			CHECKED BY	
			APPROVED BY	
			APPROVED BY	

PROFESSIONAL SEAL

ICF KAISER ENGINEERS

ICF KAISER ENGINEERS INC.
Four Gateway Center
Pittsburgh, PA 15222-1207
(412) 281-8121, TELEX: 199121

UNITED STATES DEPARTMENT OF ENERGY
ADVANCED FROTH FLOTATION PROCESS
PLAN AT ELEV. 28'-0" & 40'-0"
POWER, CONTROL & INSTR. LOCATION PLA

JOB No. 88107-250-00 | DWG. No. 10-70-2102

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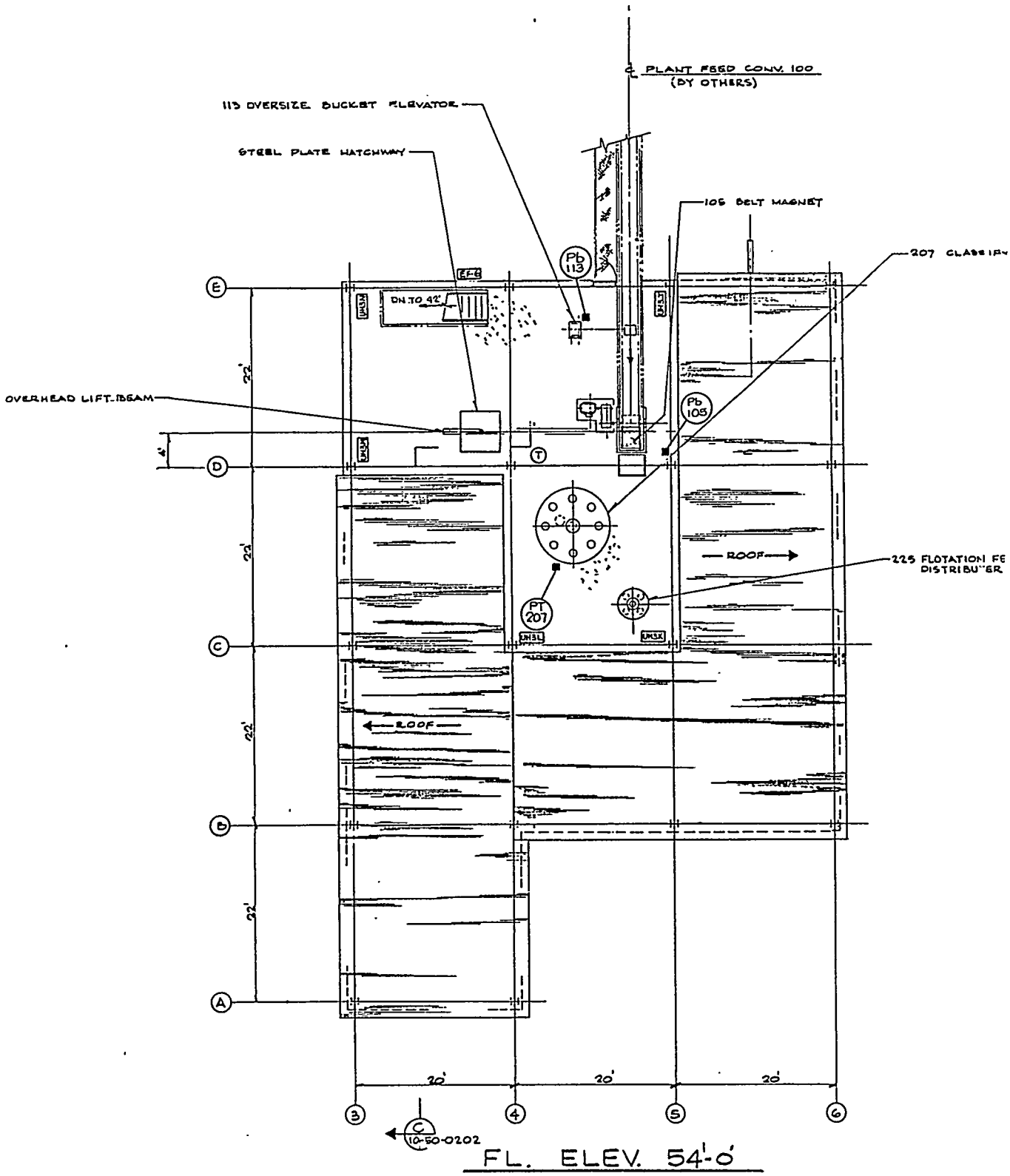
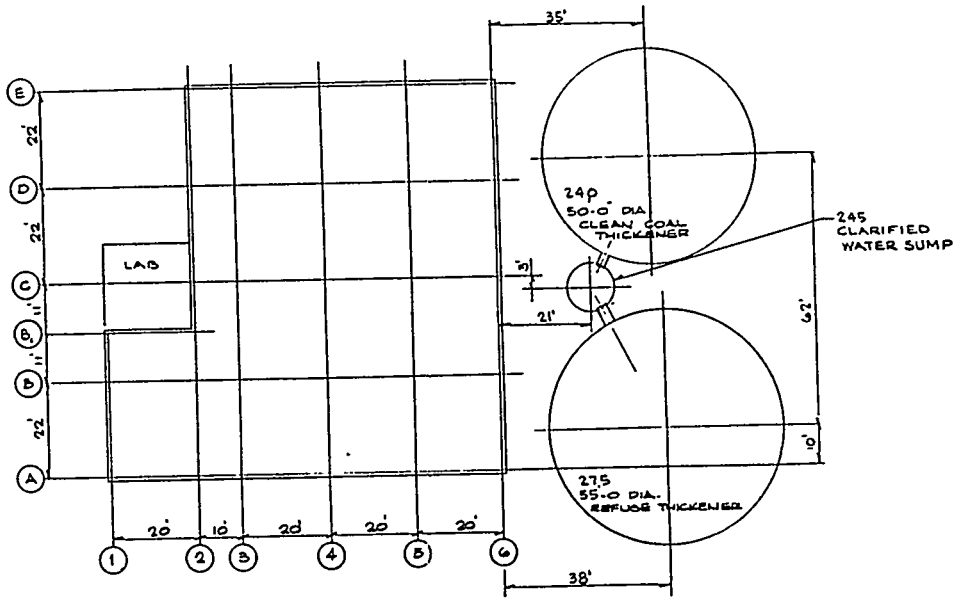


NO.	DATE	REVISION	BY	APP.	APP.	REFERENCE DRAWINGS	NUMBER	NOTES	DESCRIPTION
									COST ACCT

ING CYCLONES

ED



KEY PLAN
SCALE: 1" = 20'-0"

WORK THIS DWG. WITH DWG. 10-70-2101
10-70-2102

CONSTRUCTION APPROVAL	APPROVAL	DATE	SCALE: 1/8" = 1'-0"	DATE
			DESIGNED BY K. MOOTS	6/15/94
			DRAWN BY K. MOOTS	9/17/94
			CHECKED BY	
			APPROVED BY	
			APPROVED BY	

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PROFESSIONAL SEAL

ICF KAISER ENGINEERS
ICF KAISER ENGINEERS INC.
Four Gateway Center
Pittsburgh, PA 15222-1207
(412) 281-8121, TELEX: 199121

UNITED STATES DEPARTMENT OF ENERGY
ADVANCED FROTH FLOATATION PROCESS
PLAN AT ELEV. 54'-0" & KEY PLAN
POWER, CONTROL & INSTR. LOCATION PL

JOB No. 88107-250-00 | DWG. No. 10-70-2103 | R

MOTOR CONTROL CENTER NO. 1

1A 800 AMP INCOMING LINE SECTION	2A 112 SIZE 1NR RAW COAL SCREEN	3A DIST PNL 15A CKT. BKR.	4A 105.1 30A CKT. BKR.	5A LTG PNL 45A CKT. BKR.	6A SPARE 45A CKT. BKR.	7A SPACE
		3B UPS TRANS 15A CKT. BKR.	4B SPARE 15A CKT. BKR.	5B PWR TRANS 15A CKT. BKR.	6B SPACE	
	2C 113 SIZE 1NR OVERSIZE BUCKET ELEVATOR	3C 120 SIZE 2NR RAW COAL FEED PUMP	4C 150 SIZE 4NR MIDDLINGS CHRUSHER DRIVE #1	5C SPARE 30A CKT. BKR.	6C 120 VAC PROCESS POWER DISTRIB. PANEL	7C SPACE
				5D 152 SIZE 3NR OVERSIZE PROTECTION PUMP		
	2E 110 SIZE 3NR RAW COAL CRUSHER #1	3E 135 SIZE 1NR REFUSE CENTRIFUGE DRIVE				7E SPACE
		3G 135.1 SIZE 1NR REFUSE CENTRIFUGE VIBRATOR				7G SIZE 1NR SPARE
			4H 150.1 SIZE 4NR MIDDLINGS CHRUSHER DRIVE #2	5H 160 SIZE 4NR FINE HYDRO FEED PUMP		
	2J 111 SIZE 3NR RAW COAL CRUSHER #2	3J 135.2 SIZE 1NR REFUSE CENTRIFUGE OIL PUMP			6J 5 KVA PROCESS POWER TRANFORMER	7J SIZE 1NR SPARE
		3L 145 SIZE 1NR DESLIME SCREEN				7L SIZE 2NR SPARE

MOTOR CONT

1A 800 AMP INCOMING LINE SECTION	2A SPACI
	2B SIZE ADVANC FLOTAT FEED P
	2G SIZE CLASSIF CYCLO PUMP

MOTOR CONTROL CENTER NO. 4

1A 800 AMP INCOMING LINE SECTION	2A 395 40A CKT. BKR.	3A 380 SIZE 1NR MAGNETIC SEPARATOR	4A 405.2 SIZE 1NR FROTHER TRANSFER PUMP	5A SPACE	6A SPACE
	2B 340 SIZE 2NR MIDS DRAIN & RINSE SCREEN	3C 385.1 SIZE 1NR MAGNETITE BIN DUST COLLECTOR	4C 405.6 SIZE 1NR COLLECTOR TRANSFER PUMP	5C SPACE	6C SPACE
	2D 350 SIZE 2NR REFUSE DRAIN & RINSE SCREEN	3E 390 SIZE 1NR MAGNETITE ROTARY VALVE	4E 415 SIZE 1NR OVERDENSE MEDIA PUMP	5E 500.1 30A CKT. BKR.	6E SPARE 30A CKT. BKR.
	2F 375 SIZE 1NR DILUTE MEDIA PUMP			5F 500.2A 30A CKT. BKR.	6F SPARE 40A CKT. BKR.
	2H 325 SIZE 4NR HEAVY MEDIA CYCLONE PUMP	3G 400.2 SIZE 1NR ANIONIC MIXER	4G 485 SIZE 1NR CLEAN-UP PUMP	5G WELD RCPT. 100A CKT. BKR.	6G SPARE 60A CKT. BKR.
				5H WELD RCPT. 100A CKT. BKR.	6H 430 60A CKT. BKR.
		3J 398 300A CKT. BKR. PLANT & COLUMN AIR COMPRESSOR	4J 495 SIZE 1NR GLAND WATER PUMP	5J SIZE 1NR SPARE	6J SIZE 1NR SPARE
			4L 500.13 SIZE 1NR AUTOMATIC FLOC MIXING SYSTEM	5L SIZE 1NR SPARE	6L SIZE 2NR SPARE

MOTOR CON

1A 600 AMP INCOMING LINE SECTION	2A 20A CKT
	2B 20A CKT
	2C 20A CKT
	2D 20A CKT
	2E 20A CKT
	2F 20A CKT
	2G 20A CKT
	2H 30A CKT
	2J 30A CKT
	2K 30A CKT
	2L 30A CKT
	2M 30A CKT

NO	DATE	REVISION	BY	CHK	APP	APP	REFERENCE DRAWINGS	NUMBER	NOTES	DESCRIPTION COST
										WORK COVERED BY THIS AU CHARGED TO COST ACCOUNT

TROL CENTER NO. 2

	3A SPACE	4A SPACE
220 INR ED ION JMP	3C 230.1A SIZE 4NR ADVANCED FLOTATION PUMP "A"	4C 230.1C SIZE 4NR ADVANCED FLOTATION PUMP "C"
205 3NR RING AE	3H 230.1B SIZE 4NR ADVANCED FLOTATION PUMP "B"	4H 230.1D SIZE 4NR ADVANCED FLOTATION PUMP "D"

MOTOR CONTROL CENTER NO. 3

1A 800 AMP INCOMING LINE SECTION	2A 240 SIZE 1NR COAL STAT. THICK. DRIVE	3A 249 SIZE 2NR COAL STATIC THICK. U'FLOW PUMP	4A 260.1A SIZE 1NR AGITATOR "A"	5A SIZE 1NR SPARE	6A SPACE
	2C 260 SIZE 1NR CLEAN COAL FILTER DRIVE	3C 260.5 SIZE 1NR LUBRICATOR	4C 260.1B SIZE 1NR AGITATOR "B"	5C SIZE 1NR SPARE	6B SPACE
	2E 260.4 SIZE 1NR FILTRATE PUMP	3E 260.6 SIZE 1NR AUX. AIR COMPRESSOR	4E 260.1C SIZE 1NR AGITATOR "C"	5E SIZE 2NR SPARE	6D SPACE
	2G 240.1 SIZE 1R COAL STATIC THICK. LIFT. DEVICE	3G 247 SIZE 5NR COAL THICK. CLARIFIED WATER PUMP	4G 260.7 SIZE 1NR INTERNAL CONVEYOR	5G 275 SIZE 1NR REFUSE STATIC THICK. DRIVE	6F SIZE 1R SPARE
	2K 275.1 SIZE 1R REFUSE STATIC THICK. LIFT. DEVICE		4J 260.2 SIZE 3NR DISCHARGE GATES	5J 260.3 300A CKT. BKR. AIR COMPRESSOR	6J 290 SIZE 3NR REFUSE STATIC THICK. U'FLOW PUMP

TROL CENTER NO. 5

UH-1A BKR.	3A UH-3F 30A CKT. BKR.	4A SPARE 40A CKT. BKR.
UH-1B BKR.	3B UH-3G 30A CKT. BKR.	4B SPARE 30A CKT. BKR.
UH-1C BKR.	3C UH-3H 30A CKT. BKR.	4C SPARE 30A CKT. BKR.
UH-1D BKR.	3D UH-3I 30A CKT. BKR.	4D SPARE 30A CKT. BKR.
UH-1E BKR.	3E UH-3J 30A CKT. BKR.	4E SPARE 30A CKT. BKR.
UH-1F BKR.	3F UH-3K 30A CKT. BKR.	4F SPARE 20A CKT. BKR.
UH-1G BKR.	3G UH-3L 30A CKT. BKR.	4G SPARE 20A CKT. BKR.
UH-3A BKR.	3H UH-3M 30A CKT. BKR.	4H SPACE
UH-3B BKR.	3J UH-3N 30A CKT. BKR.	4J SPACE
UH-3C BKR.	3K AC-1 30A CKT. BKR.	4K SPACE
UH-3D BKR.	3L AC-2 30A CKT. BKR.	4L SPACE
UH-3E BKR.	3M AC-3 40A CKT. BKR.	4M SPACE

MOTOR CONTROL CENTER NO. 6

1A 600 AMP INCOMING LINE SECTION	2A UH-2A 30A CKT. BKR.	3A UH-2I 30A CKT. BKR.	4A UH-2R 30A CKT. BKR.	5A SPACE
	2B UH-2B 30A CKT. BKR.	3B UH-2J 30A CKT. BKR.	4B UH-2S 30A CKT. BKR.	
	2C UH-2C 30A CKT. BKR.	3C UH-2K 30A CKT. BKR.	4C UH-2T 30A CKT. BKR.	5C SPACE
	2D UH-2D 30A CKT. BKR.	3D UH-2L 30A CKT. BKR.	4D UH-2U 30A CKT. BKR.	
	2E UH-2E 30A CKT. BKR.	3E UH-2M 30A CKT. BKR.	4E HV-1 40A CKT. BKR.	5E SPARE 30A CKT. BKR.
	2F UH-2F 30A CKT. BKR.	3F UH-2N 30A CKT. BKR.	4F HV-2 60A CKT. BKR.	5F SPARE 30A CKT. BKR.
	2G UH-2G 30A CKT. BKR.	3G UH-2P 30A CKT. BKR.	4G SPARE 60A CKT. BKR.	5G SPARE 30A CKT. BKR.
	2H UH-2H 30A CKT. BKR.	3H UH-2Q 30A CKT. BKR.	4H SPARE 40A CKT. BKR.	5H SPARE 30A CKT. BKR.
	2J EF-1 SIZE 1NR BLDG. EXHAUST FAN #1	3J EF-2 SIZE 1NR BLDG. EXHAUST FAN #2	4J EF-3 SIZE 1NR BLDG. EXHAUST FAN #3	5J SIZE 1NR SPARE
	2L EF-4 SIZE 1NR BLDG. EXHAUST FAN #4	3L EF-5 SIZE 1NR BLDG. EXHAUST FAN #5	4L EF-6 SIZE 1NR BLDG. EXHAUST FAN #6	5L SIZE 1NR SPARE

	CONSTRUCTION APPROVAL	APPROVAL	DATE
ACCOUNT COUNT ABOVE			

SCALE: NONE

		DATE
DESIGNED BY:	R. BURTNETT	5/31/94
DRAWN BY:	D.M. KISELICA	6/6/94
CHECKED BY:		
APPROVED BY:		
APPROVED BY:		

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PROFESSIONAL SEAL

ICF KAISER

ICF KAISER ENGINEERS, INC.
FOUR GATEWAY CENTER
PITTSBURGH, PA 15222 1297
(412) 497-2000

UNITED STATES DEPARTMENT OF ENERGY
ADVANCED FROTH FLOATATION

MOTOR CONTROL CENTERS #1, #2, #3, #4, #5 & #6
FRONT VIEW LAYOUTS

JOB NO.	DWG. NO.	REVISI
88107-250	10-70-2201	R-

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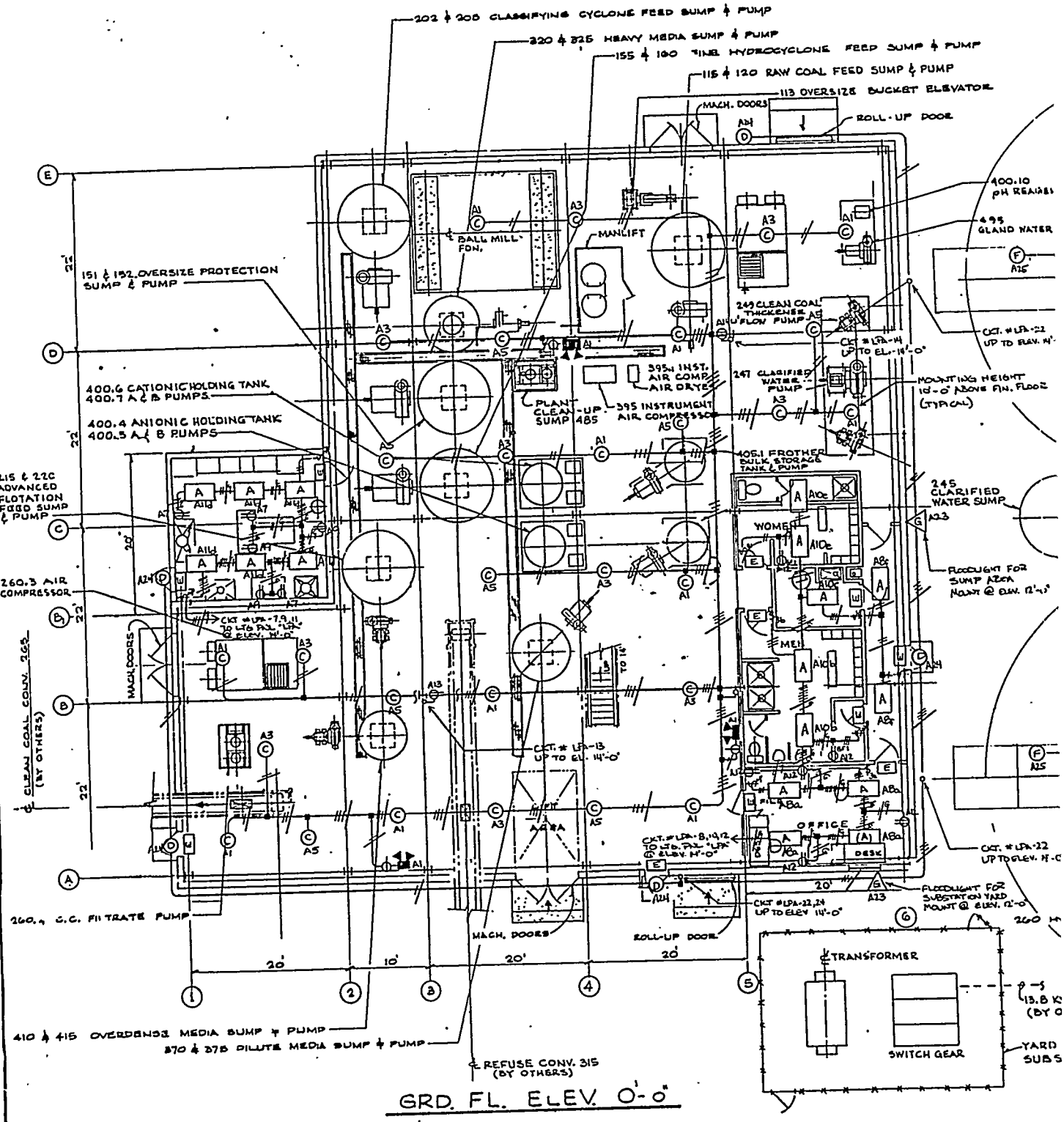
21-APR-1994 17:1



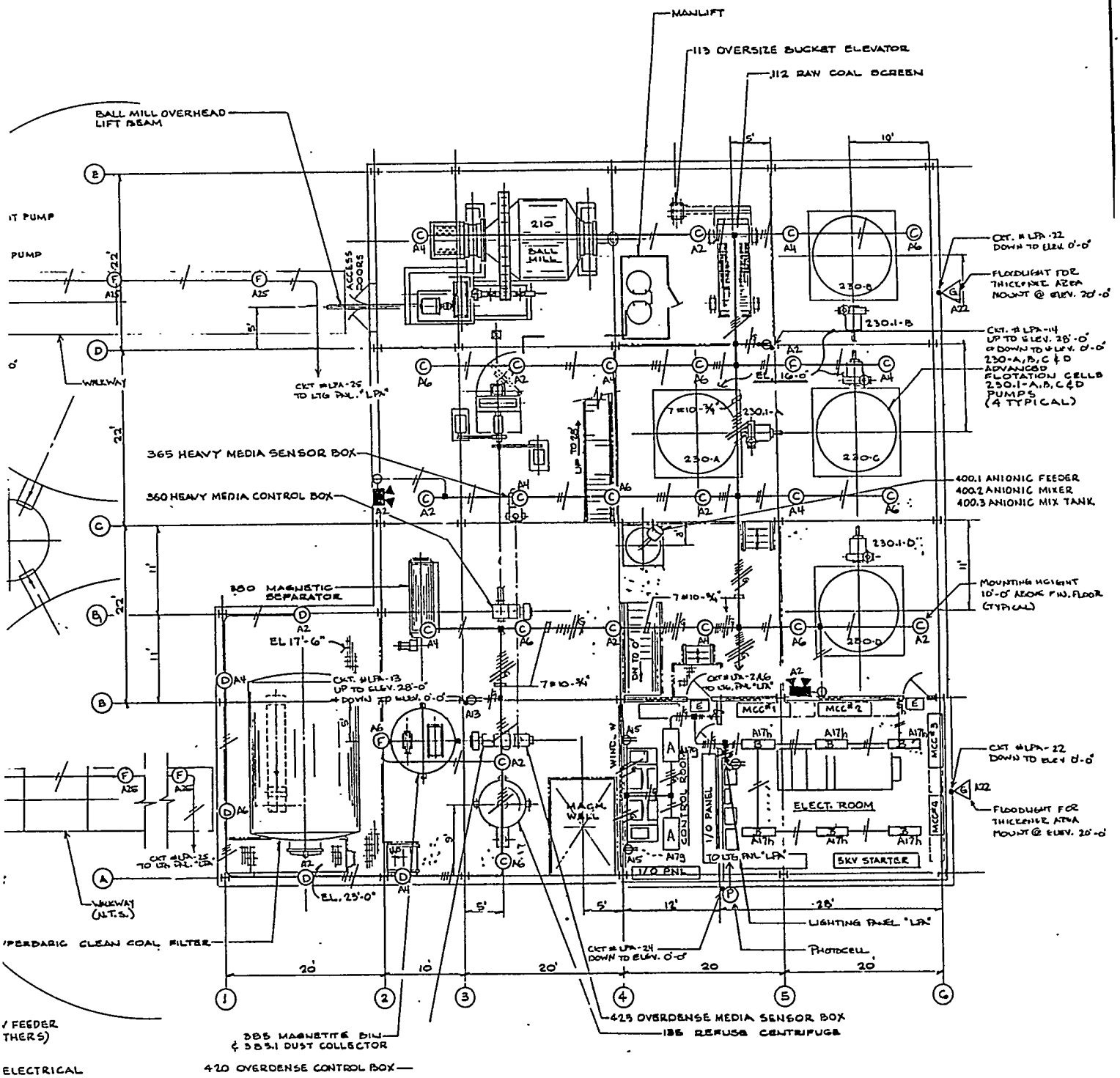
NO.	DATE	REVISION	BY	CHK.	APP.

REFERENCE DRAWINGS	NUMBER
LIGHTING PLANS @ ELEV. 25'-4" & 40'	10-70-2402
LTG. PLANS @ ELEV. 54' & KEY PLAN	10-70-2403
LTG. DETAIL, NOTES & LEGEND	10-70-2405
LTG PANEL "LPA" CIRCUIT SCHEDULE	10-70-2406

NOTES

DESCRIPTION COST / $

WORK COVERED BY THIS DR. CHARGED TO COST ACCOUNT



FL. ELEV. 14'-0" (UNLESS NOTED)

CONSTRUCTION APPROVAL	APPROVAL	DATE	SCALE: 1/8" = 1'-0"	DATE
			DESIGNED BY R SABOL	6/14/94
			DRAWN BY R. SABOL	6/21/94
			CHECKED BY	
			APPROVED BY	
			APPROVED BY	

PROFESSIONAL SEAL

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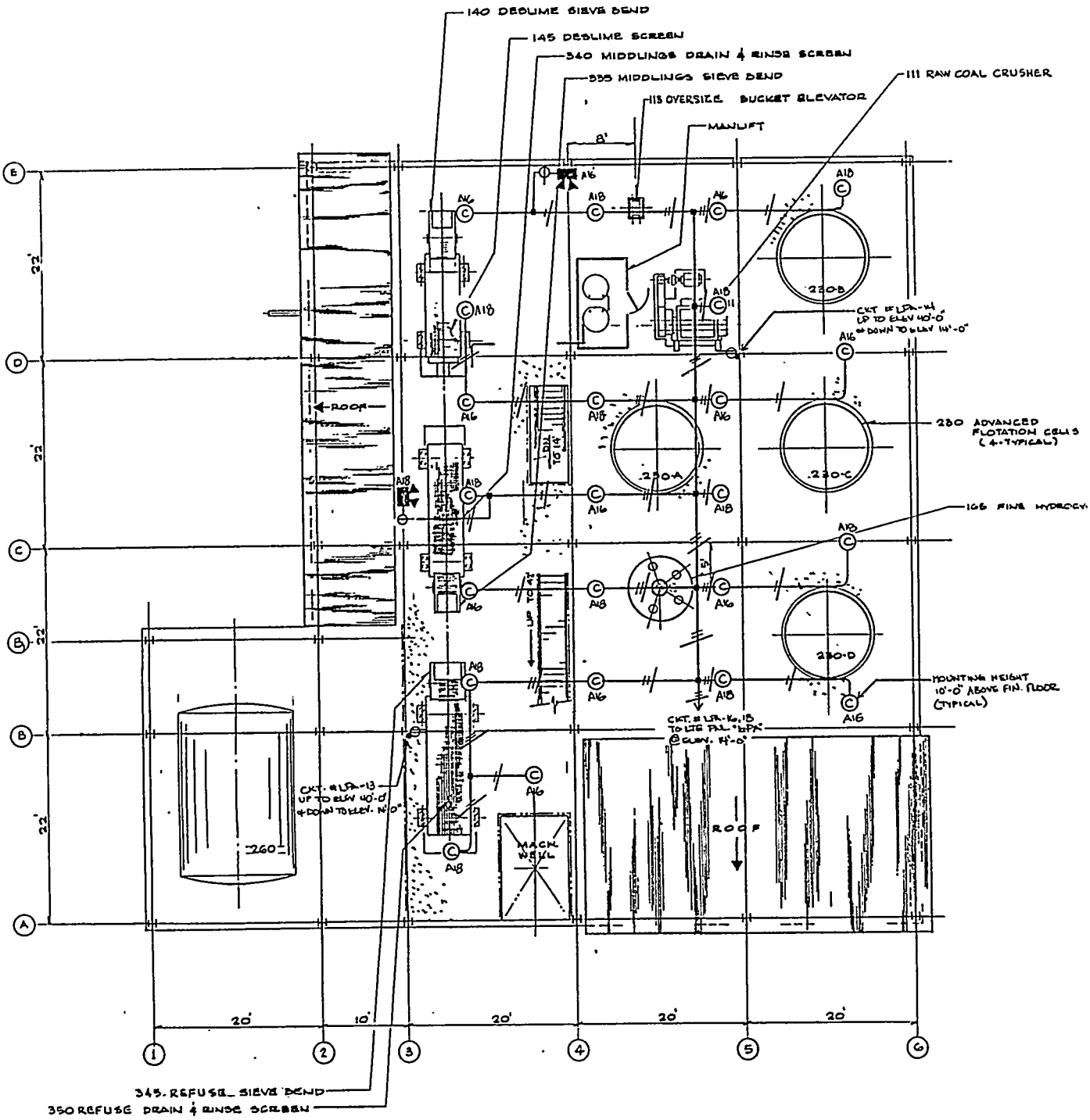
ICF KAISER ENGINEERS

ICF KAISER ENGINEERS INC.
Four Gateway Center
Pittsburgh, PA 15222-1207
(412) 281-8121, TELEX: 199121

UNITED STATES DEPARTMENT OF ENERGY

ADVANCED FROTH FLOTATION PROCESS
PLAN AT ELEV. 0'-0" & 14'-0"
LIGHTING PLANS

JOB No. 88107-250-00 | DWG. No. 10-70-2401 | REV R.



FL. ELEV. 28'-0"

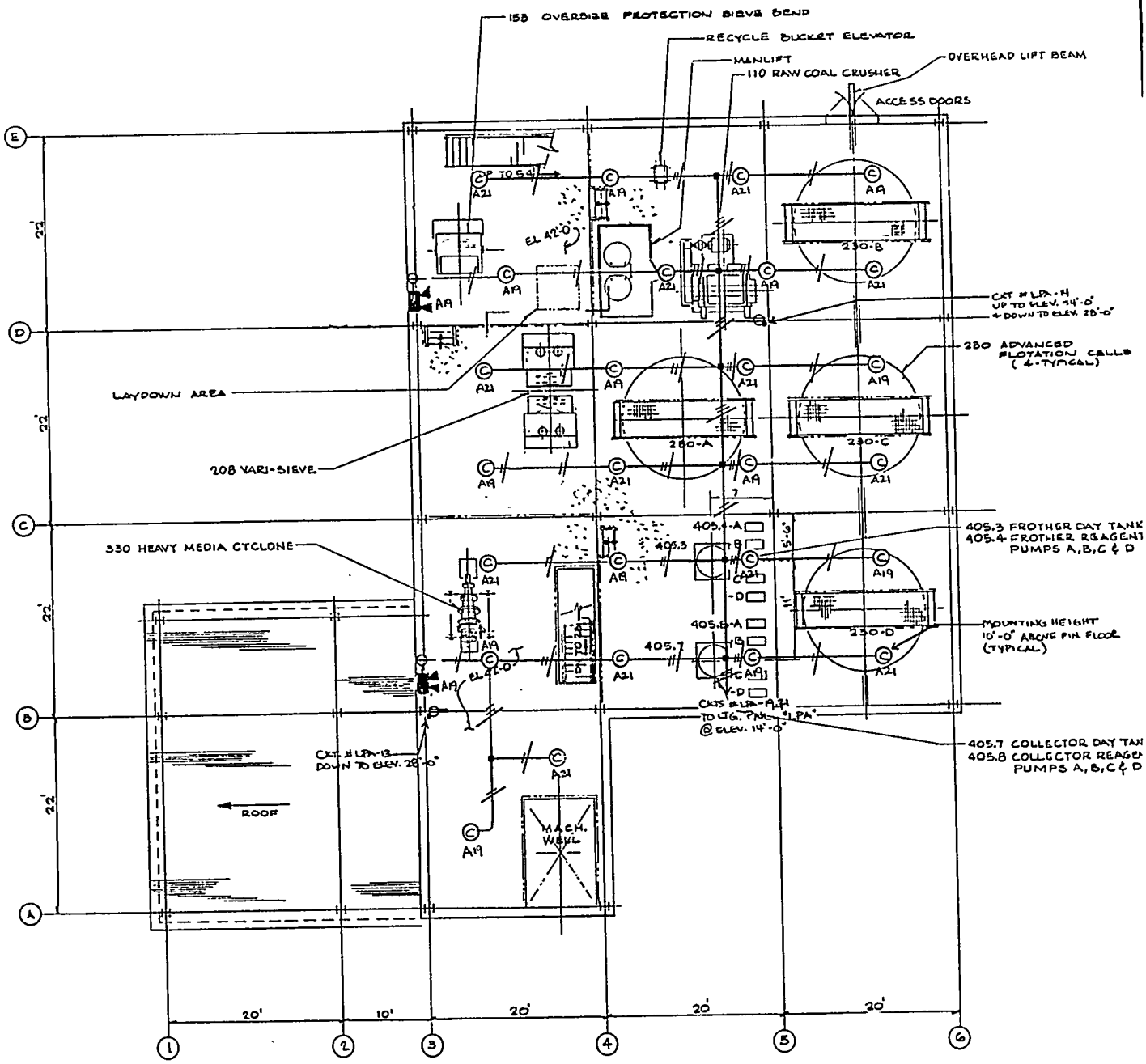
NO.	DATE	REVISION	BY	CHK	APP.	APP.

REFERENCE DRAWINGS	NUMBER
LTG PLANS @ EL. 0'-0" & 14'	10-70-2401
LTG PLANS @ EL. 54' & KEY PLAN	10-70-2403
LTG. DETAILS, NOTES & LEGEND	10-70-2405
LTG PNL. "LSA" CIRCUIT SCHEDULE	10-70-2406

NOTES

DESCRIPTION COST AC

WORK COVERED BY THIS RD CHARGED TO COST ACCOUNT



FL. ELEV. 40'-0" (UNLESS NOTED)

CONSTRUCTION APPROVAL	APPROVAL	DATE	SCALE: 1/8" = 1'-0"	DATE	PROFESSIONAL SEAL	ICF KAISER ENGINEERS	ICF KAISER ENGINEERS INC. Four Gateway Center Pittsburgh, PA 15222-1207 (412) 281-8121, TELEX: 199121
			DESIGNED BY R. SABOL	6/15/94			UNITED STATES DEPARTMENT OF ENERGY
			DRAWN BY R. SABOL	6/22/94			ADVANCED FROTH FLOTATION PROCESS PLAN AT ELEV. 28'-0" & 40'-0" LIGHTING PLANS
			CHECKED BY				
			APPROVED BY			JOB No. 88107-250-00	DWG. No. 10-70-2402 REV R-
			APPROVED BY				

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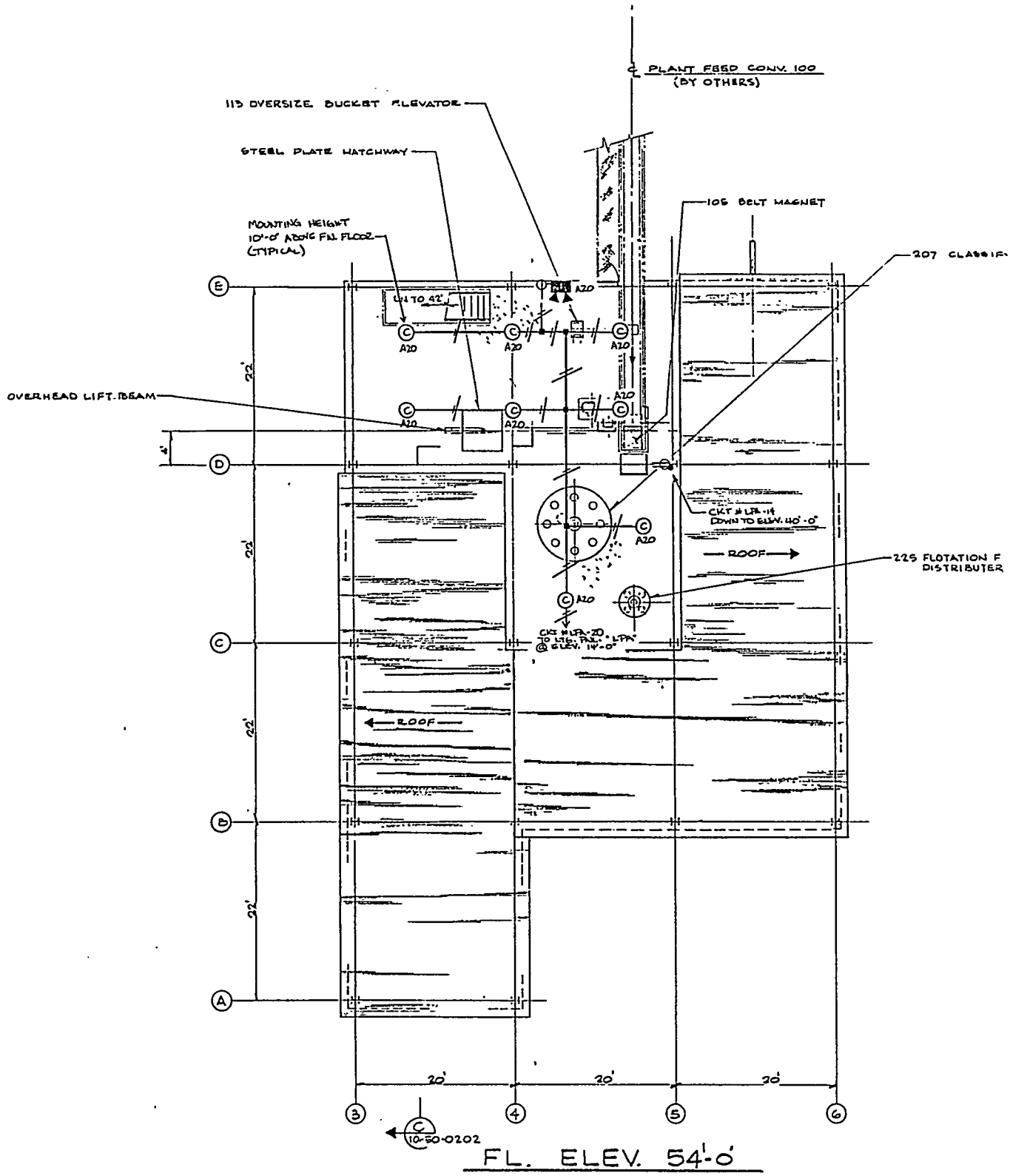
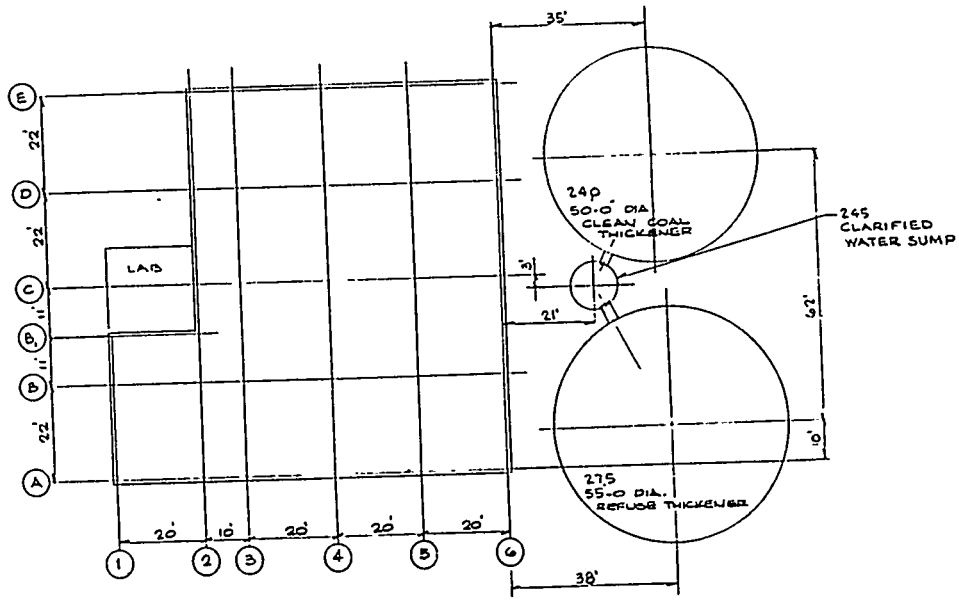


NO.	DATE	REVISION	BY	APP.	APP.	REFERENCE DRAWINGS	NUMBER	NOTES	DESCRIPTION	COST AC
						LTG PLAN @ EL. 0' & 14'	10-70-2401			
						LTG PLAN @ EL. 28' & 40'	10-70-2402			
						LTG. DETAILS, NOTES & LEGEND	10-70-2405			
						LTG PNL. "LPA" CIRCUIT SCHEDULE	10-70-2406			

WORK COVERED BY THIS DR
CHARGED TO COST ACCOUNT

TING CYCLONES

ED



KEY PLAN
SCALE: 1" = 20'-0"

CONSTRUCTION APPROVAL	APPROVAL	DATE	SCALE: 1/8" = 1'-0"	DATE
			DESIGNED BY R. SABOL	6/15/94
			DRAWN BY R SABOL	6/21/94
			CHECKED BY	
			APPROVED BY	
			APPROVED BY	

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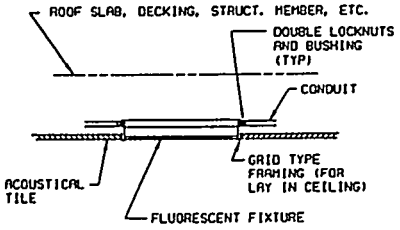
ICF KAISER ENGINEERS

ICF KAISER ENGINEERS INC.
Four Gateway Center
Pittsburgh, PA 15222-1207
(412) 281-8121, TELEX: 199121

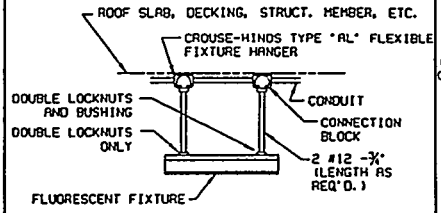
UNITED STATES DEPARTMENT OF ENERG
ADVANCED FROTH FLOTATION PROCESS
PLAN AT ELEV. 54'-0" & KEY PLAN
LIGHTING PLANS

JOB No. 88107-250-00 | DWG. No. 10-70-2403 | R

COUNT



DETAIL #1



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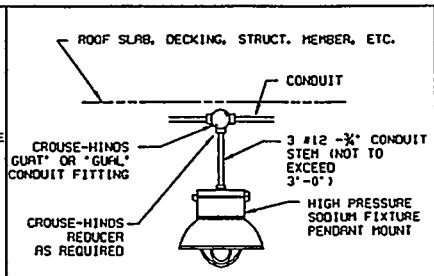

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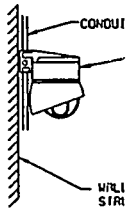

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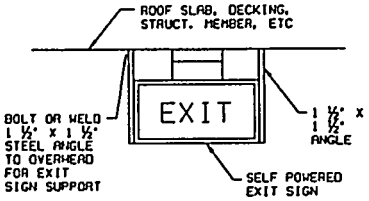

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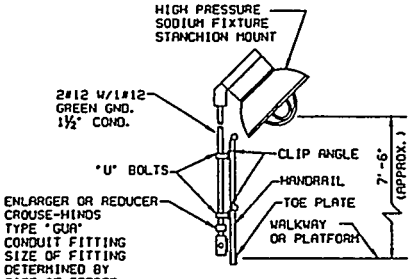

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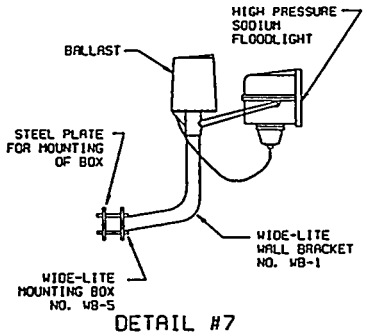
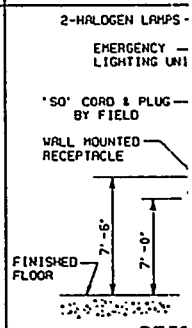
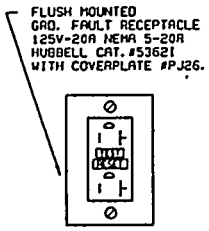


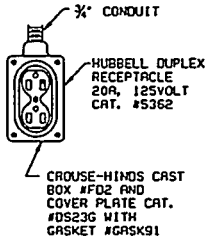
DETAIL #7



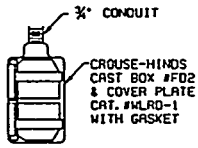
DETA



DETAIL #9

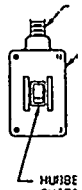


DETAIL #10



NOTE:
DUPLEX RECEPTACLE IN BOX TO BE HUBBELL 20A, 125VAC, 2 POLE, 3 WIRE GROUNDED. CAT. #53CM62

DETAIL #11



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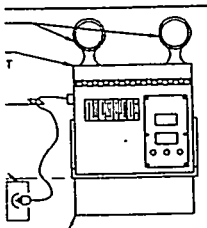
NO	DATE	REVISION	BY	CH	APP	APP	REFERENCE DRAWINGS	NUMBER	NOTES	DESCRIPTION COST F
										WORK COVERED BY THIS AC CHARGED TO COST ACCOUNT
							LIGHTING ELEV. 0' & 14'	10-70-2401		
							LIGHTING ELEV. 28' & 40'	10-70-2402		
							LIGHTING ELEV. 54' & KEY PLAN	10-70-2403		
							LTG PNL "LPA" CIRCUIT SCHEDULE	10-70-2406		

T

HIGH PRESSURE SODIUM FIXTURE WALL MOUNT

OR
JCTURAL MEMBER

TAIL #4



EMERGENCY LIGHTING UNIT MOUNTING BRACKET EXIDE CAT#M88

IIL #8

¾" CONDUIT

CROUSE-HINDS CAST BOX #FD2 & COVER PLATE #DS32G WITH GASKET #GASK91

LL AC
H, TOGGLE TYPE
20/277 VOLT
IGLE POLE #1201
IBLE POLE #1202
EE-WAY #1203

DETAIL #12

LIGHTING FIXTURE SCHEDULE

LTR CODE	LAMP WATTS	LAMP TYPE	FIXTURE MFR.	FIXTURE CAT. NO.	MTG. DET.	START CURR.	RUN CURR.	REMARKS
A	4-40 W	F40-RS/CW	DAYBRITE OR EQUAL	CG244-C02D -120V	1	1.67A	1.67A	FLUORESCENT (120VAC) 2'X4' RECESSED FOR GRID INVERTED CEILING
B	2-40 W	F40-RS/CW	DAYBRITE OR EQUAL	45267-4	2	0.83A	0.83A	FLUORESCENT (120VAC) 1'X4' RECESSED FOR STEM MOUNTED
C	100	G.E. LU100	GENERAL ELECTRIC OR EQUAL	H2110S3PGG	3	0.7A	1.2A	PENDANT MOUNTED HIGH PRESSURE SODIUM, ¾" HUBS (120 VAC)
D	100	G.E. LU100	GENERAL ELECTRIC OR EQUAL	H2110S3WGG	4	0.7A	1.2A	WALL MOUNTED HIGH PRESSURE SODIUM, ¾" HUBS (120 VAC)
E			LITHONIA OR EQUAL	XS3R-EL120	5			EMERGENCY EXIT SIGN (120V)
F	100	G.E. LU100	GENERAL ELECTRIC OR EQUAL	H2110S6JGG	6	0.7A	1.2A	STANCHION MOUNTED HIGH PRESSURE SODIUM, 1¼" HUBS (120 VAC)
G	400	LU400	WIDELITE OR EQUAL	FS-400C-QV	7		4.3A	FLOOD LIGHT, 2" HUBS (120 VAC)
H	2-25W		EXIDE OR EQUAL	NX-4002WPS2S6	8			EMERGENCY LIGHT: TWO HEAD, 120/277V, 2-25W, 6V LAMPS

LIGHTING CONTROL SCHEDULE

LTR CODE	CONTROL DEVICE MANUFACTURER	CAT. NO.	DESCRIPTION
P	CROUSE-HINDS	PHOTOCELL-#DS60 BOX-#FD2	PHOTOCELL, 120V, 1000W, 60HZ, OPERATING TEMPERATURE OF -40°F TO 120°F ENCLOSED IN FD CAST BOX WITH ALUMINUM COVER.

GENERAL LIGHTING NOTES

1. ALL WORK SHALL BE DONE IN STRICT CONFORMANCE WITH ALL REQUIREMENTS SET FORTH BY ANY MUNICIPAL ORDINANCE, PUBLIC UTILITIES, STATE CODES, NATIONAL ELECTRICAL SAFETY CODES, ALL O.S.H.A. REQUIREMENTS AND ICF KAISER ENGINEERS INSTALLATION, CONSTRUCTION, PLANS AND DETAIL DRAWINGS.
2. ALL UNDERGROUND LIGHTING CONDUIT RUNS TO BE RIGID GAL. STEEL CONDUIT (MIN. 1") ENCASED IN CONCRETE 3" MIN. COVER.
3. EXACT LOCATION OF CONDUITS AND LIGHTING FIXTURES TO BE DETERMINED BY FIELD.
4. ALL FIXTURES TO BE GROUNDED.
5. ALL CONDUIT CONNECTIONS TO BE MADE TIGHT, TO FORM A CONTINUOUS PATH FOR GROUND CURRENTS TO EARTH.
6. FIXTURE MOUNTING HEIGHT WILL BE INDICATED ON DRAWING. MOUNTING HEIGHT WILL BE FROM TOP OF FLOOR TO BOTTOM OF FIXTURE.
7. MOUNT RECEPTACLES 3'-0" ABOVE FINISHED FLOOR.
8. MOUNT SWITCHES 4'-6" ABOVE FINISHED FLOOR.
9. ALL LIGHTING CONDUITS WILL BE ¾", WITH 1/C #12 AWG. CU THHN/THWN, 600V, 90°C WIRE UNLESS OTHERWISE NOTED.
10. ALL WIRING TO BE COLOR CODED AS FOLLOWS: PHASE "A"-BLACK, PHASE "B"-RED, PHASE "C"-BLUE NEUTRAL-WHITE, GROUND-GREEN.

LIGHTING LEGEND

- FLUORESCENT LIGHTING FIXTURE (1'x4') BALLAST TO BE UL & CBM CERTIFIED - SEE DETAIL #2.
- FLUORESCENT LIGHTING FIXTURE (2'x4') BALLAST TO BE UL & CBM CERTIFIED - SEE DETAIL #1.
- FLOODLIGHT, LETTERS "AC" INDICATE PHASE CONNECTION WHERE APPLICABLE. SEE DETAIL #7.
- TYPICAL DESIGNATION OF LIGHT FIXTURE, LETTER "C" INSIDE SYMBOL INDICATES FIXTURE TYPE (SEE LIGHTING FIXTURE SCHEDULE), A10a INDICATES CIRCUIT #10 FROM PANEL "A" CONTROLLED FROM SWITCH "a" (NO SWITCH DENOTES FIXTURE IS CONTROLLED AT PANEL)
- DENOTES CONVENIENCE RECEPTACLE, 3 WIRE, 2 POLE, 20 AMP, 125VAC SEE DETAIL #10. "WP" a SYMBOL DENOTES WEATHER PROOF RECEPTACLE - SEE DETAIL #11. "GFI" a SYMBOL DENOTES GROUND FAULT INTERRUPTER - SEE DETAIL #9.
- DENOTES SINGLE POLE NEMA 12 TYPE TOGGLE SWITCH, WHICH CONTROLS ALL FIXTURES MARKED "a" - SEE DETAIL #12.
- DENOTES THREE-WAY TOGGLE SWITCH NEMA 12 WHICH CONTROLS ALL FIXTURES MARKED "a" - SEE DETAIL #12.
- INDICATES CEILING OR WALL MOUNTED EXIT LIGHT SEE DETAIL #5.
- CROUSE-HINDS TYPE "GUA" SERIES CONDUIT FITTING-DOME COVERS TO BE USED WHERE ADDITIONAL WIRING SPACE IS REQUIRED.
- SLASH MARKS INDICATE NUMBER OF WIRES IN CONDUIT, SHORT SLASH MARKS REPRESENT PHASE WIRES, LONG SLASH MARK REPRESENTS THE NEUTRAL WIRE AND G INDICATES GREEN GROUND WIRE.
- DENOTES CONDUIT TURNING UP AND DENOTES CONDUIT TURNING DOWN.
- DENOTES CONDUIT RUNNING EXPOSED AND DENOTES CONDUIT RUNNING EMBEDDED OR UNDER A FLOOR, BEHIND A WALL, ETC.
- DENOTES EMERGENCY LIGHTING WALL MOUNTED UNIT SEE DETAIL #8.

	CONSTRUCTION APPROVAL	APPROVAL	DATE	SCALE: NONE	DATE
				DESIGNED BY: R. SABOL	05/16/94
				DRAWN BY: R. SABOL	05/23/94
				CHECKED BY:	
				APPROVED BY:	
				APPROVED BY:	

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ICF KAISER ENGINEERS, INC.
FOUR GATEWAY CENTER
PITTSBURGH, PA 15222-1207
(412) 497-2000

ICF KAISER

UNITED STATES DEPARTMENT OF ENERGY
ADVANCED FROTH FLOTATION PROCESS

LIGHTING DETAILS, NOTES AND LEGEND

JOB NO. 88107-250	DWG. NO. 10-70-2405	REVISION R-

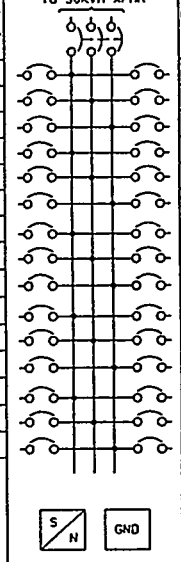
/usr5/prj/88107250/10702405.dg sabol

PANEL: LPA
LOCATION: ELECT. ROOM - EL. 14'-0"
MOUNTING: SURFACE

PANEL TYPE: 208/120V, 3ø, 4W
MAINS: 100 AMP
MINIMUM AIC: 14,000 AMP

SERVICE	CONNECTED LOAD (KVA) ØA	ØB	ØC	CIRCUIT BREAKER TYPE	TRIP	CKT NO.
PROCESS AREA - EL. 0'-0"	1.58			1P	20A	1
PROCESS AREA - EL. 0'-0"		1.44		1P	20A	3
PROCESS AREA - EL. 0'-0"			1.15	1P	20A	5
RECEPTACLES (LAB)				1P	20A	7
RECEPTACLES (LAB)				1P	20A	9
FLUORESCENT LIGHTS (LAB)			1.20	1P	20A	11
RECEPTACLES (LEFT COLUMN)				1P	20A	13
RECEPTACLES-CNTL/ELEC RM				1P	20A	15
FLUORESCENT LIGHTS - CONTROL/ELECTRIC ROOM			1.00	1P	20A	17
PROCESS AREA - EL. 42'-0"	1.87			1P	20A	19
PROCESS AREA - EL. 42'-0"		1.87		1P	20A	21
OUTDOOR FLOODLIGHTS ⊗ @ ELEV. 12'-0"			1.03	1P	20A	23
WALKWAYS - THICKENER AREA	0.86			1P	20A	25
SPARE				1P	20A	27
SPARE				1P	20A	29
	4.31	3.31	4.38	SUBTOTAL CONNECTED LOAD		

CONNECTED LOAD
PHASE A 8.10 KVA
PHASE B 8.36 KVA
PHASE C 8.27 KVA
TOTAL 24.73 KVA



CKT NO.	CIRCUIT BREAKER TRIP	TYPE	CONNECTED LOAD (KVA) ØA	ØB	ØC	SERVICE
2	20A	1P	1.44			PROCESS AREA - EL. 14'-0"
4	20A	1P		1.44		PROCESS AREA - EL. 14'-0"
6	20A	1P			1.44	PROCESS AREA - EL. 14'-0"
8	20A	1P	1.20			FLUORESCENT LIGHTS - OFFICE & HALLWAY
10	20A	1P		1.00		FLUORESCENT LIGHTS - MENS AND WOMENS RESTROOMS
12	20A	1P				RECEPTACLES - OFFICE & RESTROOMS
14	20A	1P				RECEPTACLE - RIGHT COLUMN
16	20A	1P		1.58		PROCESS AREA - EL. 28'-0"
18	20A	1P			1.73	PROCESS AREA - EL. 28'-0"
20	20A	1P	1.15			PROCESS AREA - EL. 54'-0"
22	20A	1P		1.03		OUTDOOR FLOODLIGHTS ⊗ @ ELEV. 20'-0"
24	20A	1P			0.72	OUTDOOR LIGHTS ⊗
26	20A	1P				SPARE
28	20A	1P				SPARE
30	20A	1P				SPARE
			3.79	5.05	3.89	SUBTOTAL CONNECTED LOAD

⊗ PHOTOCELL CONTROLLED

NO	DATE	REVISION	BY	APP	APP	REFERENCE DRAWINGS	NUMBER
						LIGHTING ELEV. 0' & 14'	10-70-2401
						LIGHTING ELEV. 28' & 40'	10-70-2402
						LIGHTING ELEV. 54' & KEY PLAN	10-70-2403
						LIGHTING DETAILS, NOTES & LEGEND	10-70-2405

NOTES

DESCRIPTION COST
WORK COVERED BY THIS
CHARGED TO COST ACCOUN

	CONSTRUCTION APPROVAL	APPROVAL	DATE	SCALE: NONE	DATE	PROFESSIONAL SEAL
				DESIGNED BY: R. SABOL	05/16/94	
				DRAWN BY: R. SABOL	05/23/94	
				CHECKED BY:		
				APPROVED BY:		
				APPROVED BY:		
ACCOUNT						
CCOUNT ABOVE						

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ICF KAISER

ICF KAISER ENGINEERS, INC
FOUR GATEWAY CENTER
PITTSBURGH, PA 15222-1207
(412) 497-2000

UNITED STATES DEPARTMENT OF ENERGY
ADVANCED FROTH FLOTATION PROCESS

LIGHTING PANEL 'LPA'
CIRCUIT SCHEDULE

JOB NO. 88107-250	DWG. NO. 10-70-2406	REVISION R-

/usr5/prj/88107250/10702406.dg sabol

APPENDIX D

ECONOMIC EVALUATIONS

ADVANCED FROTH FLOTATION ECONOMICS
200 TPH COMMERCIAL PLANT

3 CASE STUDIES

1) 7560 HOURS PER YEAR OPERATION
   - A) AT 10 % RATE OF RETURN
   - B) AT 15 % RATE OF RETURN
   - C) AT 20 % RATE OF RETURN

2) 5040 HOURS PER YEAR OPERATION

3) 3456 HOURS PER YEAR OPERATION

ADVANCED FROTH FLOTATION ECONOMICS AT 10 PERCENT RATE OF RETURN
200 TPH COMMERCIAL PLANT OPERATING 7560 HOURS PER YEAR

Cost Item	PITTSBURGH NO. 8 COAL	UPPER FREEPORT COAL	ILLNOIS NO. 6 COAL
Annualized Costs			
Raw Coal $/MMBtu	0.80	0.80	0.80
Raw Coal $/Ton	11.73	17.68	14.66
Clean Coal Incremental $/MMBtu	0.69	0.70	0.75
Clean Coal Total $/MMBtu	1.49	1.50	1.55
Clean Coal Total $/Ton	40.65	40.27	41.96
Levelized Costs			
Raw Coal $/MMBtu	1.06	1.06	1.06
Raw Coal $/Ton	15.48	23.33	19.35
Clean Coal Incremental $/MMBtu	0.91	0.92	0.98
Clean Coal Total $/MMBtu	1.97	1.98	2.04
Clean Coal Total $/Ton	53.66	53.16	55.39
Other Costs			
Present Value Of Costs	$180,642,000	$179,495,000	$193,879,000
Annualized Desulfurization Cost	$326.82	$305.42	$304.60
Payback Period (years)	7.9	7.9	7.9

ADVANCED FROTH FLOTATION ECONOMICS AT 15 PERCENT RATE OF RETURN
200 TPH COMMERCIAL PLANT OPERATING 7560 HOURS PER YEAR

Cost Item	PITTSBURGH NO. 8 COAL	UPPER FREEPORT COAL	ILLNOIS NO. 6 COAL
Annualized Costs			
Raw Coal $/MMBtu	0.80	0.80	0.80
Raw Coal $/Ton	11.73	17.68	14.66
Clean Coal Incremental $/MMBtu	0.78	0.79	0.83
Clean Coal Total $/MMBtu	1.58	1.59	1.63
Clean Coal Total $/Ton	43.04	42.66	44.36
Levelized Costs			
Raw Coal $/MMBtu	1.01	1.01	1.01
Raw Coal $/Ton	14.75	22.24	18.44
Clean Coal Incremental $/MMBtu	0.98	0.99	1.05
Clean Coal Total $/MMBtu	1.99	1.99	2.06
Clean Coal Total $/Ton	54.14	53.66	55.80
Other Costs			
Present Value Of Costs	$136,415,000	$135,621,000	$145,301,000
Annualized Desulfurization Cost	$368.27	$344.35	$340.64
Payback Period (years)	5.8	5.8	5.8

ADVANCED FROTH FLOTATION ECONOMICS AT 20 PERCENT RATE OF RETURN
200 TPH COMMERCIAL PLANT OPERATING 7560 HOURS PER YEAR

Cost Item	PITTSBURGH NO. 8 COAL	UPPER FREEPORT COAL	ILLNOIS NO. 6 COAL
Annualized Costs			
Raw Coal $/MMBtu	0.80	0.80	0.80
Raw Coal $/Ton	11.73	17.68	14.66
Clean Coal Incremental $/MMBtu	0.89	0.89	0.94
Clean Coal Total $/MMBtu	1.69	1.69	1.74
Clean Coal Total $/Ton	45.92	45.53	47.24
Levelized Costs			
Raw Coal $/MMBtu	0.97	0.97	0.97
Raw Coal $/Ton	14.19	21.39	17.74
Clean Coal Incremental $/MMBtu	1.07	1.08	1.14
Clean Coal Total $/MMBtu	2.04	2.05	2.11
Clean Coal Total $/Ton	55.57	55.10	57.16
Other Costs			
Present Value Of Costs	$111,087,000	$110,496,000	$117,473,000
Annualized Desulfurization Cost	$418.14	$391.17	$383.98
Payback Period (years)	4.5	4.5	4.5

CAPITAL REQUIREMENTS FOR 200 TPH (PRODUCT) PLANTS OPER ATING 7560 HOURS PER YEAR			
DIRECT PROCESSING COSTS ESTIMATION			
COST ITEM	ALL THRE COALS		
A–CAPITAL COST OF PLANT	54,706,341		
B–CAPITAL COST OF EQUIPMENT	23,433,315		
C–MECHANICAL EQUIPMENT COST	19,988,023		
D–LAND PURCHASE	2,500,000		
E–STARTUP MODIFICATIONS	1,094,127		
F–PREPRODUCTION COSTS	PITTSBURGH NO. 8	UPPER FREEPORT	ILLINOIS NO. 6
POWER	720,166	720,166	720,166
FLOCCULANTS	55,138	76,572	151,339
FLOTATION REAGENTS	150,312	58,449	103,185
WATER	3,345	2,003	2,911
GRINDING MEDIA	54,425	51,296	53,881
LUBRICANTS	5,882	3,940	4,890
MAGNETITE	17,418	17,418	14,787
MANPOWER	122,303	122,303	122,303
MAINTENANCE SUPPLIES	195,278	195,278	195,278
DIRECT PROCESSING COSTS (A+D+E+F)	59,624,735	59,547,893	59,669,206
WORKING CAPITAL REQUIREMENT ESTIMATION			
COST ITEM	PITTSBURGH NO. 8	UPPER FREEPORT	ILLINOIS NO. 6
FLOCCULANTS	13,233	18,377	36,321
FLOTATION REAGENTS	36,075	14,028	24,764
GRINDING MEDIA	13,062	12,311	12,931
LUBRICANTS	1,412	946	1,174
MAGNETITE	4,180	4,180	3,549
SPARE PARTS= 2 % OF MECH. EQUIP.	399,760	399,760	399,760
TOTAL WORKING CAPITAL REQUIRED	467,723	449,603	478,500

ANNUAL OPERATING AND MAINTENANCE COSTS FOR 200 TPH (PRODUCT) PLANTS OPER ATING 7560 HOURS PER YEAR			
YEARLY FIXED OPERATING AND MAINTENANCE COSTS			
COST ITEM	PITTSBURGH NO. 8	UPPER FREEPORT	ILLINOIS NO. 6
PLANT LABOR COSTS	1,467,639	1,467,639	1,467,639
ADMINISTATIVE LABOR AND COSTS	440,292	440,292	440,292
MAINTENANCE SUPPLIEIS	2,343,330	2,343,330	2,343,330
INSURANCE AND TAXES	1,641,190	1,641,190	1,641,190
TOTAL YEARLY FIXED O&M COSTS	5,892,451	5,892,451	5,892,451
YEARLY VARIABLE OPERATING AND MAINTENANCE COSTS			
COST ITEM	PITTSBURGH NO. 8	UPPER FREEPORT	ILLINOIS NO. 6
FLOCCULANTS	661,651	918,861	1,816,063
FLOTATION REAGENTS	1,803,749	701,393	1,238,219
GRINDING MEDIA	653,105	615,551	646,574
LUBRICANTS	70,583	47,282	58,677
MAGNETITE	209,019	209,019	177,448
POWER	8,641,987	8,641,987	8,641,987
PROCESS WATER	40,144	24,041	34,927
TOTAL YEARLY VARIABLE O&M COSTS	12,080,238	11,158,134	12,613,895

OPERATING AND MAINTENANCE COSTS FOR PITTSBURGH SEAM FLOWSHEET

BASIC PLANT DATA AND COST RELATED ASSUMPTIONS

OPERATING CRITERIA		
CONNECTED HORSEPOWER	22,415	HP
WATER REQUIREMENTS	1770.00	GPM
PLANT FEED RATE	415.00	TPH
PLANT RECOVERY	48.19%	
PRODUCTION RATE	200.00	TPH
PLANT AVAILABILTY	90.00%	
UNIT SUPPLY COSTS		
ELECTRIC POWER	0.06	$/KW HR
ANIONIC FLOC	2.00	$/#
CATIONIC FLOC	2.00	$/#
MIBC	0.55	$/#
KEROSENE	0.09	$/#
MAKE UP WATER	0.05	$/1000 GAL
LUBRICANTS	0.02	PER TON CLEAN COAL
GRINDING MEDIA	0.36	$/#
MAGNETITE	0.06	$/#
SODIUM HYDROXIDE	0.07	$/#
SUPERINTENDENT	61,458	PER YEAR
BENEFITS	27,656	0.45 TIMES SALARY
FOREMAN	43,021	PER YEAR
BENEFITS	19,359	0.45 TIMES SALARY
LABOR		
CLASS A	17.46	PER HOUR
BENEFITS	9.61	0.55 TIMES RATE
CLASS B	16.86	
BENEFITS	9.27	0.55 TIMES RATE
YEARLY OPERATING HOURS		
HOURS/SHIFT	8	
SHIFTS/DAY	3	
DAYS/YEAR	350	
HOURS/YEAR	7,560	
RAW COAL/YEAR	3,137,400	
CLEAN COAL/YEAR	1,512,000	

OPERATING AND MAINTENANCE COSTS FOR PITTSBURGH SEAM FLOWSHEET

FLOTATION REAGENT COSTS PER YEAR

ADVANCED FLOTATION		
FEED RATE	267.00	TPH
MIBC RATE	1.43	#/TON
KEROSENE RATE	1.19	#/TON
TOTAL MIBC	1,587,566	$/YEAR
TOTAL KEROSENE	216,183	$/YEAR
TOTAL FLOTATION REAGENTS COST	1,803,749	$/YEAR

FLOCCULATION AND pH CONTROL COSTS PER YEAR

CLEAN COAL STATIC THICKENER		
FEED RATE	200.00	TPH
ANIONIC RATE	0.07	#/TON
CATIONIC RATE	0.00	#/TON
REFUSE STATIC THICKENER		
FEED RATE	93.00	TPH
ANIONIC RATE	0.32	#/TON
CATIONIC RATE	0.00	#/TON
SODIUM HYDROXIDE RATE	0.00	#/TON
TOTAL ANIONIC COST	661,651	$/YEAR
TOTAL CATIONIC COST	0	$/YEAR
TOTAL SODIUM HYDROXIDE COST	0	$/YEAR
TOTAL THICKENER CHEMICAL COST	661,651	$/YEAR

MAGNETITE COSTS PER YEAR

HEAVY MEDIA CYCLONE FEED RATE	384.00	TPH
MAGNETITE CONSUMPTION RATE	1.20	#/TON
TOTAL MAGNETITE COSTS	209,019	$/YEAR

GRINDING MEDIA COSTS PER YEAR

BALL MILL FEED RATE	400.00	TPH
GRINDING MEDIA CONSUMPTION RATE	0.60	#/TON
TOTAL GRINDING MEDIA COSTS	653,105	$/YEAR

OPERATING AND MAINTENANCE COSTS FOR PITTSBURGH SEAM FLOWSHEET

I. ESTIMATED OPERATING COSTS

A. OPERATING SUPPLIES		
1. POWER		
DIVERSITY	0.80	FACTOR
CONNECTED HP	22,415	KWH
HEAT AND LIGHT	1,400	KWH
POWER COST	8,641,987	$/YEAR
ASSUME 1HP=1KVA=1KWH		
2. FLOCCULANT / pH CONTROL COST	661,651	$/YEAR
3. FLOTATION REAGENT COST	1,803,749	$/YEAR
4. WATER COST	40,144	$/YEAR
5. GRINDING MEDIA COST	653,105	$/YEAR
6. LUBRICANTS	70,583	$/YEAR
7. MAGNETITE COST	209,019	$/YEAR
TOTAL OPERATING SUPPLIES	12,080,238	$/YEAR
B. TOTAL MANNPOWER		
1. SUPERVISION		
SUPERINTENDENT	1	PER YEAR
SALARY	61,458	$/YEAR
BENEFITS	27,656	$/YEAR
FOREMAN	4	PER YEAR
SALARY	172,084	$/YEAR
BENEFITS	77,438	$/YEAR
2. LABOR		PER SHIFT
CLASS A		
PLANT OPERATER	1	PER SHIFT
EQUIPMENT OPERATOR	1	PER SHIFT
MECHANIC–ELECTRIAN	2	PER SHIFT
TOTAL CLASS A	586,790	$/YEAR
BENEFITS	322,735	$/YEAR
CLASS B		
UTILITY	1	PER SHIFT
TOTAL CLASS B	141,599	$/YEAR
BENEFITS	77,879	$/YEAR
TOTAL MANPOWER	1,467,639	$/YEAR
TOTAL OPERATING COST	**13,547,878**	**$/YEAR**

OPERATING AND MAINTENANCE COSTS FOR PITTSBURGH SEAM FLOWSHEET

II. ESTIMATED MAINTENANCE COST

A. MAINTENANCE SUPPLIES		
EQUIPMENT COST	23,433,304	TOTAL DOLLARS
PER CENT MULTIPLIER	10.00%	
TOTAL MAINTENANCE SUPPLIES	2,343,330	$/YEAR
B. MAINTENANCE SUPERVISION AND LABOR		
1. SUPERVISION		
FOREMAN	0	PER YEAR
SALARY	0	$/YEAR
BENEFITS	0	$/YEAR
2. LABOR	0	SHIFT
CLASS A		
MECHANICS	2	PER SHIFT
WELDERS	2	PER SHIFT
ELECTRICIAN	1	PER SHIFT
TOTAL CLASS A	0	$/YEAR
BENEFITS	0	$/YEAR
TOTAL MAINTENANCE MANPOWER	0	$/YEAR
TOTAL MAINTENANCE COST	**2,343,330**	**$/YEAR**

OPERATING AND MAINTENANCE COSTS FOR PITTSBURGH SEAM FLOWSHEET

ESTIMATED OPERATING AND MAINTENANCE COSTS

	PER YEAR	PER RAW TON	PER CLEAN TON
I. OPERATING SUPPLIES			
POWER	8,641,987	2.755	5.716
FLOCCULANTS	661,651	0.211	0.438
FLOTATION REAGENTS	1,803,749	0.575	1.193
WATER	40,144	0.013	0.027
GRINDING MEDIA	653,105	0.208	0.432
LUBRICANTS	70,583	0.022	0.047
MAGNETITE	209,019	0.067	0.138
TOTAL OPERATING SUPPLIES	12,080,238	3.850	7.990
II. SUPERVISION AND LABOR			
SUPERVISION	233,542	0.074	0.154
BENEFITS	105,094	0.033	0.070
LABOR	728,389	0.232	0.482
BENEFITS	400,614	0.128	0.265
TOTAL MANPOWER	1,467,639	0.468	0.971
TOTAL OPERATING COSTS	13,547,878	4.318	8.960
III. MAINTENANCE SUPPLIES	2,343,330	0.747	1.550
IV. MAINTENANCE SUPERVISION AND LABOR			
SUPERVISION	0	0.000	0.000
BENEFITS	0	0.000	0.000
LABOR	0	0.000	0.000
BENEFITS	0	0.000	0.000
TOTAL MAINTENANCE MANPOWER	0	0.000	0.000
TOTAL MAINTENANCE COST	2,343,330	0.747	1.550
TOTAL OPERATING & MAINTENANCE COST	**$15,891,208**	**5.065**	**10.510**

COAL PREPARATION PLANT DATA
Costs in $1000

*Direct Processing	$ 59625	*Fuel stockpile	0 days
*Emission/Waste Equip	$ 0	*Expensible Cap.	0 %
*Off-Site Utilities	$ 0	*Year 1 outlay	50 %
*On-Site Assembly	$ 0	*Year 2 outlay	50 %
*Site Modifications	$ 0	*Year 3 outlay	0 %
*Engineering	$ 0	*Fixed O&M, Per Year	$ 5892
*Contingency	$ 0	*Var O&M/yr @100% Ld	$ 13998
*Working Capital	$ 468	*Ins.&prop. tax/yr.	0 %
*Coal Input	415 tons/hr	*Heating Value	7329 Btu/
*Primary Coal output	200 tons/hr	*Heating Value	13618 Bt
*Second Coal output	0 tons/hr	*Heating Value	0 Btu/lb
*Fuel Consumption	0 MMBtu/hr	*Reagent Consumption	0 tons/h
*Sulfur-Input	2.9 %	*Sulfur-Primary	2.5 %
*Sulfur-Secondary	0 %		

File Record # 7 File code 200PGH-7560
PITTSBURGH 200 TPH COMMERCIAL @7560

COAL PREPARATION PLANT DATA
Costs in $1000

*Direct Processing	$ 59548	*Fuel stockpile	0 days
*Emission/Waste Equip	$ 0	*Expensible Cap.	0 %
*Off-Site Utilities	$ 0	*Year 1 outlay	50 %
*On-Site Assembly	$ 0	*Year 2 outlay	50 %
*Site Modifications	$ 0	*Year 3 outlay	0 %
*Engineering	$ 0	*Fixed O&M, Per Year	$ 5892
*Contingency	$ 0	*Var O&M/yr @100% Ld	$ 12929
*Working Capital	$ 450	*Ins.&prop. tax/yr.	0 %
*Coal Input	278 tons/hr	*Heating Value	11048 Bt
*Primary Coal output	200 tons/hr	*Heating Value	13456 Bt
*Second Coal output	0 tons/hr	*Heating Value	0 Btu/lb
*Fuel Consumption	0 MMBtu/hr	*Reagent Consumption	0 tons/h
*Sulfur-Input	4.41 %	*Sulfur-Primary	2.3 %
*Sulfur-Secondary	0 %		

File Record # 8 File code 200FRE-7560
UPPER FREEPORT 200 TPH COMMERCIAL @7560

COAL PREPARATION PLANT DATA
Costs in $1000

*Direct Processing	$ 59669	*Fuel stockpile	0 days
*Emission/Waste Equip	$ 0	*Expensible Cap.	0 %
*Off-Site Utilities	$ 0	*Year 1 outlay	50 %
*On-Site Assembly	$ 0	*Year 2 outlay	50 %
*Site Modifications	$ 0	*Year 3 outlay	0 %
*Engineering	$ 0	*Fixed O&M, Per Year	$ 5892
*Contingency	$ 0	*Var O&M/yr @100% Ld	$ 14616
*Working Capital	$ 479	*Ins.&prop. tax/yr.	0 %
*Coal Input	345 tons/hr	*Heating Value	9162 Btu
*Primary Coal output	200 tons/hr	*Heating Value	13574 Bt
*Second Coal output	0 tons/hr	*Heating Value	0 Btu/lb
*Fuel Consumption	0 MMBtu/hr	*Reagent Consumption	0 tons/h
*Sulfur-Input	4.27 %	*Sulfur-Primary	3 %
*Sulfur-Secondary	0 %		

File Record # 9 File code 200ILL-7560
ILLINOIS NO. 6 200 TPH COMMERCIAL @7560

ADVANCED FROTH FLOTATION ECONOMICS AT 10 PERCENT RATE OF RETURN 200 TPH COMMERCIAL PLANT OPERATING 5040 HOURS PER YEAR			
Cost Item	PITTSBURGH NO. 8 COAL	UPPER FREEPORT COAL	ILLNOIS NO. 6 COAL
Annualized Costs			
Raw Coal $/MMBtu	0.80	0.80	0.80
Raw Coal $/Ton	11.73	17.68	14.66
Clean Coal Incremental $/MMBtu	0.82	0.82	0.88
Clean Coal Total $/MMBtu	1.62	1.62	1.68
Clean Coal Total $/Ton	44.21	43.56	45.52
Levelized Costs			
Raw Coal $/MMBtu	1.06	1.06	1.06
Raw Coal $/Ton	15.48	23.33	19.35
Clean Coal Incremental $/MMBtu	1.09	1.08	1.16
Clean Coal Total $/MMBtu	2.14	2.14	2.21
Clean Coal Total $/Ton	58.35	57.51	60.08
Other Costs			
Present Value Of Costs	$143,119,000	$140,685,000	$151,943,000
Annualized Desulfurization Cost	$388.42	$359.10	$358.10
Payback Period (years)	7.9	7.9	7.9

CAPITAL REQUIREMENTS FOR 200 TPH (PRODUCT) PLANTS OPER ATING 5040 HOURS PER YEAR			
DIRECT PROCESSING COSTS ESTIMATION			
COST ITEM	ALL THRE COALS		
A–CAPITAL COST OF PLANT	54,706,341		
B–CAPITAL COST OF EQUIPMENT	23,433,315		
C–MECHANICAL EQUIPMENT COST	19,988,023		
D–LAND PURCHASE	2,500,000		
E–STARTUP MODIFICATIONS	1,094,127		
F–PREPRODUCTION COSTS	PITTSBURGH NO. 8	UPPER FREEPORT	ILLINOIS NO. 6
POWER	480,110	480,110	480,110
FLOCCULANTS	36,758	29,297	100,892
FLOTATION REAGENTS	100,208	38,966	68,790
WATER	2,230	1,336	1,940
GRINDING MEDIA	36,284	34,197	35,921
LUBRICANTS	3,921	2,627	3,260
MAGNETITE	11,612	11,612	9,858
MANPOWER	85,744	85,744	85,744
MAINTENANCE SUPPLIES	195,278	195,278	195,278
DIRECT PROCESSING COSTS (A+D+E+F)	59,252,613	59,179,634	59,282,261
WORKING CAPITAL REQUIREMENT ESTIMATION			
COST ITEM	PITTSBURGH NO. 8	UPPER FREEPORT	ILLINOIS NO. 6
FLOCCULANTS	8,822	7,031	24,214
FLOTATION REAGENTS	24,050	9,352	16,510
GRINDING MEDIA	8,708	8,207	8,621
LUBRICANTS	941	630	782
MAGNETITE	2,787	2,787	2,366
SPARE PARTS= 2 % OF MECH. EQUIP.	399,760	399,760	399,760
TOTAL WORKING CAPITAL REQUIRED	445,069	427,768	452,254

ANNUAL OPERATING AND MAINTENANCE COSTS FOR 200 TPH (PRODUCT) PLANTS OPER ATING 5040 HOURS PER YEAR			
YEARLY FIXED OPERATING AND MAINTENANCE COSTS			
COST ITEM	PITTSBURGH NO. 8	UPPER FREEPORT	ILLINOIS NO. 6
PLANT LABOR COSTS	1,028,924	1,028,924	1,028,924
ADMINISTATIVE LABOR AND COSTS	308,677	308,677	308,677
MAINTENANCE SUPPLIEIS	2,343,330	2,343,330	2,343,330
INSURANCE AND TAXES	1,641,190	1,641,190	1,641,190
TOTAL YEARLY FIXED O&M COSTS	5,322,121	5,322,121	5,322,121
YEARLY VARIABLE OPERATING AND MAINTENANCE COSTS			
COST ITEM	PITTSBURGH NO. 8	UPPER FREEPORT	ILLINOIS NO. 6
FLOCCULANTS	441,101	351,561	1,210,709
FLOTATION REAGENTS	1,202,500	467,595	825,479
GRINDING MEDIA	435,403	410,368	431,049
LUBRICANTS	47,055	31,521	39,118
MAGNETITE	139,346	139,346	118,299
POWER	5,761,325	5,761,325	5,761,325
PROCESS WATER	26,762	16,027	23,285
TOTAL YEARLY VARIABLE O&M COSTS	8,053,492	7,177,743	8,409,264

COAL PREPARATION PLANT DATA
Costs in $1000

*Direct Processing	$ 59253	*Fuel stockpile	0 days
*Emission/Waste Equip	$ 0	*Expensible Cap.	0 %
*Off-Site Utilities	$ 0	*Year 1 outlay	50 %
*On-Site Assembly	$ 0	*Year 2 outlay	50 %
*Site Modifications	$ 0	*Year 3 outlay	0 %
*Engineering	$ 0	*Fixed O&M, Per Year	$ 5322
*Contingency	$ 0	*Var O&M/yr @100% Ld	$ 13998
*Working Capital	$ 445	*Ins.&prop. tax/yr.	0 %
*Coal Input	415 tons/hr	*Heating Value	7329 Btu/lb
*Primary Coal output	200 tons/hr	*Heating Value	13618 Btu/lb
*Second Coal output	0 tons/hr	*Heating Value	0 Btu/lb
*Fuel Consumption	0 MMBtu/hr	*Reagent Consumption	0 tons/hr
*Sulfur-Input	2.9 %	*Sulfur-Primary	2.5 %
*Sulfur-Secondary	0 %		

File Record # 13 File code 200PGH-5040
PITTSBURGH 200 TPH COMMERCIAL @5040

COAL PREPARATION PLANT DATA
Costs in $1000

*Direct Processing	$ 59180	*Fuel stockpile	0 days
*Emission/Waste Equip	$ 0	*Expensible Cap.	0 %
*Off-Site Utilities	$ 0	*Year 1 outlay	50 %
*On-Site Assembly	$ 0	*Year 2 outlay	50 %
*Site Modifications	$ 0	*Year 3 outlay	0 %
*Engineering	$ 0	*Fixed O&M, Per Year	$ 5322
*Contingency	$ 0	*Var O&M/yr @100% Ld	$ 12476
*Working Capital	$ 428	*Ins.&prop. tax/yr.	0 %
*Coal Input	278 tons/hr	*Heating Value	11048 Btu/lb
*Primary Coal output	200 tons/hr	*Heating Value	13456 Btu/lb
*Second Coal output	0 tons/hr	*Heating Value	0 Btu/lb
*Fuel Consumption	0 MMBtu/hr	*Reagent Consumption	0 tons/hr
*Sulfur-Input	4.41 %	*Sulfur-Primary	2.3 %
*Sulfur-Secondary	0 %		

File Record # 14 File code 200FRE-5040
UPPER FREEPORT 200 TPH COMMERCIAL @5040

COAL PREPARATION PLANT DATA
Costs in $1000

*Direct Processing	$ 59282	*Fuel stockpile	0 days
*Emission/Waste Equip	$ 0	*Expensible Cap.	0 %
*Off-Site Utilities	$ 0	*Year 1 outlay	50 %
*On-Site Assembly	$ 0	*Year 2 outlay	50 %
*Site Modifications	$ 0	*Year 3 outlay	0 %
*Engineering	$ 0	*Fixed O&M, Per Year	$ 5322
*Contingency	$ 0	*Var O&M/yr @100% Ld	$ 14616
*Working Capital	$ 452	*Ins.&prop. tax/yr.	0 %
*Coal Input	345 tons/hr	*Heating Value	9162 Btu/lb
*Primary Coal output	200 tons/hr	*Heating Value	13574 Btu/lb
*Second Coal output	0 tons/hr	*Heating Value	0 Btu/lb
*Fuel Consumption	0 MMBtu/hr	*Reagent Consumption	0 tons/hr
*Sulfur-Input	4.27 %	*Sulfur-Primary	3 %
*Sulfur-Secondary	0 %		

File Record # 15 File code 200ILL-5040
ILLINOIS NO. 6 200 TPH COMMERCIAL @5040

ADVANCED FROTH FLOTATION ECONOMICS AT 10 PERCENT RATE OF RETURN 200 TPH COMMERCIAL PLANT OPERATING 3456 HOURS PER YEAR			
Cost Item	PITTSBURGH NO. 8 COAL	UPPER FREEPORT COAL	ILLNOIS NO. 6 COAL
Annualized Costs			
Raw Coal $/MMBtu	0.80	0.80	0
Raw Coal $/Ton	11.73	17.68	14
Clean Coal Incremental $/MMBtu	1.01	1.01	1
Clean Coal Total $/MMBtu	1.81	1.81	1
Clean Coal Total $/Ton	49.32	48.68	50
Levelized Costs			
Raw Coal $/MMBtu	1.06	1.06	1
Raw Coal $/Ton	15.48	23.33	19
Clean Coal Incremental $/MMBtu	1.33	1.33	1
Clean Coal Total $/MMBtu	2.39	2.39	2
Clean Coal Total $/Ton	65.11	64.26	66
Other Costs			
Present Value Of Costs	$120,697,000	$119,025,000	$126,755,(
Annualized Desulfurization Cost	$477.08	$442.49	$435
Payback Period (years)	7.9	7.9	

CAPITAL REQUIREMENTS FOR 200 TPH (PRODUCT) PLANTS OPER ATING 3456 HOURS PER YEAR			
DIRECT PROCESSING COSTS ESTIMATION			
COST ITEM	ALL THRE COALS		
A–CAPITAL COST OF PLANT	54,706,341		
B–CAPITAL COST OF EQUIPMENT	23,433,315		
C–MECHANICAL EQUIPMENT COST	19,988,023		
D–LAND PURCHASE	2,500,000		
E–STARTUP MODIFICATIONS	1,094,127		
F–PREPRODUCTION COSTS	PITTSBURGH NO. 8	UPPER FREEPORT	ILLINOIS NO. 6
POWER	329,219	329,219	329,219
FLOCCULANTS	25,206	20,089	69,183
FLOTATION REAGENTS	68,714	26,720	47,170
WATER	1,529	916	1,331
GRINDING MEDIA	24,880	23,450	24,631
LUBRICANTS	2,689	1,801	2,235
MAGNETITE	7,963	7,963	6,760
MANPOWER	73,826	73,826	73,826
MAINTENANCE SUPPLIES	195,278	195,278	195,278
DIRECT PROCESSING COSTS (A+D+E+F)	59,029,770	58,979,728	59,050,100
WORKING CAPITAL REQUIREMENT ESTIMATION			
COST ITEM	PITTSBURGH NO. 8	UPPER FREEPORT	ILLINOIS NO. 6
FLOCCULANTS	6,301	5,022	17,296
FLOTATION REAGENTS	17,179	6,680	11,793
GRINDING MEDIA	6,220	5,862	6,158
LUBRICANTS	672	450	559
MAGNETITE	1,991	1,991	1,690
SPARE PARTS= 2 % OF MECH. EQUIP.	399,760	399,760	399,760
TOTAL WORKING CAPITAL REQUIRED	432,123	419,766	437,256

ANNUAL OPERATING AND MAINTENANCE COSTS FOR 200 TPH (PRODUCT) PLANTS OPER ATING 3456 HOURS PER YEAR			
YEARLY FIXED OPERATING AND MAINTENANCE COSTS			
COST ITEM	PITTSBURGH NO. 8	UPPER FREEPORT	ILLINOIS NO. 6
PLANT LABOR COSTS	885,910	885,910	885,910
ADMINISTATIVE LABOR AND COSTS	265,773	265,773	265,773
MAINTENANCE SUPPLIEIS	2,343,330	2,343,330	2,343,330
INSURANCE AND TAXES	1,641,190	1,641,190	1,641,190
TOTAL YEARLY FIXED O&M COSTS	5,136,203	5,136,203	5,136,203
YEARLY VARIABLE OPERATING AND MAINTENANCE COSTS			
COST ITEM	PITTSBURGH NO. 8	UPPER FREEPORT	ILLINOIS NO. 6
FLOCCULANTS	302,469	241,071	830,200
FLOTATION REAGENTS	824,571	320,637	566,043
GRINDING MEDIA	298,562	281,395	295,577
LUBRICANTS	32,266	21,615	26,824
MAGNETITE	95,551	95,551	81,119
POWER	3,950,623	3,950,623	3,950,623
PROCESS WATER	18,351	10,990	15,967
TOTAL YEARLY VARIABLE O&M COSTS	5,522,393	4,921,882	5,766,353

COAL PREPARATION PLANT DATA
Costs in $1000

*Direct Processing	$ 59030	*Fuel stockpile	0 days
*Emission/Waste Equip	$ 0	*Expensible Cap.	0 %
*Off-Site Utilities	$ 0	*Year 1 outlay	50 %
*On-Site Assembly	$ 0	*Year 2 outlay	50 %
*Site Modifications	$ 0	*Year 3 outlay	0 %
*Engineering	$ 0	*Fixed O&M, Per Year	$ 5136
*Contingency	$ 0	*Var O&M/yr @100% Ld	$ 13998
*Working Capital	$ 432	*Ins.&prop. tax/yr.	0 %
*Coal Input	415 tons/hr	*Heating Value	7329 Btu
*Primary Coal output	200 tons/hr	*Heating Value	13618 Bt
*Second Coal output	0 tons/hr	*Heating Value	0 Btu/lb
*Fuel Consumption	0 MMBtu/hr	*Reagent Consumption	0 tons/h
*Sulfur-Input	2.9 %	*Sulfur-Primary	2.5 %
*Sulfur-Secondary	0 %		

File Record # 10 File code 200PGH-3456
PITTSBURGH 200 TPH COMMERCIAL @3456

COAL PREPARATION PLANT DATA
Costs in $1000

*Direct Processing	$ 58980	*Fuel stockpile	0 days
*Emission/Waste Equip	$ 0	*Expensible Cap.	0 %
*Off-Site Utilities	$ 0	*Year 1 outlay	50 %
*On-Site Assembly	$ 0	*Year 2 outlay	50 %
*Site Modifications	$ 0	*Year 3 outlay	0 %
*Engineering	$ 0	*Fixed O&M, Per Year	$ 5136
*Contingency	$ 0	*Var O&M/yr @100% Ld	$ 12476
*Working Capital	$ 420	*Ins.&prop. tax/yr.	0 %
*Coal Input	278 tons/hr	*Heating Value	11048 Bt
*Primary Coal output	200 tons/hr	*Heating Value	13456 Bt
*Second Coal output	0 tons/hr	*Heating Value	0 Btu/lb
*Fuel Consumption	0 MMBtu/hr	*Reagent Consumption	0 tons/l
*Sulfur-Input	4.41 %	*Sulfur-Primary	2.3 %
*Sulfur-Secondary	0 %		

File Record # 11 File code 200FRE-3456
UPPER FREEPORT 200 TPH COMMERCIAL @3456

COAL PREPARATION PLANT DATA
Costs in $1000

*Direct Processing	$ 59050	*Fuel stockpile	0 days
*Emission/Waste Equip	$ 0	*Expensible Cap.	0 %
*Off-Site Utilities	$ 0	*Year 1 outlay	50 %
*On-Site Assembly	$ 0	*Year 2 outlay	50 %
*Site Modifications	$ 0	*Year 3 outlay	0 %
*Engineering	$ 0	*Fixed O&M, Per Year	$ 5136
*Contingency	$ 0	*Var O&M/yr @100% Ld	$ 14616
*Working Capital	$ 437	*Ins.&prop. tax/yr.	0 %
*Coal Input	345 tons/hr	*Heating Value	9162 Bt
*Primary Coal output	200 tons/hr	*Heating Value	13574 B
*Second Coal output	0 tons/hr	*Heating Value	0 Btu/l
*Fuel Consumption	0 MMBtu/hr	*Reagent Consumption	0 tons/
*Sulfur-Input	4.27 %	*Sulfur-Primary	3 %
*Sulfur-Secondary	0 %		

File Record # 12 File code 200ILL-3456
No description

ADVANCED FROTH FLOTATION ECONOMICS
500 TPH COMMERCIAL PLANT

CASE STUDY

7560 HOURS PER YEAR OPERATION
AT 10 % RATE OF RETURN

ADVANCED FROTH FLOTATION ECONOMICS AT 10 PERCENT RATE OF RETURN 500 TPH COMMERCIAL PLANT OPERATING 7560 HOURS PER YEAR			
Cost Item	PITTSBURGH NO. 8 COAL	UPPER FREEPORT COAL	ILLNOIS NO. 6 COAL
Annualized Costs			
Raw Coal $/MMBtu	0.80	0.80	0.80
Raw Coal $/Ton	11.73	17.68	14.66
Clean Coal Incremental $/MMBtu	0.58	0.59	0.64
Clean Coal Total $/MMBtu	1.38	1.39	1.44
Clean Coal Total $/Ton	37.68	37.30	38.99
Levelized Costs			
Raw Coal $/MMBtu	1.06	1.06	1.06
Raw Coal $/Ton	15.48	23.33	19.35
Clean Coal Incremental $/MMBtu	0.77	0.77	0.84
Clean Coal Total $/MMBtu	1.83	1.83	1.90
Clean Coal Total $/Ton	49.73	49.23	51.47
Other Costs			
Present Value Of Costs	$380,373,000	$377,515,000	$413,473,000
Annualized Desulfurization Cost	$275.27	$256.95	$259.84
Payback Period (years)	7.9	7.9	7.9

CAPITAL REQUIREMENTS FOR 500 TPH (PRODUCT) PLANTS OPERATING 7560 HOURS PER YEAR			
DIRECT PROCESSING COSTS ESTIMATION			
COST ITEM	ALL THRE COALS		
A–CAPITAL COST OF PLANT	103,895,245		
B–CAPITAL COST OF EQUIPMENT	44,503,251		
C–MECHANICAL EQUIPMENT COST	37,960,145		
D–LAND PURCHASE	5,000,000		
E–STARTUP MODIFICATIONS	2,077,905		
F–PREPRODUCTION COSTS	PITTSBURGH NO. 8	UPPER FREEPORT	ILLINOIS NO. 6
POWER	1,630,934	1,630,934	1,630,934
FLOCCULANTS	137,844	191,429	378,347
FLOTATION REAGENTS	375,781	146,124	257,962
WATER	8,363	5,009	7,277
GRINDING MEDIA	136,064	128,240	134,703
LUBRICANTS	14,705	9,850	12,225
MAGNETITE	43,546	43,546	36,968
MANPOWER	122,303	122,303	122,303
MAINTENANCE SUPPLIES	370,860	370,860	370,860
DIRECT PROCESSING COSTS (A+D+E+F)	113,813,550	113,621,445	113,924,729
WORKING CAPITAL REQUIREMENT ESTIMATION			
COST ITEM	PITTSBURGH NO. 8	UPPER FREEPORT	ILLINOIS NO. 6
FLOCCULANTS	33,083	45,943	90,803
FLOTATION REAGENTS	90,187	35,070	61,911
GRINDING MEDIA	32,655	30,778	32,329
LUBRICANTS	3,529	2,364	2,934
MAGNETITE	10,451	10,451	8,872
SPARE PARTS= 2 % OF MECH. EQUIP.	759,203	759,203	759,203
TOTAL WORKING CAPITAL REQUIRED	929,108	883,808	956,052

ANNUAL OPERATING AND MAINTENANCE COSTS FOR 500 TPH (PRODUCT) PLANTS OPERATING 7560 HOURS PER YEAR			
YEARLY FIXED OPERATING AND MAINTENANCE COSTS			
COST ITEM	PITTSBURGH NO. 8	UPPER FREEPORT	ILLINOIS NO. 6
PLANT LABOR COSTS	1,467,639	1,467,639	1,467,639
ADMINISTATIVE LABOR AND COSTS	440,292	440,292	440,292
MAINTENANCE SUPPLIEIS	4,450,325	4,450,325	4,450,325
INSURANCE AND TAXES	3,116,857	3,116,857	3,116,857
TOTAL YEARLY FIXED O&M COSTS	9,475,113	9,475,113	9,475,113
YEARLY VARIABLE OPERATING AND MAINTENANCE COSTS			
COST ITEM	PITTSBURGH NO. 8	UPPER FREEPORT	ILLINOIS NO. 6
FLOCCULANTS	1,654,128	2,297,151	4,540,158
FLOTATION REAGENTS	4,509,374	1,753,482	3,095,548
GRINDING MEDIA	1,632,763	1,538,879	1,616,435
LUBRICANTS	176,457	118,205	146,694
MAGNETITE	522,547	522,547	443,621
POWER	19,571,207	19,571,207	19,571,207
PROCESS WATER	100,359	60,102	87,318
TOTAL YEARLY VARIABLE O&M COSTS	28,166,835	25,861,573	29,500,981

COAL PREPARATION PLANT DATA
Costs in $1000

*Direct Processing	$ 113814	*Fuel stockpile	0 days
*Emission/Waste Equip	$ 0	*Expensible Cap.	0 %
*Off-Site Utilities	$ 0	*Year 1 outlay	50 %
*On-Site Assembly	$ 0	*Year 2 outlay	50 %
*Site Modifications	$ 0	*Year 3 outlay	0 %
*Engineering	$ 0	*Fixed O&M, Per Year	$ 9475
*Contingency	$ 0	*Var O&M/yr @100% Ld	$ 32638
*Working Capital	$ 929	*Ins.&prop. tax/yr.	0 %
*Coal Input	1037.5 tons/hr	*Heating Value	7329 Btu/lb
*Primary Coal output	500 tons/hr	*Heating Value	13618 Btu/lb
*Second Coal output	0 tons/hr	*Heating Value	0 Btu/lb
*Fuel Consumption	0 MMBtu/hr	*Reagent Consumption	0 tons/hr
*Sulfur-Input	2.9 %	*Sulfur-Primary	2.5 %
*Sulfur-Secondary	0 %		

File Record # 16 File code 500PGH-7560
PITTSBURGH 500 TPH COMMERCIAL @7560

COAL PREPARATION PLANT DATA
Costs in $1000

*Direct Processing	$ 113621	*Fuel stockpile	0 days
*Emission/Waste Equip	$ 0	*Expensible Cap.	0 %
*Off-Site Utilities	$ 0	*Year 1 outlay	50 %
*On-Site Assembly	$ 0	*Year 2 outlay	50 %
*Site Modifications	$ 0	*Year 3 outlay	0 %
*Engineering	$ 0	*Fixed O&M, Per Year	$ 9475
*Contingency	$ 0	*Var O&M/yr @100% Ld	$ 29967
*Working Capital	$ 884	*Ins.&prop. tax/yr.	0 %
*Coal Input	695 tons/hr	*Heating Value	11048 Btu/lb
*Primary Coal output	500 tons/hr	*Heating Value	13456 Btu/lb
*Second Coal output	0 tons/hr	*Heating Value	0 Btu/lb
*Fuel Consumption	0 MMBtu/hr	*Reagent Consumption	0 tons/hr
*Sulfur-Input	4.41 %	*Sulfur-Primary	2.3 %
*Sulfur-Secondary	0 %		

File Record # 17 File code 500FRE-7560
UPPER FREEPORT 500 TPH COMMERCIAL @7560

COAL PREPARATION PLANT DATA
Costs in $1000

*Direct Processing	$ 113925	*Fuel stockpile	0 days
*Emission/Waste Equip	$ 0	*Expensible Cap.	0 %
*Off-Site Utilities	$ 0	*Year 1 outlay	50 %
*On-Site Assembly	$ 0	*Year 2 outlay	50 %
*Site Modifications	$ 0	*Year 3 outlay	0 %
*Engineering	$ 0	*Fixed O&M, Per Year	$ 9475
*Contingency	$ 0	*Var O&M/yr @100% Ld	$ 34184
*Working Capital	$ 956	*Ins.&prop. tax/yr.	0 %
*Coal Input	862.5 tons/hr	*Heating Value	9162 Btu/lb
*Primary Coal output	500 tons/hr	*Heating Value	13574 Btu/lb
*Second Coal output	0 tons/hr	*Heating Value	0 Btu/lb
*Fuel Consumption	0 MMBtu/hr	*Reagent Consumption	0 tons/hr
*Sulfur-Input	4.27 %	*Sulfur-Primary	3 %
*Sulfur-Secondary	0 %		

File Record # 18 File code 500ILL-7560
ILLINOIS NO. 6 500 TPH COMMERCIAL @7560

ADVANCED FROTH FLOTATION ECONOMICS
20 TPH SEMI–WORKS PLANT

CASE STUDY

7560 HOURS PER YEAR OPERATION
AT 10 % RATE OF RETURN

ADVANCED FROTH FLOTATION ECONOMICS AT 10 PERCENT RATE OF RETURN 20 TPH SEMI WORKS PLANT OPERATING 7560 HOURS PER YEAR			
Cost Item	PITTSBURGH NO. 8 COAL	UPPER FREEPORT COAL	ILLNOIS NO. 6 COAL
Annualized Costs			
Raw Coal $/MMBtu	0.80	0.80	0.80
Raw Coal $/Ton	11.73	17.68	14.66
Clean Coal Incremental $/MMBtu	1.43	1.44	1.49
Clean Coal Total $/MMBtu	2.23	2.24	2.29
Clean Coal Total $/Ton	60.76	60.38	62.08
Levelized Costs			
Raw Coal $/MMBtu	1.06	1.06	1.06
Raw Coal $/Ton	15.48	23.33	19.35
Clean Coal Incremental $/MMBtu	1.89	1.91	1.96
Clean Coal Total $/MMBtu	2.95	2.96	3.02
Clean Coal Total $/Ton	80.21	79.71	81.94
Other Costs			
Present Value Of Costs	$37,328,000	$37,213,000	$38,653,000
Annualized Desulfurization Cost	$675.33	$633.20	$607.27
Payback Period (years)	7.9	7.9	7.9

CAPITAL REQUIREMENTS FOR 20 TPH (PRODUCT) PLANTS OPERATING 7560 HOURS PER YEAR

DIRECT PROCESSING COSTS ESTIMATION

COST ITEM	ALL THRE COALS		
A–CAPITAL COST OF PLANT	10,915,350		
B–CAPITAL COST OF EQUIPMENT	4,675,561		
C–MECHANICAL EQUIPMENT COST	3,988,135		
D–LAND PURCHASE	250,000		
E–STARTUP MODIFICATIONS	218,307		
F–PREPRODUCTION COSTS	PITTSBURGH NO. 8	UPPER FREEPORT	ILLINOIS NO. 6
POWER	95,921	95,921	95,921
FLOCCULANTS	5,514	7,657	15,134
FLOTATION REAGENTS	15,031	5,845	10,319
WATER	335	200	291
GRINDING MEDIA	5,443	5,130	5,388
LUBRICANTS	588	394	489
MAGNETITE	1,742	1,742	1,479
MANPOWER	122,303	122,303	122,303
MAINTENANCE SUPPLIES	38,963	38,963	38,963
DIRECT PROCESSING COSTS (A+D+E+F)	11,669,497	11,661,812	11,673,944

WORKING CAPITAL REQUIREMENT ESTIMATION

COST ITEM	PITTSBURGH NO. 8	UPPER FREEPORT	ILLINOIS NO. 6
FLOCCULANTS	1,323	1,838	3,632
FLOTATION REAGENTS	3,608	1,403	2,476
GRINDING MEDIA	1,306	1,231	1,293
LUBRICANTS	141	95	117
MAGNETITE	418	418	355
SPARE PARTS= 2 % OF MECH. EQUIP.	79,763	79,763	79,763
TOTAL WORKING CAPITAL REQUIRED	86,559	84,747	87,637

ANNUAL OPERATING AND MAINTENANCE COSTS FOR 20 TPH (PRODUCT) PLANTS OPERATING 7560 HOURS PER YEAR

YEARLY FIXED OPERATING AND MAINTENANCE COSTS

COST ITEM	PITTSBURGH NO. 8	UPPER FREEPORT	ILLINOIS NO. 6
PLANT LABOR COSTS	1,467,639	1,467,639	1,467,63
ADMINISTATIVE LABOR AND COSTS	440,292	440,292	440,29
MAINTENANCE SUPPLIEIS	467,556	467,556	467,55
INSURANCE AND TAXES	327,461	327,461	327,461
TOTAL YEARLY FIXED O&M COSTS	2,702,947	2,702,947	2,702,94

YEARLY VARIABLE OPERATING AND MAINTENANCE COSTS

COST ITEM	PITTSBURGH NO. 8	UPPER FREEPORT	ILLINOIS NO. 6
FLOCCULANTS	66,165	91,886	181,60
FLOTATION REAGENTS	180,375	70,139	123,82
GRINDING MEDIA	65,311	61,555	64,65
LUBRICANTS	7,058	4,728	5,86
MAGNETITE	20,902	20,902	17,74
POWER	1,151,055	1,151,055	1,151,05
PROCESS WATER	4,014	2,404	3,49
TOTAL YEARLY VARIABLE O&M COSTS	1,494,880	1,402,669	1,548,24

COAL PREPARATION PLANT DATA
Costs in $1000

*Direct Processing	$ 11669	*Fuel stockpile	0 days
*Emission/Waste Equip	$ 0	*Expensible Cap.	0 %
*Off-Site Utilities	$ 0	*Year 1 outlay	50 %
*On-Site Assembly	$ 0	*Year 2 outlay	50 %
*Site Modifications	$ 0	*Year 3 outlay	0 %
*Engineering	$ 0	*Fixed O&M, Per Year	$ 2703
*Contingency	$ 0	*Var O&M/yr @100% Ld	$ 1732
*Working Capital	$ 87	*Ins.&prop. tax/yr.	0 %
*Coal Input	41.5 tons/hr	*Heating Value	7329 Btu/lb
*Primary Coal output	20 tons/hr	*Heating Value	13618 Btu/lb
*Second Coal output	0 tons/hr	*Heating Value	0 Btu/lb
*Fuel Consumption	0 MMBtu/hr	*Reagent Consumption	0 tons/hr
*Sulfur-Input	2.9 %	*Sulfur-Primary	2.5 %
*Sulfur-Secondary	0 %		

File Record # 4 File code 20PGH-7560
PITTBURGH 20 TPH SEMI WORKS

COAL PREPARATION PLANT DATA
Costs in $1000

*Direct Processing	$ 11662	*Fuel stockpile	0 days
*Emission/Waste Equip	$ 0	*Expensible Cap.	0 %
*Off-Site Utilities	$ 0	*Year 1 outlay	50 %
*On-Site Assembly	$ 0	*Year 2 outlay	50 %
*Site Modifications	$ 0	*Year 3 outlay	0 %
*Engineering	$ 0	*Fixed O&M, Per Year	$ 2703
*Contingency	$ 0	*Var O&M/yr @100% Ld	$ 1625
*Working Capital	$ 85	*Ins.&prop. tax/yr.	0 %
*Coal Input	27.8 tons/hr	*Heating Value	11048 Btu/lb
*Primary Coal output	20 tons/hr	*Heating Value	13456 Btu/lb
*Second Coal output	0 tons/hr	*Heating Value	0 Btu/lb
*Fuel Consumption	0 MMBtu/hr	*Reagent Consumption	0 tons/hr
*Sulfur-Input	4.41 %	*Sulfur-Primary	2.3 %
*Sulfur-Secondary	0 %		

File Record # 5 File code 20FRE-7560
UPPER FREEPORT 20 TPH SEMI WORKS

COAL PREPARATION PLANT DATA
Costs in $1000

*Direct Processing	$ 11674	*Fuel stockpile	0 days
*Emission/Waste Equip	$ 0	*Expensible Cap.	0 %
*Off-Site Utilities	$ 0	*Year 1 outlay	50 %
*On-Site Assembly	$ 0	*Year 2 outlay	50 %
*Site Modifications	$ 0	*Year 3 outlay	0 %
*Engineering	$ 0	*Fixed O&M, Per Year	$ 2703
*Contingency	$ 0	*Var O&M/yr @100% Ld	$ 1794
*Working Capital	$ 88	*Ins.&prop. tax/yr.	0 %
*Coal Input	34.5 tons/hr	*Heating Value	9162 Btu/lb
*Primary Coal output	20 tons/hr	*Heating Value	13574 Btu/lb
*Second Coal output	0 tons/hr	*Heating Value	0 Btu/lb
*Fuel Consumption	0 MMBtu/hr	*Reagent Consumption	0 tons/hr
*Sulfur-Input	4.27 %	*Sulfur-Primary	3 %
*Sulfur-Secondary	0 %		

File Record # 6 File code 20ILL-7560
ILLINOIS NO. 6 20 TPH SEMI WORKS

ADVANCED FROTH FLOTATION ECONOMICS
200 TPH PLANT ADDITION

2 CASE STUDIES

1) 7560 HOURS PER YEAR OPERATION AT 10 % RATE OF RETURN

2) 3456 HOURS PER YEAR OPERATION AT 10 % RATE OF RETURN

UNITED STATES DEPARTMENT OF ENGERY

REVISION 0

PROCESS EQUIPMENT FOR PLANT ADDITION

20 TPH CLEAN COAL SEMI-WORKS CONCEPTUAL DESIGN
ICF KAISER ENGINEERS PROJECT NUMBER 88107-250-00

ADVEQUIP.wk3

TASK 15 EQUIPMENT LIST FOR 20 TONS PER HOUR, SEMI-WORKS FLOWSHEET

EQUIP. NO.	DESCRIPTION	# OF UNITS	WEIGHT	PRICE	UNIT HP	TOTAL HP	ENCL	VOLTS	RPM	MOTOR SUPPLIED	COMMENTS
111	RAW COAL CRUSHER	1	12,000	79,500	50.00	50.00	TEFC	480	1800	YES	GUNDLACH 45 DA
150	MIDDLINGS CRUSHER DRIVE 1	1	12,000	125,811	100.00	100.00	TEFC	480	1800	YES	GUNDLACH CAGEPACTOR
150.1	MIDDLINGS CRUSHER DRIVE 2	1	–	INCLUDED	75.00	75.00	TEFC	480	1800	YES	SAME
152	OVERSIZE PROTECTION PUMP	1	5,000	12,912	40.00	40.00	TEFC	480	1800	YES	GOYNE PUMP
153	OVERSIZE PROTECTION SIEVE BEND	2	5,600	10,600	–	–	–	–	–	–	5'W,40'R,60,.35 MM,3/32 ISO
208	VARI-SIEVE	2	7500	103414	–	–	–	–	–	–	KREBS 5'W VARI-SIEVE
210	BALL MILL	1	186,000	606,320	750.00	750.00	TEFC	4160	900	YES	10' DIA. X 6' CONICAL BALL MILL
220	ADVANCED FLOTATION FEED PUMP	1	5,000	25,803	100.00	100.00	TEFC	480	1800	YES	GOYNE PUMP
230	ADVANCED FLOTATION CELL	4	46,000	466,400	–	–	–	–	–	–	ICF KE MICROCEL™ MODEL 12025
230.1	ADVANCED FLOTATION PUMP	4	5,000	INCLUDED	75.00	300.00	TEFC	480	1800	YES	GOYNE PUMP
240	COAL STATIC THICKENER DRIVE	1	17,000	68,900	3.00	3.00	TEFC	480	1800	YES	EIMCO 50' DIAMETER HIRATE
240.1	COAL STATIC THICKENER LIFTING DEVICE	1	–	INCLUDED	1.00	1.00	TEFC	480	900	YES	SAME
247	COAL THICK. CLARIFIED WATER PUMP	1	5,000	30,152	200.00	200.00	TEFC	480	1800	YES	GOYNE PUMP
249	COAL STATIC THICKENER U'FLOW PUMP	1	5,000	12,207	25.00	25.00	TEFC	480	1800	YES	GOYNE PUMP
260	CLEAN COAL FILTER DRIVE	1	122,000	1,228,710	10.00	10.00	TEFC	480	1800	YES	ANDRITZ RUTHNER, INC.
260.1	AGITATOR	3	–	INCLUDED	1.50	4.50	TEFC	480	1800	YES	SAME
260.2	DISCHARGE GATES	1	–	INCLUDED	30.00	30.00	TEFC	480	1800	YES	SAME
260.3	AIR COMPRESSOR	1	8,000	52,391	200.00	200.00	TEFC	480	1800	YES	AIRTEC
260.4	FILTRATE PUMP	1	5,000	8,509	5.00	5.00	TEFC	480	1800	YES	GOYNE PUMP
260.5	LUBRICATOR	1	–	INCLUDED	1.00	1.00	TEFC	480	1800	YES	ANDRITZ RUTHNER, INC.
260.6	AUXILLARY AIR COMPRESSOR	1	5,000	INCLUDED	7.50	7.50	TEFC	480	1800	YES	SAME
260.7	INTERNAL CONVEYOR	1	–	INCLUDED	10.00	10.00	TEFC	480	1800	YES	SAME
335	MIDS SIEVE BEND	1	2,200	4,876	–	–	–	–	–	–	3'W,80'R,60,.5 MM,3/32 ISO
340	MIDS DRAIN & RINSE SCREEN	1	18,000	23,320	20.00	20.00	TEFC	480	1800	YES	TABOR 4X16 SD VIB. HORIZONTAL
398	1/2 OF PLANT & COLUMN AIR COMPRESS.	1	8000	26,200	200.00	100.00	TEFC	480	1800	YES	AIRTEC
398.1	PREFILTERS	1	500	INCLUDED	–	–	–	–	–	–	SAME
398.2	AFTER FILTERS	2	750	INCLUDED	–	–	–	–	–	–	SAME
400	PROPORTION OF FLOCCULANT SYSTEM	1	–	37,893	–	2.00	–	–	–	–	MINETEC
405	REAGENT SYSTEM	1	–	33,454	–	–	–	–	–	–	SAME
430	BALL MILL OVERHEAD CRANE HOIST	1	5,000	44,520	25.00	25.00	TEFC	480	1800	YES	THERN
430.1	BALL MILL OVERHEAD CRANE TRAM	1	–	8,480	10.00	10.00	TEFC	480	1800	YES	THERN

	TOTAL VALUES		485,550	3,010,372		2,069					HEATING LOAD 715 KW

ADVANCED FROTH FLOTATION ECONOMICS AT 10 PERCENT RATE OF RETURN 200 TPH COMMERCIAL PLANT ADDITION OPERATING 7560 HOURS PER YEAR			
Cost Item	PITTSBURGH NO. 8 COAL	UPPER FREEPORT COAL	ILLNOIS NO. 6 COA
Annualized Costs			
Raw Coal $/MMBtu	0.80	0.80	(
Raw Coal $/Ton	16.80	19.07	1
Clean Coal Incremental $/MMBtu	0.45	0.49	(
Clean Coal Total $/MMBtu	1.25	1.29	
Clean Coal Total $/Ton	34.07	34.69	3
Levelized Costs			
Raw Coal $/MMBtu	1.06	1.06	
Raw Coal $/Ton	22.17	25.18	2
Clean Coal Incremental $/MMBtu	0.60	0.65	
Clean Coal Total $/MMBtu	1.65	1.70	
Clean Coal Total $/Ton	44.97	45.80	4
Other Costs			
Present Value Of Costs	$117,603,000	$126,080,000	$130,996
Annualized Desulfurization Cost	$1,148.40	$969.02	$1,45
Payback Period (years)	7.9	7.9	

CAPITAL REQUIREMENTS FOR 200 TPH (PRODUCT) PLANT ADDITION OPER ATING 7560 HOURS PER YEAR			
DIRECT PROCESSING COSTS ESTIMATION			
COST ITEM	ALL THRE COALS		
A–CAPITAL COST OF PLANT	42,030,183		
B–CAPITAL COST OF EQUIPMENT	18,003,516		
C–MECHANICAL EQUIPMENT COST	14,558,225		
D–LAND PURCHASE	1,920,718		
E–STARTUP MODIFICATIONS	840,604		
F–PREPRODUCTION COSTS	PITTSBURGH NO. 8	UPPER FREEPORT	ILLINOIS NO. 6
POWER	537,062	537,062	537,062
FLOCCULANTS	36,187	58,446	97,776
FLOTATION REAGENTS	150,312	58,449	103,185
WATER	1,673	1,002	1,455
GRINDING MEDIA	54,425	51,296	53,881
LUBRICANTS	3,787	2,537	4,890
MAGNETITE	0	0	0
MANPOWER	18,948	18,948	18,948
MAINTENANCE SUPPLIES	125,726	125,726	125,726
DIRECT PROCESSING COSTS (A+D+E+F)	45,719,626	45,644,971	45,734,428
WORKING CAPITAL REQUIREMENT ESTIMATION			
COST ITEM	PITTSBURGH NO. 8	UPPER FREEPORT	ILLINOIS NO. 6
FLOCCULANTS	8,685	14,027	23,466
FLOTATION REAGENTS	36,075	14,028	24,764
GRINDING MEDIA	13,062	12,311	12,931
LUBRICANTS	909	609	1,174
MAGNETITE	0	0	0
SPARE PARTS= 2 % OF MECH. EQUIP.	291,165	291,165	291,165
TOTAL WORKING CAPITAL REQUIRED	349,895	332,139	353,500

ANNUAL OPERATING AND MAINTENANCE COSTS FOR 200 TPH (PRODUCT) PLANT ADDITION OPER ATING 7560 HOURS PER YEAR			
YEARLY FIXED OPERATING AND MAINTENANCE COSTS			
COST ITEM	PITTSBURGH NO. 8	UPPER FREEPORT	ILLINOIS NO. 6
PLANT LABOR COSTS	227,381	227,381	227,381
ADMINISTATIVE LABOR AND COSTS	68,214	68,214	68,214
MAINTENANCE SUPPLIEIS	1,508,710	1,508,710	1,508,710
INSURANCE AND TAXES	1,260,905	1,260,905	1,260,905
TOTAL YEARLY FIXED O&M COSTS	3,065,211	3,065,211	3,065,211
YEARLY VARIABLE OPERATING AND MAINTENANCE COSTS			
COST ITEM	PITTSBURGH NO. 8	UPPER FREEPORT	ILLINOIS NO. 6
FLOCCULANTS	434,246	701,350	1,173,312
FLOTATION REAGENTS	1,803,749	701,393	1,238,219
GRINDING MEDIA	653,105	615,551	646,574
LUBRICANTS	45,443	30,442	58,677
MAGNETITE	0	0	0
POWER	6,444,749	6,444,749	6,444,749
PROCESS WATER	20,072	12,020	17,464
TOTAL YEARLY VARIABLE O&M COSTS	9,401,364	8,505,505	9,578,995

COAL PREPARATION PLANT DATA
Costs in $1000

*Direct Processing	$ 45720	*Fuel stockpile	0 days
*Emission/Waste Equip	$ 0	*Expensible Cap.	0 %
*Off-Site Utilities	$ 0	*Year 1 outlay	50 %
*On-Site Assembly	$ 0	*Year 2 outlay	50 %
*Site Modifications	$ 0	*Year 3 outlay	0 %
*Engineering	$ 0	*Fixed O&M, Per Year	$ 3065
*Contingency	$ 0	*Var O&M/yr @100% Ld	$ 10894
*Working Capital	$ 350	*Ins.&prop. tax/yr.	0 %
*Coal Input	267 tons/hr	*Heating Value	10499 Bt
*Primary Coal output	200 tons/hr	*Heating Value	13618 Bt
*Second Coal output	0 tons/hr	*Heating Value	0 Btu/lb
*Fuel Consumption	0 MMBtu/hr	*Reagent Consumption	0 tons/h
*Sulfur-Input	2.34 %	*Sulfur-Primary	2.5 %
*Sulfur-Secondary	0 %		

File Record # 19 File code ADV-PGH7560
PITTSBURGH 200TPH PLANT ADDITION @7560

COAL PREPARATION PLANT DATA
Costs in $1000

*Direct Processing	$ 45645	*Fuel stockpile	0 days
*Emission/Waste Equip	$ 0	*Expensible Cap.	0 %
*Off-Site Utilities	$ 0	*Year 1 outlay	50 %
*On-Site Assembly	$ 0	*Year 2 outlay	50 %
*Site Modifications	$ 0	*Year 3 outlay	0 %
*Engineering	$ 0	*Fixed O&M, Per Year	$ 3065
*Contingency	$ 0	*Var O&M/yr @100% Ld	$ 9856
*Working Capital	$ 332	*Ins.&prop. tax/yr.	0 %
*Coal Input	248 tons/hr	*Heating Value	11921 Bt
*Primary Coal output	200 tons/hr	*Heating Value	13456 Bt
*Second Coal output	0 tons/hr	*Heating Value	0 Btu/lb
*Fuel Consumption	0 MMBtu/hr	*Reagent Consumption	0 tons/h
*Sulfur-Input	2.64 %	*Sulfur-Primary	2.3 %
*Sulfur-Secondary	0 %		

File Record # 20 File code ADV-FRE7560
UPPER FREEPORT 200TPH PLANT ADDITION @7560

COAL PREPARATION PLANT DATA
Costs in $1000

*Direct Processing	$ 45734	*Fuel stockpile	0 days
*Emission/Waste Equip	$ 0	*Expensible Cap.	0 %
*Off-Site Utilities	$ 0	*Year 1 outlay	50 %
*On-Site Assembly	$ 0	*Year 2 outlay	50 %
*Site Modifications	$ 0	*Year 3 outlay	0 %
*Engineering	$ 0	*Fixed O&M, Per Year	$ 3065
*Contingency	$ 0	*Var O&M/yr @100% Ld	$ 11099
*Working Capital	$ 354	*Ins.&prop. tax/yr.	0 %
*Coal Input	264 tons/hr	*Heating Value	11191 B
*Primary Coal output	200 tons/hr	*Heating Value	13574 B
*Second Coal output	0 tons/hr	*Heating Value	0 Btu/l
*Fuel Consumption	0 MMBtu/hr	*Reagent Consumption	0 tons/
*Sulfur-Input	2.86 %	*Sulfur-Primary	3 %
*Sulfur-Secondary	0 %		

File Record # 21 File code ADV-ILL7560
ILLINOIS NO.6 200TPH PLANT ADDITION @7560

ADVANCED FROTH FLOTATION ECONOMICS AT 10 PERCENT RATE OF RETURN 200 TPH COMMERCIAL PLANT ADDITION OPERATING 3456 HOURS PER YEAR			
Cost Item	PITTSBURGH NO. 8 COAL	UPPER FREEPORT COAL	ILLNOIS NO. 6 COAL
Annualized Costs			
Raw Coal $/MMBtu	0.80	0.80	0.80
Raw Coal $/Ton	16.80	19.07	17.91
Clean Coal Incremental $/MMBtu	0.68	0.72	0.73
Clean Coal Total $/MMBtu	1.48	1.52	1.53
Clean Coal Total $/Ton	40.19	40.81	41.50
Levelized Costs			
Raw Coal $/MMBtu	1.06	1.06	1.06
Raw Coal $/Ton	22.17	25.18	23.64
Clean Coal Incremental $/MMBtu	0.89	0.95	0.96
Clean Coal Total $/MMBtu	1.95	2.00	2.02
Clean Coal Total $/Ton	53.05	53.88	54.78
Other Costs			
Present Value Of Costs	$80,653,000	$84,533,000	$86,723,000
Annualized Desulfurization Cost	$1,720.72	$1,419.48	$2,111.18
Payback Period (years)	7.9	7.9	7.9

CAPITAL REQUIREMENTS FOR 200 TPH (PRODUCT) PLANT ADDITION OPER ATING 3456 HOURS PER YEAR			
DIRECT PROCESSING COSTS ESTIMATION			
COST ITEM	ALL THRE COALS		
A–CAPITAL COST OF PLANT	42,030,183		
B–CAPITAL COST OF EQUIPMENT	18,003,516		
C–MECHANICAL EQUIPMENT COST	14,558,225		
D–LAND PURCHASE	1,920,718		
E–STARTUP MODIFICATIONS	840,604		
F–PREPRODUCTION COSTS	PITTSBURGH NO. 8	UPPER FREEPORT	ILLINOIS NO. 6
POWER	245,514	245,514	245,514
FLOCCULANTS	16,543	26,718	44,698
FLOTATION REAGENTS	68,714	26,720	47,170
WATER	765	458	665
GRINDING MEDIA	24,880	23,450	24,631
LUBRICANTS	1,731	1,160	1,439
MAGNETITE	0	0	0
MANPOWER	8,662	8,662	8,662
MAINTENANCE SUPPLIES	125,726	125,726	125,726
DIRECT PROCESSING COSTS (A+D+E+F)	45,284,040	45,249,912	45,290,010
WORKING CAPITAL REQUIREMENT ESTIMATION			
COST ITEM	PITTSBURGH NO. 8	UPPER FREEPORT	ILLINOIS NO. 6
FLOCCULANTS	4,136	6,680	11,174
FLOTATION REAGENTS	17,179	6,680	11,793
GRINDING MEDIA	6,220	5,862	6,158
LUBRICANTS	433	290	360
MAGNETITE	0	0	0
SPARE PARTS= 2 % OF MECH. EQUIP.	291,165	291,165	291,165
TOTAL WORKING CAPITAL REQUIRED	319,132	310,676	320,649

ANNUAL OPERATING AND MAINTENANCE COSTS FOR 200 TPH (PRODUCT) PLANT ADDITION OPER ATING 3456 HOURS PER YEAR			
YEARLY FIXED OPERATING AND MAINTENANCE COSTS			
COST ITEM	PITTSBURGH NO. 8	UPPER FREEPORT	ILLINOIS NO. 6
PLANT LABOR COSTS	103,946	103,946	103,946
ADMINISTATIVE LABOR AND COSTS	31,184	31,184	31,184
MAINTENANCE SUPPLIEIS	1,508,710	1,508,710	1,508,710
INSURANCE AND TAXES	1,260,905	1,260,905	1,260,905
TOTAL YEARLY FIXED O&M COSTS	2,904,745	2,904,745	2,904,745
YEARLY VARIABLE OPERATING AND MAINTENANCE COSTS			
COST ITEM	PITTSBURGH NO. 8	UPPER FREEPORT	ILLINOIS NO. 6
FLOCCULANTS	198,513	320,617	536,371
FLOTATION REAGENTS	824,571	320,637	566,043
GRINDING MEDIA	298,562	281,395	295,577
LUBRICANTS	20,774	13,916	17,270
MAGNETITE	0	0	0
POWER	2,946,171	2,946,171	2,946,171
PROCESS WATER	9,176	5,495	7,983
TOTAL YEARLY VARIABLE O&M COSTS	4,297,767	3,888,231	4,369,415

COAL PREPARATION PLANT DATA
Costs in $1000

*Direct Processing	$ 45284	*Fuel stockpile	0 days
*Emission/Waste Equip	$ 0	*Expensible Cap.	0 %
*Off-Site Utilities	$ 0	*Year 1 outlay	50 %
*On-Site Assembly	$ 0	*Year 2 outlay	50 %
*Site Modifications	$ 0	*Year 3 outlay	0 %
*Engineering	$ 0	*Fixed O&M, Per Year	$ 2905
*Contingency	$ 0	*Var O&M/yr @100% Ld	$ 10894
*Working Capital	$ 319	*Ins.&prop. tax/yr.	0 %
*Coal Input	267 tons/hr	*Heating Value	10499 Btu/lb
*Primary Coal output	200 tons/hr	*Heating Value	13618 Btu/lb
*Second Coal output	0 tons/hr	*Heating Value	0 Btu/lb
*Fuel Consumption	0 MMBtu/hr	*Reagent Consumption	0 tons/hr
*Sulfur-Input	2.34 %	*Sulfur-Primary	2.5 %
*Sulfur-Secondary	0 %		

File Record # 22 File code ADV-PGH3456
PITTSBURGH 200TPH PLANT ADDITION @3456

COAL PREPARATION PLANT DATA
Costs in $1000

*Direct Processing	$ 45250	*Fuel stockpile	0 days
*Emission/Waste Equip	$ 0	*Expensible Cap.	0 %
*Off-Site Utilities	$ 0	*Year 1 outlay	50 %
*On-Site Assembly	$ 0	*Year 2 outlay	50 %
*Site Modifications	$ 0	*Year 3 outlay	0 %
*Engineering	$ 0	*Fixed O&M, Per Year	$ 2905
*Contingency	$ 0	*Var O&M/yr @100% Ld	$ 9856
*Working Capital	$ 311	*Ins.&prop. tax/yr.	0 %
*Coal Input	248 tons/hr	*Heating Value	11921 Btu/lb
*Primary Coal output	200 tons/hr	*Heating Value	13456 Btu/lb
*Second Coal output	0 tons/hr	*Heating Value	0 Btu/lb
*Fuel Consumption	0 MMBtu/hr	*Reagent Consumption	0 tons/hr
*Sulfur-Input	2.64 %	*Sulfur-Primary	2.3 %
*Sulfur-Secondary	0 %		

File Record # 23 File code ADV-FRE3456
UPPER FREEPORT 200TPH PLANT ADDITION @3456

COAL PREPARATION PLANT DATA
Costs in $1000

*Direct Processing	$ 45290	*Fuel stockpile	0 days
*Emission/Waste Equip	$ 0	*Expensible Cap.	0 %
*Off-Site Utilities	$ 0	*Year 1 outlay	50 %
*On-Site Assembly	$ 0	*Year 2 outlay	50 %
*Site Modifications	$ 0	*Year 3 outlay	0 %
*Engineering	$ 0	*Fixed O&M, Per Year	$ 2905
*Contingency	$ 0	*Var O&M/yr @100% Ld	$ 11075
*Working Capital	$ 321	*Ins.&prop. tax/yr.	0 %
*Coal Input	264 tons/hr	*Heating Value	11191 Btu/lb
*Primary Coal output	200 tons/hr	*Heating Value	13574 Btu/lb
*Second Coal output	0 tons/hr	*Heating Value	0 Btu/lb
*Fuel Consumption	0 MMBtu/hr	*Reagent Consumption	0 tons/hr
*Sulfur-Input	2.86 %	*Sulfur-Primary	3 %
*Sulfur-Secondary	0 %		

File Record # 24 File code ADV-ILL3456
ILLINOIS NO.6 200TPH PLANT ADDITION @3456