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CHARACTERISTICS OF AMERICAN COALS IN RELATION TO
THEIR CONVERSION INTO CLEAN ENERGY FUELS

Quarterly Technical Progress Report,
January—March 1976

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Work Performed Under Contract No. E(49-18)-2030

Coal Research Section
Pennsylvania State University
University Park, Pennsylvania

ENERGY RESEARCH AND DEVELOPMENT ADMINISTRATION

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ABSTRACT

Responses to the questionnaire, which was distributed to determine the extent to which the nation's coal seams have been sampled and characterized, are being received.

Early comparisons indicate a mathematical relationship between average random reflectance (Rapid Scan) and the mean-maximum reflectance as obtained by standard reflectance analysis.

Results obtained so far show support of a diffusion dominance mechanism in the oxidation region of a combustion pot and a chemical kinetic mechanism in the gasification region. Values of reaction rates in coke beds have been calculated from experiments with a fixed bed shaft gasifier.

Devolatilization of a North Dakota lignite in a laminar flow reactor and subsequent treatment of the resulting char has shown that weight loss is strongly dependent upon the isothermal decomposition time.

Although gasification rates increase with increase in partial pressure of oxygen, the mechanism for gasification of a given char is independent of partial pressure of oxygen. Study of the reactivity of ion-exchanged lignite chars to steam shows that increased heat treatment decreases reactivity and ion exchange increases reactivity.

Use of the DSC technique to study the thermal effects involved during chemisorption of oxygen on Saran carbon has yielded information on the activation energy (E_a) of the reaction.

Work on the infinite parallel plane char combustion computer model has determined that low volatile chars and coals can be suitable fuels if adequate available internal surface area is present.

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OBJECTIVE AND SCOPE OF WORK

The primary objective of the overall program is to achieve the capability of predicting, from a knowledge of coal composition, the behavior of a coal in pre-conversion processing, coal gasification and coal liquefaction processes.

It is reasonable to ask if this goal is in fact attainable, recognizing the heterogeneity of coal seams. Clearly, it is not if one concerns oneself simply with the rank of the coal seam and its aggregate chemistry. A high volatile B coal from Indiana need not react to processing in the same manner as a high volatile B coal from Utah, even though their "chemistries" may be very similar. In contrast, a coal lithotype of a specific kind, at a given level of rank, can be expected to behave consistently, whether it derives from Alabama or Pennsylvania. Hence, the goal may very well be attainable if, as in the case of coal carbonization, we concern ourselves with the reacting entities and the properties of the important lithotypes.

The goal is to attain the same high level of predictive accuracy that is now found in the area of coal carbonization, where Penn State's collaborative work with the steel industry proved highly successful. To achieve this goal Penn State has devised an integrated program in which the success of the research is highly dependent on the effective operation of ALL of the program's Facets and Sub-facets which are as follows:

- Facet I: Characterization of the Nation's Coal Resources
 - I-A: Sample Collection and Seam Characterization
 - I-B: Coal Characterization
 - I-C: Sample Bank Operation, Maintenance and Development
 - I-D: Penn State-ERDA Coal Data Base
- Facet II: Coal Beneficiation and Pre-Use Processing
- Facet IV: Significance of Coal Characteristics in Gasification Processes
 - IV-A: Reactor Development and Operation
 - IV-B: Cokes and Chars
 - IV-D: Reactivity of Coal Chars
 - IV-E: Catalysis Research
 - IV-F: Differential Scanning Calorimetry
- Facet V: Coal Combustion Research
 - V-A: Combustion of Chars and Low Volatile Fuels
 - V-B: Combustion of Coal-Oil Emulsions

THE CHARACTERISTICS OF AMERICAN COALS IN RELATION TO
THEIR CONVERSION INTO CLEAN ENERGY FUELS

TASK DESCRIPTIONS

<u>FACET I-A</u>	<u>Sample Collection and Seam Characterization</u>
Task 1	Sampling Survey
Task 2	Sampling Plan
Task 3	Sampling
<u>FACET I-B</u>	<u>Coal Characterization</u>
Task 5	Characteristics and Use Potential of U. S. Coal Seams
Task 6	Characterization of Other ERDA Contractor Samples
Task 7	Automation of Microscopic Analytical Methods
<u>FACET I-C</u>	<u>Sample Bank Operation, Maintenance and Development</u>
Task 8	Maintenance of Coal Sample Bank
Tasks 9-14	Provision of Samples and Data to Penn State and Other Investigators
<u>FACET I-D</u>	<u>Penn State/ERDA Coal Data Base</u>
Task 15	Computerization of Data
Task 16	Evaluation of the Data Base
Task 17	Structuring and Utilization of the Data Base
<u>FACET II</u>	<u>Coal Beneficiation and Pre-Use Processing</u>
Task 18	Washability Characterization
Task 19	Physical Properties of Coal Lithotypes
Task 20	Techniques for Fractionation
Task 21	Beneficiation of Conversion Feedstocks
Task 22	Evaluation of Dry Flo Separator
<u>FACET IV-A</u>	<u>Reactor Development and Operation</u>
Task 23	Operation of Isothermal Furnace
Task 24	Pyrolysis of Coal Lithotypes
Task 25	Operation of Pressurized Isothermal Reactor
Task 26	Coal Reactivity
<u>FACET IV-B</u>	<u>Cokes and Chars</u>
Task 27	Effect of Variables on Char Structures
Task 28	Effect of Char Structures on Reactivities
Task 29	Catalytic Effect of Minerals in Gasification
Task 30	Effect of Catalytic Cations on Gasification
<u>FACET IV-F</u>	<u>Differential Scanning Calorimetry</u>
Task 31	DSC in Evaluating Coals for Conversion
<u>FACET V-A</u>	<u>Combustion of Chars and Low Volatile Fuels</u>
Task 32	Flame Ball Combustion Model
Task 33	Plane Flame Furnace
<u>FACET V-B</u>	<u>Combustion of Coal - Oil Emulsions</u>
Task 34	Combustion of Coal - Oil Emulsions

LEGEND

SCHEDULED

SCHEDULE EXTENSION

PROGRESS

EARLY START

PROJECT PLAN AND PROGRESS REPORT

Quarter Ending March 31, 1976

SUMMARY OF PROGRESS TO DATE

A survey of state geological agencies, universities, and private research organizations engaged in coal research is being conducted to determine the extent to which the nation's coal seams have been sampled and characterized. The results of this survey will be used as a guide to plan and schedule future coal sampling trips.

Work on the automated reflectance microscope (Rapid Scan) has been directed toward system refinements and improving maceral analyses. Other microscopy endeavors include plans to study thermal stress using the Leitz 1350 heating stage.

During the report period, 27 characterized coal samples and 39 printouts of analytical data were sent to outside agencies; as Penn State continues providing services to others engaged in coal research.

The Penn State Coal Data Base has been structured to run on a dedicated minicomputer system. Demonstrations of the data system have been given in Allentown, Pittsburgh, and Philadelphia, Pennsylvania and Washington, D.C.

The difficulties in locating a suitable industrial feed for the DryFlo Separator have been further addressed. A possibility is being investigated at a preparation plant utilizing Super Flow Air Cleaners on a minus 1/2 in. feed. The dust product from this plant, which is recovered via cyclones, appears to be a potential feed for the DryFlo studies. An effort is being made to make DryFlo tests at this location.

The final design of the pressurized laminar-flow isothermal reactor is nearly complete. A meeting to finalize the plans on March 17 indicated that Autoclave Engineers, Inc. is nearly ready to begin manufacture of components. The job planning diagram provided by Autoclave Engineers, Inc. is presented in this report.

Devolatilization of a North Dakota lignite in a laminar flow reactor and subsequent treatment of the resulting char has shown that weight loss is strongly dependent upon the isothermal decomposition time.

Reactivity of the most reactive char (PSOC-91) has been studied at 405°C in different mixtures of oxygen and nitrogen. The char reactivity increases with increase in partial pressure of oxygen. Effect of particle size on char reactivity has been studied in the case of two chars: a low volatile bituminous char (PSOC-127) and a lignite char (PSOC-87). Reduction in particle size increases the reactivity of both raw and demineralized PSOC-127 char. However, in the case of raw and demineralized PSOC-87 chars reactivities are almost independent of particle size. Relative reactivities of various chars in air and carbon dioxide are the same.

Preliminary results of reactivities of chars to steam are presented in this report. The reactivity of PSOC-91 char in steam at 910°C is about the same as that in air at 405°C. Reactivity of a given char in steam at 910°C is independent of bed height or starting weights ≤ 3 mg. Reactivities of four lignite chars show appreciable decrease upon removal of mineral matter.

Reactivities of variously treated chars made from PSOC-140, a Darco Texas lignite, have been measured at three reaction temperatures. Preliminary results show 1) reactivity decreases as heat treatment temperature increases, 2) raw coal chars are approximately ten times more reactive than the demineralized coal char for all reaction temperatures, and 3) reactivities of chars made from demineralized coals which had been ion exchanged with calcium⁺⁺ were ten times greater than reactivities of raw coal char at a reaction temperature of 650°C, but were only twice as great at a reaction temperature of 700°C, and only slightly greater at a reaction temperature of 750°C. In addition to reactivities, helium densities, mercury densities, and carbon dioxide surface areas for some of the coals, chars, and reacted chars have been measured. Also, ash and moisture contents have been determined.

The effect of various modes of heat treatment on char reactivity in air at 500°C has been studied. Reactivities have been shown to be maximized by keeping the maximum heat treatment temperature as low as possible, the heating rate as high as possible, and allowing no soak time at the maximum temperature. It has been observed that aging of chars in dry air has little or no effect on subsequent reactivity. Heat treatment of chars in different atmospheres (nitrogen, carbon dioxide, hydrogen) to the same temperature has no significant effect on subsequent char reactivity.

The use of small angle x-ray scattering to characterize heat treated coals continues to show promise. Systematic variations of a primary structural parameter are noted with variations in heat treatment temperature and the rank of the parent coal. At present we are obtaining values for the volume fraction of pores in order to calculate secondary parameters such as surface area and pore dimensions.

The differential scanning calorimetry technique has been used to study the thermal effects involved during chemisorption of oxygen on Saran carbon. In the temperature range 100-202°C, the Saran carbon, previously activated to 63.8 percent carbon burn-off, showed the existence of different groups of active sites. The activation energy for chemisorption of oxygen increased with increasing surface coverage and ultimately attained a constant value. The unactivated Saran carbon also showed different kinetic stages in the temperature range 202-304°C, but activation energy was independent of surface coverage. The order of chemisorption process is proportional to square root of the oxygen partial pressure. Following adsorption at a given temperature, the sample was heated to high temperatures in nitrogen. Resorption experiments were then performed to find out the

fraction of the carbon surface regenerated. The fraction regenerated increases with increase in adsorption or desorption temperature.

A large body of experimental results indicates that low to nearly zero volatile matter fuels (coal chars and anthracite coals) can be stabilized in a laboratory-scale combustion apparatus (the plane flame furnace). Order of magnitude shifts in the distance from the water-cooled inlet tube bank to the flame front can occur in switching from fuels suspected of having large accessible internal surface areas (macroporous) to fuels thought to have little readily accessible internal surface area (microporous).

Much of our work to date has been focused on the development of computer models to analyze and explain past experiments and to design future experiments. A model which considers only the stable combustion of a pulverized char flame in an infinite parallel plane geometry (properties varying only along direction of flow) is a logical starting point toward further three dimensional modeling. The model permits examination of the detailed structure of pulverized char flames simply, yet realistically. Capabilities for using uneven nodal spacing and variable radiation absorption coefficient were incorporated into the infinite parallel plane mode, greatly enhancing the computational ability of the computer program. A study of hot wall ignition of a pulverized char/air mixture was conducted and an unambiguously defined ignition temperature was found for the system. Further uses of the model include a recent study to predict infinite parallel plane combustion results using the experimentally measured char kinetics of Field.²⁵

The results of experiments conducted during the past year on oil/water/air emulsions with and without small coal additions have been compiled and evaluated for presentation to The Combustion Institute.

FACET I-A: SAMPLE COLLECTION AND SEAM CHARACTERIZATION

COAL SAMPLING AND ROUTINE CHARACTERIZATION

During the last report period initial steps were taken in conducting a survey to determine the extent to which the nation's coal seams have been sampled and characterized. Questionnaires were distributed to 25 state agencies, from which 24 replies were received. As a follow-up to the questionnaire, the following geological surveys have been contacted by personal visit or telephone: USGS, Arizona, Arkansas, Illinois, Indiana, Kansas, Kentucky, Missouri, New Mexico, Oklahoma, and Texas. In addition, universities and private research organizations have now been contacted, of which 18 have responded. Upon completion of the survey, the University will use the information obtained as a guide to plan and schedule the collection of 1300 coal samples. Agencies included in the survey are listed in Table 1.

Thin sections of eight coals have been made from oriented coal blocks and Hardgrove grindability tests were run of 44 polished blocks made from PSOC samples 357 through 378. Reflectance data were generated on eight samples (PSOC-357 through 364), while fluorescence analyses were completed on eight samples (PSOC-343, 344, 346, 350, 352-355).

Coals sent to our Mineral Constitution Lab by March 1, 1976 (PSOC-230, 233, 235, 249, 272, 273, 279-281, 286, 287, 290, 305-321, 323-334, 336-351, 353-356) have undergone preliminary processing and are in the course of being analyzed for major, minor, and trace elements. Mineral matter will also be eventually determined.

A typical sample is split into two lots, one to be used in all analyses and the other to be saved as a possible check. From the lot to be analyzed, an x-ray fluorescence pellet, a high temperature ash (HTA), and a low temperature ash (LTA) are prepared.

The elements sulfur, chlorine, and phosphorus are determined directly in the whole coal via x-ray fluorescence analysis of the pellet while major and minor elements such as silicon, aluminum, iron, calcium, magnesium, manganese, sodium, potassium, titanium, zinc, and lead are determined by atomic absorption analysis of the HTA. Involatile trace elements such as boron, barium, beryllium, cobalt, chromium, germanium, lanthanum, molybdenum, niobium, nickel, selenium, strontium, vanadium, yttrium, ytterbium, zirconium, cerium, and copper are determined via emission spectrographic analysis of the HTA. Volatile elements such as arsenic, selenium, cadmium, and fluorine can be determined via special atomic absorption or wet chemical techniques on the LTA or the whole coal. Mineral content is determined on the basis of quantitative x-ray diffraction and infra-red analysis of the LTA. A general flow diagram of the entire analytical procedure is presented in Figure 1 (this will be modified when the new Plasma Spectrometer is obtained).

Table 1. Agencies Included in Survey

<u>State Geological Agencies</u>	<u>Universities and Research Organizations</u>
Alabama	University of Arizona
Alaska	Batelle Columbus Labs.
Arizona	Batelle Northwest
Arkansas	Bechtel Corporation
Colorado	Bethlehem Steel
Illinois	Bituminous Coal Research, Inc.
Indiana	Brigham Young University
Iowa	Carnegie-Mellon University
Kansas	Colorado School of Mines
Kentucky	Combustion Engineering, Inc.
Maryland	Conoco Coal Development Co.
Missouri	University of Denver Research Inst.
Montana	Dow Chemical Co.
New Mexico	Exxon
North Dakota	Fluor Engineers & Constructors
Ohio	Fluor Utah, Inc.
Oklahoma	FMC Corp.
Pennsylvania	Gulf Research and Development
Tennessee	IGT
Texas	Lawrence Livermore
Utah	Arthur D. Little, Inc.
Virginia	Los Alamos
Washington	Massachusetts Institute of Technology
West Virginia	Mobil Oil
Wyoming	University of Montana
	State University of NY at Buffalo
	University of North Dakota
	Oak Ridge
	Pittsburg & Midway Coal Mining Co.
	Purdue University
	Shell Mining Ventures
	Stanford Research Institute
	United States Steel
	University of Utah
	University of Utah (Fuels Engineering)
	Virginia Polytechnic Institute
	Virginia State University
	University of West Virginia
	West Michigan University
	Westinghouse Electric Corporation

Figure 1. FLOW CHART FOR ANALYTICAL PROCEDURES

Currently, major and minor element data as well as percent chlorine are available for all of the samples. In addition, trace element data is available for PSOC samples 233-310. Completion of all trace element analyses is a matter of time as is percent sulfur trioxide. While the technique for the determination of percent sulfur and percent phosphorus is ready, completion awaits the calibration of reliable standards. Such is also the case for the determination of mineral content. Here, the problem lies in what internal standard is to be employed. While previous workers in this and other labs have made use of a calcium fluoride internal standard, communications with the Illinois State Geological Survey indicate that aluminum oxide may be more desirable. It is the aluminum oxide series of standards which are now being tested.

FACET I-B: COAL CHARACTERIZATION

RAPID SCAN AUTOMATED REFLECTANCE MICROSCOPE SYSTEM

Work on the automated reflectance microscope (Rapid Scan) has been directed toward system refinements and improving maceral analyses. Both the system electronics and the computer based programming were modified in order to reduce inherent system noise. A variable gain, low noise amplifier was added to the system immediately prior to the computer input. This allowed the photomultiplier potential voltage to be set at an optimum, constant level, independent of system standardization. The result was a minor improvement of the signal to noise ratio. A more sophisticated computer program was also developed to minimize the effect of noise on the coal reflectogram.

A study was conducted to visually check data recorded by the Rapid Scan from a known scan line. A photomosaic of a traverse (approximately 2000 μ in length) was made and then compared to the digital data recorded by the Rapid Scan while passing over the same line. When the effects of scale were equalized, a one to one comparison showed the Rapid Scan to be completely accurate.

Many times however, it is difficult to distinguish the lower reflecting coal constituents as the translucent epoxy binder allows particles below the surface to reflect anomalously low readings. This distorts the lower portion of the reflectogram. In order to correct this problem, several dyes were mixed with the epoxy to make it opaque. Two of the dyes, which were particle dyes, proved unsatisfactory because they raised the reflectance of the resin into the coal region of the reflectogram. However, the third dye, a special pigment dye, has been successful in significantly lessening this effect.

Studies were conducted to test the reproducibility of the maceral analysis on a single pellet. A coal was selected and several analyses, consisting of 100,000 data pts each, were run covering different areas of the pellet. Good precision was obtained when the results were plotted on an x-y graphic plotter.

A suite of 11 coals was then analyzed. These coals varied in rank from lignite to anthracite and all had a high vitrinite content. The purpose of this study was to compare average random reflectance as recorded by the Rapid Scan to the mean-maximum reflectance as obtained by standard reflectance analysis. Early comparisons indicate a mathematical relationship between these two values.

Future work will be directed toward better quantifying this relationship. This will entail analyzing additional suites of coals of

varying rank and graphically comparing the two values. Emphasis will also be directed toward distinguishing between the various minor macerals in the coal reflectogram.

HOT-STAGE MICROSCOPY

Introduction

The purpose of this investigation is to characterize the behavior and optical properties of selected coal components subjected to thermal stress in atmospheres of nitrogen, steam, carbon dioxide, and hydrogen by direct observation using the Leitz 1350 heating stage.

Heating stages facilitate the dynamic investigation of physical conditions and reactions of small particles at elevated temperatures. Although the hot-stage microscope is a well-known tool in the fields of metallography and ceramic science, little has been done to apply hot-stage microscopic technique to the study of coal.

Berry^{1,2} first applied heating stage technique to coal research in his investigation of thermal properties of bituminous coal components in an inert atmosphere using the Leitz 1000 model hot-stage. Walsh and Dutcher³ investigated the properties of anthracite lithotypes, and Dutcher⁴ briefly reviewed reactions of coal constituents under the hot-stage microscope. Rau and Robertson⁵ briefly discussed the potential and several applications of hot-stage microscopy in coal research. Nandi and Montgomery⁶ studied the thermal reactivity of the maceral semifusinite from some coals of western Canada.

Experimental

All of the above investigations were conducted in an inert atmosphere. Furthermore, the older investigations utilized coal petrographic terminology, which has since become obsolete following the institution of the standardized nomenclature of the International Commission for Coal Petrology.⁷

Presented here, in outline form, are proposals for investigations using the Leitz 1350 hot-stage and appropriate photographic and thermal monitoring accessories and controls:

1. Observe the reactions of vitrinite macerals in "pure" concentrations under the hot-stage microscope using modern vitrinoid group nomenclature.
2. Conduct the above study using a nitrogen atmosphere as an experimental control and then introduce the variables of:

- a. rank
- b. ambient atmospheres of:
 - (1) steam
 - (2) carbon dioxide
 - (3) hydrogen
- c. heating rate
- d. sample preoxidation
- e. sample size
- f. addition of mineral matter

3. Study macerals and combinations of macerals (microlithotypes) from coal of various rank under the conditions outlined in 2.

- a. exinite
- b. semifusinite
- c. pseudovitrinite

4. Study petrographically, particle residues at various stages of thermal treatment and compare them to char and filter cake residues of coal liquefaction and gasification processes.

5. Monitor evolved gases during thermal treatment in nitrogen atmospheres using either:

- a. on-line gas chromatography or residual gas analysis
- b. room-temperature chromatography

6. Correlate the observed properties and reactions with the calculated or measured basic analytical parameters of:

- a. rank (reflectivity)
- b. Vicker microhardness
- c. Hardgrove grindability
- d. Geiseler plasticity
- e. Free-Swelling Index and/or Gray-King Coke Type
- f. Proximate and ultimate analyses

7. Produce time-lapse motion pictures, visually demonstrating the reactions of coal macerals and microlithotypes when subjected to thermal stress, for distribution to interested consumers.

FACET I-C: SAMPLE BANK OPERATION, MAINTENANCE, AND DEVELOPMENT

SERVICE TO OTHER AGENCIES

During the report period, 27 characterized coal samples were sent to outside agencies engaged in coal research. In addition, 39 printouts of analytical data were dispatched.

Fourteen samples containing large quantities of organic and total sulfur were provided the General Electric Space Center for desulfurization studies; five samples were selected for the Penn State Materials Research Laboratory for use in work to improve the efficiency of grinding processes; seven coal pellets of different ranks were sent to the University of Southern California; and one coal sample was sent to E. Soehngen and Associates for use in ultra-fine grinding.

Maceral data was generated on eight washability fractions each from PSOC-296 and 297, from 21 sized samples sent by IGT, and on eight coal samples sent by other ERDA contracting agencies and numbered POC-280 through 287. Both maceral and reflectance analyses were performed on two samples from Calgon and four samples sent by Alcoa and numbered PSCS-1 through 4.

FACET I-D: PENN STATE/ERDA COAL DATA BASE

COAL DATA BASE ACTIVITY REPORT

The Penn State Coal Data Base has been structured to run on a dedicated minicomputer system. The implementation of this system has enabled on-line searches and manipulations of the data base to be made through the use of remote terminals. Demonstrations of the data system have been given in Allentown, Pittsburgh, and Philadelphia, Pennsylvania and Washington, D.C.

The computer system used for this project is a PDP-8/A with 16K core memory. The bulk storage used for the data base is a dual IBM type floppy disc system. For remote operation the computer is interfaced to a 300 Band modern.

Two independent data files have been established. One file is structured according to each coal, listing all the characteristics of each coal. The second file is structured according to each characteristic, listing the values of that characteristic for all coals.

The development of programs for use with the data base is an on-going process. In order to make them transportable, the programs have been written in Fortran-IV. In addition, they have been designed so that an untrained operator can use them in a prompting question-answer mode. Four modes of operation are now on-line:

1. Search mode - in this mode the operator can search the data base for those coals that fall within selected value ranges for variables such as composition, location, etc.

2. Map mode - in this mode coals are mapped according to selected ranges of two variables.

3. Combined - in this option coals screened by the search program can be selectively mapped.

4. Calculation mode - this mode enables parameters such as coke strength, which can be calculated from data within the base, to be obtained for any coal or blend of coal.

FACET II: COAL BENEFICIATION AND PRE-USE PROCESSING

COAL PREPARATION STUDIES

Computerization of Coal Fractionation Data

The petrographic analytical details of the fractions previously developed for PSOC-306 (a high volatile A coal from the Ohio No. 12 seam, Yorkville, Ohio) were incorporated into the coal preparation data bank. These new data show the following variations between fractions, and in comparison with the as received analysis:

	Volume, %	
	Range	Feed
Vitrinite	91.3 - 55.70	61.9
Exinite	5.6 - 0.10	7.5
Micrinite	9.8 - 2.30	9.0
Fusinite	34.4 - 4.60	21.6

Fractionation of Coal Samples

The studies in Task 18 include the fractionation of three samples described in the July-September 1975 Quarterly Technical Progress Report (PSOC-326, 337, and 184), four additional samples that are now completed including chemical analysis (PSOC-329, 317, 183, and 349), and PSOC-357 which is nearly fractionated. The identification of the recently completed samples are shown in Table 2, and their basic preparation characteristics in Table 3. In summary, seven seams representing four ranks have been fractionated.

Development of Plans for Pilot Plant Test of the DryFlo Separator

The difficulties in locating a suitable industrial feed for the DryFlo Separator have been further addressed. Sampling was made of raw coal which had been deep-mined from a Lower Kittanning seam and subsequently sized at 3/8 in. The coal from this location had had a history of constant and relatively low moisture contents. However, when tested, the moisture content was unacceptably high and a field pilot screen test gave unacceptable yields.

Another potential is being investigated at a preparation plant utilizing Super Flow Air Cleaners on a minus 1/2 in. feed from the B and D seams. This large plant (270 ton/hr) was inefficient because its feed was too wet. Test samples were taken and analyzed from this plant

Table 2. Identification of Coals Fractionated

PSOC No.	ASTM Rank	Parr Volatile Matter, %	Seam - Location
329	High Volatile A	42.6	Brookville Pennsylvania
317	Low Volatile	17.7	Lower Freeport Pennsylvania
183	High Volatile B	42.4	Upper Block Indiana
349	- High Volatile A	42.5	Lower Clarion Pennsylvania
357	High Volatile A	34.3	Lower Elkhorn Kentucky

as shown in Tables 4 and 5. The dust product from this plant, which is recovered via cyclones, appears to be a potential feed for the DryFlo studies, although it does not adequately represent the ROM coal, has a somewhat small size distribution, and has higher than desirable moisture content. An effort is being made to make DryFlo tests at this location.

Review Statement Describing the DryFlo Separator⁸

Mechanized mining systems now being used in deep mines are producing greater levels of fine particle sizes which characteristically include more mineral matter and higher moisture contents than coal extracted by conventional methods.⁹ These mined coal properties are contraproductive in conventional coal beneficiation, including higher processing costs, although most coal now consumed (for combustion and carbonization) is finally crushed to at least minus 1/4 in. Most advanced coal conversion and fluidized bed combustion processes being developed will also use fine sized coal particles. Most fine coal is currently beneficiated by "wet" processes that require costly unit operations to remove the process water from levels as high as 35 weight percent. The need to beneficiate coal (especially fine sizes) to control and reduce ash and sulfur content, as well as to manage organic composition, is evidenced by the current all-time high level of activity in this study area. Accordingly, any development capable of fine coal beneficiation without using water, especially with low costs, has great potential in contribution to the solution of the nation's energy needs. The DryFlo system appears to offer this potential, and is worthy of further evaluation.

Table 3. Summary of Preparation Characteristics
of Coals Fractionated
(Dry Basis)

Sample Designation	Feed	Clean Coal Product	
		Lowest Fraction	at 1.40 g/cc (+16 mesh)
<u>PSOC-329</u>			
Ash, %	17.7	2.8	6.0
Sulfur, %	3.07	0.94	2.08
Yield, %			61.9
Hardgrove Grindability Index			
A			74.0
B			68.4
C			64.3
<u>PSOC-317*</u>			
Ash, %	12.8	2.4	4.1
Sulfur, %	5.81	0.68	0.90
Yield, %			75.4
Hardgrove Grindability Index			
A			114.2
<u>PSOC-183</u>			
Ash, %	6.08	1.69	4.64
Sulfur, %	1.27	0.78	0.99
Yield, %			82.4
Hardgrove Grindability Index			
A			69.1
B			63.6
C			60.1
<u>PSOC-349</u>			
Ash, %	10.51	2.32	4.93
Sulfur, %	4.65	1.63	2.67
Yield, %			67.69
Hardgrove Grindability Index			
A			81.6
B			76.0
C			71.9

*The particle size of the sample received in the laboratory did not permit fractionation by hardness. Gravity fractionation was necessarily limited to the 1/4 in. x 16 mesh fraction.

Table 4. Plant Samples Describing Performances
of Superflow Air Cleaner

Treating Central Pennsylvania B and D Seams
Size Analyses

Raw Coal (7.1% Moisture)

Passed	Retained	Direct		Cumulative			
		Wt. % ¹	Ash % ²	Passed		Retained	
		Wt. %	Ash % ²	Wt. %	Ash % ²	Wt. %	Ash % ²
	1/4"	12.9	19.87	12.9	19.87	100.0	15.94
1/4"	16M	48.0	17.29	60.9	17.84	87.1	15.35
16M	30M	13.8	12.22	74.7	16.80	39.1	12.98
30M	100M	14.6	12.01	89.3	16.02	25.3	13.34
100M		10.6	15.28	100.0	15.94	10.7	15.28

Clean Coal (7.4% Moisture)

	1/4"	11.7	18.17	11.7	18.17	100.0	14.63
1/4"	16M	49.4	14.99	61.1	15.60	88.3	14.16
16M	30M	13.8	12.84	74.9	15.09	38.9	13.10
30M	100M	14.7	11.43	89.6	14.49	25.1	13.24
100M		10.4	15.80	100.0	14.63	10.4	15.80

Middling (6.1% Moisture)

	1/4"	30.3	35.91	30.3	35.91	100.0	29.18
1/4"	16M	42.2	33.88	72.5	34.73	69.7	26.26
16M	30M	8.3	14.96	80.8	32.70	27.5	14.57
30M	100M	10.6	12.43	91.4	30.35	19.2	14.40
100M		8.6	16.83	100.0	29.18	8.6	16.83

Reject Refuse (5.5% Moisture)

	1/4"	31.2	53.15	31.2	53.15	100.0	36.31
1/4"	16M	47.1	35.05	78.3	42.26	68.8	46.67
16M	30M	6.0	15.30	84.3	40.34	21.7	14.81
30M	100M	8.2	12.52	92.5	37.88	15.7	14.63
100M		7.5	16.93	100.0	36.31	7.5	16.93

Dust (3.8% Moisture)

	1/4"	--	--	--	--		
1/4"	16M	--	--	--	--		
16M	30M	0.6	13.75	0.6	13.75	100.0	8.37
30M	100M	85.6	8.01	86.2	8.02	99.4	8.34
100M		13.8	10.37	100.0	8.37	13.8	10.37

¹Air Dried Basis

²Dry Basis

Table 5. Plant Samples Describing Performances of Superflow Air Cleaner
Treating Central Pennsylvania B and D Seams
Washability Analyses

Raw Coal											
Sink	Float	Wt. %	Direct		Cumulative						
			H ₂ O %	Ash %*	Float		Sink				
					Wt. %	Ash %*	Wt. %	Ash %*			
	1.30	66.8	0.10	5.96	66.8	5.96	100.0	19.62			
1.30	1.60	15.1	0.10	15.47	81.9	5.71	33.2	47.11			
1.60		18.1	0.20	73.50	100.0	19.62	18.1	73.50			
Clean Coal											
	1.30	56.9	0.10	3.10	56.9	3.10	100.0	14.72			
1.30	1.60	29.3	0.10	10.76	86.2	5.70	43.1	30.05			
1.60		13.8	0.30	71.01	100.0	14.72	13.8	71.01			
Middling											
	1.30	38.9	0.10	3.10	38.9	3.10	100.0	34.32			
1.30	1.60	24.0	0.10	14.31	62.9	7.38	61.1	54.19			
1.60		37.1	0.30	79.99	100.0	34.32	37.1	79.99			
Reject											
	1.30	40.3	0.06	3.79	40.3	3.79	100.0	37.37			
1.30	1.60	17.9	0.30	15.25	58.2	7.31	59.7	60.03			
1.60		41.8	0.90	79.21	100.0	37.37	41.8	79.21			
Dust											
					S %	Wt. %	Ash %	Sulf. %	Wt. %	Ash %	Sulf. %
	1.30	54.3	0.25	1.75	0.81	54.3	1.75	0.81	100.0	7.70	1.17
1.30	1.60	39.7	0.30	8.07	0.93	94.0	4.42	0.86	45.7	14.77	1.60
1.60		6.0	0.30	59.08	6.02	100.0	7.70	1.17	6.0	59.08	6.02

CALCULATED RECOVERIES: Clean Coal - 90.0%; Middling - 4.0%; Reject - 5.9%; Dust - 0.1%

*Dry Basis

All pneumatic-cleaning approaches have feed moisture content limitations. The DryFlo Separator is not an exception. However, should the ROM feed to such a system require drying, moisture reduction from five or six percent is obviously better than from 35 percent.

The DryFlo device functions pneumatically and has the capability to process coal feeds whose top sized particles range from 1/4 in. to less than 100 mesh. Its pinch sluice format transports the feed from the outer periphery by gravity to an inner gate discharge with an increasing bed depth. At the gate, the particle momentum results in a free fall trajectory defined by particle mass and shape. The particle target location permits separation of particles by composition using a splitter system. During transport down the sluice, the bed is partially fluidized by air passing through a controlled permeability bed bottom.

The Model 30 previously studied has a bed area of one square foot, with bed dimensions of 20 in. length and nine in. feed width. It has a feed capacity of about 2 ton/hr requiring 2 hp, primarily for air movement. The operating parameters are sluice bed angle (12-23°), air flow rate, splitter positions, feed rate, and feed characteristics. Dust control is critical, however can probably be achieved. Feed moisture content will have limitations and can be a process constraint.

The fundamental principal of separation relates particle mass to terminal settling velocity as applied through the equipment design. This concept is illustrated in Figure 2.

The feed material must be adequately fluidized on the DryFlo bed to allow particle segregation to occur prior to separation of the discharge plume by the splitters. The potential sensitivity of the machine to separate particles of different properties relates to plume length and the degree of horizontal segregation attained within the plume. There is a wall effect. The fluidization of the coal feed is primarily a function of coal particle size and size distribution; however, the air flow rate through the bed may be controlled (20-50 ft³/min). The pressure drop across the bed (<7 in. water) is primarily a design and maintenance factor. The plume characteristics relate to fluidization, but are associated with bed retention time and particle momentum at the discharge gate.

A unique process applicable to the DryFlo Separator permits the introduction of a dry heavy media (magnetite) into the feed to achieve beneficiation of top particle sizes between 1/4 in. and 16 mesh. Small sized feeds do not require this addition. The media is recovered by screening and recycled.

The modified Model 60 now being studied varies in bed length and in plume product separation design. These changes are described in Figure 3. The modifications are expected to increase unit capacity, enhance bed segregation, improve separation efficiency, and minimize wall effects.

Figure 2. PARTICLE DISTRIBUTION PATTERN
FROM DRY FLOW SEPARATOR PLUME

Figure 3. SCHEMATIC DRAWING OF MODEL 60 DRYFLO SEPARATOR

Figure 3 (Continued). SCHEMATIC DRAWING OF MODEL 60 DRYFLO SEPARATOR

Fifty-eight runs were made using the Model 30 with nine different American coals (Table 6) of six ranks under different process parameters. These tests were short runs utilizing about 50 to 100 lb feed per test. Three product streams were developed (clean coal, middling, and refuse), which were sampled and analyzed. The ranges of coal feed characteristics were ash (4.8-14.5%), sulfur (0.8-4.3%), total moisture (0.6-31.7%), and particle size ranges (1/4 in. x 16 mesh, 30 x 100 mesh, minus 8 mesh, minus 16 mesh, minus 30 mesh, and minus 100 mesh).

The following two tables (Table 7 and 8) summarize the test conditions employed and results attained. Five tests (Nos. 3, 4, 22, 23, and 24) gave sulfur rejections from the clean coal of greater than sixty percent; while six tests (Nos. 3, 4, 22-24, and 26) gave ash rejections from the clean coal of greater than fifty-eight percent. As a specific example, Test 4 made with Brookville seam coal of minus 30 mesh resulted in a clean coal product of 68.3 weight percent. The ash was reduced from 15.3 to 9.1 percent, the sulfur from 4.25 to 2.43 percent. The corresponding ash and sulfur contents of limited size fractions having lowest levels were, respectively, 7.2 and 1.32 percent.

Another set of data showing more detailed results for the same coal is given in Table 9.

A further attempt to analyze the data was made with Test Run 13, using an anthracite feed. The analysis of the products follow in Table 10. In this test 23.4 percent of the ash, and 11.9 percent of the sulfur were rejected from the clean coal product. An attempt to correlate the results with terminal settling velocities is illustrated in Figure 4. Reasonable agreement is indicated. However, the horizontal velocity extensively modulates the particle trajectory to achieve a physical separation by placement of the three products in different locations. The densities plotted represent an average based upon ash content as determined from washability data. The product cut was near 1.65 density, the middling in the range of 1.65 and 1.67, while the refuse contained particles above 1.67 density.

A further evaluation was made by performing sink-float separations at the several gravities used for reference in Figure 4. These separations are very tedious and time-consuming to perform, requiring centrifugation. The data are presented in Table 11. Although the levels of misplaced material are not equivalent to those attained by wet-coarse coal processing, substantial beneficiation did occur in a single pass. The greatest error appears to be represented by the presence of clean coal in the refuse. All separations apparently occurred at somewhat higher densities than predicted. This coal obviously contained very high levels of near gravity material, estimated to be greater than 30 percent $\pm$ 0.1 gravity at 1.55 separation point.

The actual test data of the above are attached in Appendix A.

Table 6. Coal Utilized in DryFlc Separator Evaluations

PSOC No.	Designation		Moisture %	Ash %	Total Sulfur %	Pyritic Sulfur %
	Seam	Rank				
85	No. 8 Leader	Anthracite	1.25	8.32	1.05	0.28
Bradford	Lower Kittanning	Medium Volatile	0.50	12.62	3.77	
Elliot	Brookville	Medium Volatile	0.59	14.49	4.15	
208	Freeport	Medium Volatile	7.13	10.19	4.29	2.68
102	Pittsburgh	High Volatile A	1.64	7.07	1.36	0.54
5	Elkhorn No. 3	High Volatile A	1.87	4.78	1.60	0.77
105	Indiana No. 1 Block	High Volatile B	6.20	11.32	2.21	1.24
233	Wadge	High Volatile C	6.59	7.55	0.60	
86	Zap	Lignite	31.70	11.49	1.22	0.56

Table 7. Test Conditions Utilized with Model 30 DryFlo Separator

Test No.	PSOC No.	Seam Name	Coal Rank	Coal Size (mesh)	Coal Feed Rate (tons/hr)	Bed Angle (degrees)	Air Flow Rate (cfm)	Splitter Settings Distance in Inches			
								K ₁	K ₂	K ₃	K ₄
1	Elliot	Brookville	MV	-30	1.011	16	28	1.500	0.000	1.000	2.875
2	Elliot	Brookville	MV	-30	1.401	16	28	1.187	0.000	1.215	2.750
3	Elliot	Brookville	MV	-30	1.332	16	20	1.187	0.000	1.125	2.750
4	Elliot	Brookville	MV	-30	1.164	16	24	1.187	0.000	1.125	2.750
5	233	Wadge	HVC	-30	1.008	16	24	0.625	0.000	1.125	2.750
6	233	Wadge	HVC	-30	1.293	16	24	0.812	0.000	1.125	2.750
7	233	Wadge	HVC	30x100	2.158	12	20	1.000	0.000	1.125	2.750
8	233	Wadge	HVC	30x100	1.506	12	24	1.000	0.000	1.125	2.750
9	233	Wadge	HVC	30x100	2.026	23	24	1.343	0.125	1.250	2.750
10	233	Wadge	HVC	30x100	2.067	23	20	1.343	0.125	1.250	2.750
11	233	Wadge	HVC	30x100	1.903	17.5	20	1.343	0.125	1.125	2.875
12	233	Wadge	HVC	30x100	1.873	17.5	24	1.343	0.125	1.125	2.875
13	85	#8 Leader	AN	30x100	1.740	16	20	1.250	0.000	1.750	2.656
14	85	#8 Leader	AN	30x100	1.680	16	24	1.250	0.000	1.750	2.656
15HM	102	Pittsburgh	HVA	-30	1.571	16	25	1.062	0.000	1.656	2.437
16HM	102	Pittsburgh	HVA	-30	1.861	16	30	1.062	0.000	1.656	2.437
17HM	102	Pittsburgh	HVA	-30	1.897	16	20	1.062	0.000	1.656	2.437
18RM	102	Pittsburgh	HVA	-30	1.047	16	20	1.062	0.000	1.656	2.437
19RM	102	Pittsburgh	HVA	-30	1.485	16	25	1.062	0.000	1.656	2.437
20RM	102	Pittsburgh	HVA	-30	1.647	16	30	1.062	0.000	1.656	2.437
21	Elliot	Brookville	MV	-100	0.624	16	20	0.343	-0.250	1.500	2.125
22	Elliot	Brookville	MV	-100	0.894	16	20	0.343	-0.250	1.500	2.125

Table 7 (continued). Test Conditions Utilized with Model 30 DryFlo Separator

Test No.	PSOC No.	Seam Name	Coal Rank	Coal Size (mesh)	Coal Feed Rate (tons/hr)	Bed Angle (degrees)	Air Flow Rate (cfm)	Splitter Settings Distance in Inches			
								K ₁	K ₂	K ₃	K ₄
23RM	5	Elkhorn No. 3	HVA	-30	0.647	16	24	1.062	0.000	1.656	2.437
24RM	5	Elkhorn No. 3	HVA	-30	0.997	12	24	1.062	-0.062	1.406	2.500
25RM	5	Elkhorn No. 3	HVA	-30	0.535	23	24	1.187	0.062	1.737	2.406
26RM	5	Elkhorn No. 3	HVA	-30	0.710	16	20	1.062	0.000	1.656	2.437
27RM	5	Elkhorn No. 3	HVA	-30	0.594	16	23	1.062	0.000	1.656	2.437
28	105	Indiana #1 Block	HVB	-16	N.A.	16	24	1.750	0.625	1.000	3.000
29H	105	Indiana #1 Block	HVB	1/4"x16	0.641	16	30	1.4375	0.5372	1.2872	2.84375
30H	105	Indiana #1 Block	HVB	1/4"x16	0.767	12.5	30	1.4375	0.4437	1.1937	2.84375
31H	105	Indiana #1 Block	HVB	1/4"x16	1.028	12.5	30	1.4375	0.4437	1.1937	2.84375
32H	105	Indiana #1 Block	HVB	1/4"x16	0.910	16	30	1.4375	0.5372	1.2872	2.84375
33H	208	Freeport	MV	1/4"x16	0.629	12.5	30	1.4375	0.4437	1.1937	2.84375
34H	208	Freeport	MV	1/4"x16	1.060	12.5	30	1.4375	0.4437	1.1937	2.84375
35H	208	Freeport	MV	1/4"x16	0.896	16	30	1.4375	0.5372	1.2872	2.84375
36H	208	Freeport	MV	1/4"x16	1.082	16	30	1.4375	0.5372	1.2872	2.84375
*37H	86	Zap	Lig.	1/4"x16	0.921	16	30	1.4375	0.5372	1.2872	2.84375
*38H	86	Zap	Lig.	1/4"x16	0.979	12.5	30	1.4375	0.4437	1.1937	2.84375
*39H	Elliot	Brookville	MV	1/4"x16	1.424	12.5	30	1.4375	0.4437	1.1937	2.84375
*40H	Elliot	Brookville	MV	1/4"x16	0.837	16	30	1.4375	0.5372	1.2872	2.84375
41	86	Zap	Lig.	-16	1.255	16	30	1.250	0.375	1.000	3.000
42	86	Zap	Lig.	-16	1.123	12.5	30	1.187	0.375	0.875	3.000
43	86	Zap	Lig.	-16	1.169	12.5	30	1.187	0.375	0.875	3.000
44	86	Zap	Lig.	-16	1.667	16	40	1.250	0.375	1.000	3.000
45	86	Zap	Lig.	-16	1.536	16	40	1.125	0.250	1.000	3.000

Table 7 (continued). Test Conditions Utilized with Model 30 DryFlo Separator

Test No.	PSOC No.	Seam Name	Coal Rank	Coal Size (mesh)	Coal Feed Rate (tons/hr)	Bed Angle (degrees)	Air Flow Rate (cfm)	Splitter Settings Distance in Inches			
								K ₁	K ₂	K ₃	K ₄
46	208	Freeport	MV	-16	1.776	16	24	1.250	0.375	1.000	3.000
47	208	Freeport	MV	-16	1.822	16	24	1.250	0.375	1.000	3.000
48	208	Freeport	MV	-16	1.760	16	24	1.125	0.250	1.000	3.000
49	208	Freeport	MV	-16	1.522	12.5	30	1.000	0.187	0.875	3.000
50	208	Freeport	MV	-16	1.843	12.5	40	1.000	0.187	0.875	3.000
51	Elliot	Brookville	MV	-8	1.433	16	24	1.125	0.250	1.000	3.000
52	Elliot	Brookville	MV	-8	1.545	16	30	1.125	0.250	1.000	3.000
53	Elliot	Brookville	MV	-8	1.664	16	40	1.125	0.250	1.000	3.000
54R	105	Indiana #1 Block	HVB	-16	1.582	16	40	0.875	0.3759	1.1259	2.28125
55R	105	Indiana #1 Block	HVB	-16	1.799	16	45	0.875	0.3759	1.1259	2.28125
56R	105	Indiana #1 Block	HVB	-16	1.684	16	50	0.875	0.3759	1.1259	2.28125
57H	Bradford	Wadge	MV	1/4"x16	0.913	16	30	1.4375	0.5372	1.2872	2.84375
58H	Bradford	Wadge	MV	1/4"x16	1.047	12.5	30	1.4375	0.4437	1.1937	2.84375

N.A. = Not available
 HM = Sample crushed by hammer mill
 RM = Sample crushed by roll mill
 H = Heavy med test run
 R = Recycled refuse from test #28
 * = Twin runs combined

K₁ = x distance to #1 splitter edge
 K₂ = y distance to #1 splitter edge
 K₃ = y distance to #2 splitter edge
 K₄ = x distance to #2 splitter edge

Table 8. DryFlo Separator Test Results

Test. Number	Weight % Recovery			% Recovered in Clean Coal		% Rejected from Clean Coal		% Recovered in Middling		% Recovered in Refuse	
	Product	Mid	Refuse	Sulfur	Ash	Sulfur	Ash	Sulfur	Ash	Sulfur	Ash
1	66.9	10.7	32.4	44.81	47.19	55.19	52.81	8.55	9.08	46.64	43.73
2	68.3	12.9	18.8	40.54	47.14	59.46	52.86	11.08	12.34	48.38	40.52
3	57.3	21.9	20.8	31.67	34.93	68.33	65.07	19.33	22.30	49.00	42.77
4	53.0	20.9	26.1	30.30	31.36	69.70	68.64	14.61	18.59	55.09	50.05
5	68.5	19.0	12.5	68.50	64.33	31.50	35.67	18.17	19.60	13.33	16.08
6	80.7	9.7	9.6	79.33	76.95	20.67	23.05	9.03	9.92	10.74	13.13
7	73.4	19.0	7.6	73.40	70.80	26.60	29.20	18.57	19.08	8.03	10.13
13	86.9	4.4	8.7	88.13	76.62	11.87	23.38	4.40	6.41	7.47	16.97
14	88.2	3.9	7.9	89.44	78.50	10.56	21.50	3.83	5.14	6.73	16.36
15	88.2	5.3	6.5	86.86	78.54	13.14	21.46	5.45	6.93	7.68	14.53
16	89.8	4.9	5.3	89.11	79.42	10.89	20.58	4.29	6.75	6.59	13.82
17	69.1	22.4	8.5	68.53	53.24	31.47	46.76	21.64	27.10	9.82	19.66
18	76.1	14.9	9.0	74.01	62.10	25.99	37.90	15.10	17.46	10.90	20.44
19	89.2	5.2	5.6	87.55	78.98	12.45	21.02	5.40	7.70	7.05	13.32
20	91.0	3.8	5.2	89.38	81.66	10.62	18.34	3.85	5.23	6.78	13.11
21	61.7		38.3	53.65	53.08	46.35	46.92	0.00	0.00	46.42	46.95
22	30.6		69.4	25.25	25.63	74.75	74.37	0.10	0.00	74.65	74.37
23	48.5	26.5	25.0	39.35	41.03	60.65	58.97	21.66	23.24	38.99	35.73
24	32.0	45.8	22.2	27.24	26.87	72.76	73.13	38.11	40.99	34.65	32.14
25	67.4	4.7	27.9	56.83	55.81	43.17	44.19	4.33	4.43	38.84	39.76
26	47.5	28.0	24.5	40.53	41.36	59.47	58.64	25.49	27.20	33.97	31.45

Table 8 (continued). DryFlo Separator Test Results

Test Number	Weight % Recovery			% Recovered in Clean Coal		% Rejected from Clean Coal		% Recovered in Middling		% Recovered in Refuse	
	Product	Mid	Refuse	Sulfur	Ash	Sulfur	Ash	Sulfur	Ash	Sulfur	Ash
27	53.9	18.4	27.7	44.79	45.17	55.21	54.83	15.61	16.73	39.60	38.10
28	56.4		43.6	54.93	52.61	45.07	47.39	0.11	0.03	44.96	47.36
29	85.8	5.6	8.6	80.66	81.35	19.34	18.65	8.73	7.30	10.61	11.35
30	66.9	22.0	11.1	56.83	59.70	43.17	40.30	26.10	25.31	17.07	15.00
31	71.3	18.7	10.0	62.54	63.70	37.46	36.30	17.91	19.99	19.55	16.31
32	87.5	6.0	6.5	81.47	83.37	18.53	16.63	7.03	7.34	11.51	9.30
33	63.9	26.7	9.4	45.77	46.70	54.23	53.30	29.48	28.67	24.75	24.63
34	61.8	26.5	11.7	41.08	42.90	58.92	57.10	26.58	26.89	32.34	30.20
53	60.6	23.6	15.8								
54	44.3	39.4	16.3	37.64	33.19	62.36	66.81	39.40	38.06	22.96	26.76
55	65.0	24.8	10.2	56.88	56.95	43.13	43.05	24.28	27.48	18.84	15.57
56	71.9	19.2	8.9	64.67	65.13	35.33	34.87	20.39	21.87	14.94	13.00
57	87.4	6.2	6.4	71.99	73.24	28.01	26.76	12.71	11.31	15.30	15.46
58	72.4	16.1	11.5	48.82	50.50	51.18	49.50	21.63	19.62	29.55	29.88

Table 9. Data for DryFlo Separator Test No. 1

Figures from Elliot Feed Sample

Product Coal Data

This fraction = 66.9% of the feed

Size Fraction Passed Retained	Direct Values				Cumulative Retained				Cumulative Passed			
	Weight %	Ash %	Sulfur %	Moisture %	Weight %	Ash %	Sulfur %	Moisture %	Weight %	Ash %	Sulfur %	Moisture %
30M 30M	0.60	6.60	1.04	0.75	0.60	6.60	1.04	0.75	100.00	10.22	2.78	0.61
30M 60M	50.50	8.14	1.51	0.55	51.10	8.12	1.50	0.55	99.40	10.24	2.79	0.61
60M 100M	24.70	9.56	2.46	0.60	75.80	8.59	1.82	0.57	48.90	12.41	4.12	0.67
100M	24.20	15.31	5.81	0.75	100.0	10.22	2.78	0.61	24.20	15.31	5.81	0.75

Middling Coal Data

This fraction = 10.7% of the feed

29	30M 30M	7.50	10.97	2.21	0.60	7.50	10.97	2.21	0.60	100.00	12.33	3.29	0.64
	30M 60M	77.40	10.22	2.21	0.65	84.90	10.29	2.21	0.65	92.50	12.44	3.38	0.64
	60M 100M	12.00	21.49	7.30	0.65	96.90	11.67	2.84	0.65	15.10	23.83	9.35	0.61
	100M	3.10	32.90	17.27	0.45	100.0	12.33	3.29	0.64	3.10	32.90	17.27	0.45

Refuse Coal Data

This fraction = 22.4% of the feed

30M 30M	15.70	32.86	6.17	0.50	15.70	32.86	6.17	0.50	100.00	28.29	8.64	0.50
30M 60M	74.60	25.43	8.34	0.50	90.30	26.72	7.96	0.50	84.30	27.43	9.10	0.50
60M 100M	8.20	41.33	15.81	0.55	98.50	27.94	8.62	0.50	9.70	42.85	14.98	0.51
100M	1.50	51.15	10.46	0.30	100.0	28.29	8.64	0.50	1.50	51.15	10.46	0.30

Composite Data

This fraction = 100.0% of the feed

30M 30M	4.72	26.91	5.06	0.54	4.72	26.91	5.06	0.54	100.00	14.49	4.15	0.59
30M 60M	58.78	13.35	3.55	0.55	63.50	14.36	3.66	0.55	95.28	13.88	4.10	0.59
60M 100M	19.65	13.31	4.02	0.60	83.14	14.11	3.75	0.56	36.50	14.72	5.00	0.66
100M	16.86	16.37	6.13	0.74	100.0	14.49	4.15	0.59	16.86	16.37	6.13	0.74

Table 10. Washability Data for DryFlo Separator Test No. 13

Figures from PSOC - 85 (Anthracite) Feed

Product Coal Data

This fraction = 86.9% of the feed

Size Fraction		Direct Values				Cumulative Retained				Cumulative Passed			
		Weight %	Ash %	Sulfur %	Moisture %	Weight %	Ash %	Sulfur %	Moisture %	Weight %	Ash %	Sulfur %	Moisture %
Passed	Retained												
	30M	5.10	7.46	1.40	0.80	5.10	7.46	1.40	0.80	100.00	9.39	1.43	0.88
30M	60M	47.30	8.32	1.35	0.80	52.40	8.24	1.35	0.80	94.90	9.50	1.43	0.88
60M	100M	24.30	8.93	1.50	0.95	76.70	8.46	1.40	0.85	47.60	10.67	1.51	0.96
100M	150M	10.40	9.89	1.60	0.90	87.10	8.63	1.42	0.85	23.30	12.48	1.52	0.98
150M	200M	0.90	11.30	1.60	0.90	88.00	8.65	1.43	0.85	12.90	14.57	1.46	1.04
200M		12.00	14.81	1.45	1.05	100.00	9.39	1.43	0.88	12.00	14.81	1.45	1.05

Middling Coal Data

This fraction = 4.4% of the feed

30		30M	14.40	11.58	1.20	0.70	14.40	11.58	1.20	0.70	100.00	15.38	1.34	0.74
	30M	60M	68.60	16.78	1.30	0.80	83.00	15.88	1.28	0.78	85.60	16.01	1.36	0.74
	60M	100M	13.60	16.16	1.45	0.65	96.60	15.92	1.31	0.76	17.00	12.93	1.59	0.52
	100M	150M	1.70	0.00	2.20	0.00	98.30	15.64	1.32	0.75	3.40	0.00	2.17	0.00
	150M	200M	0.00	0.00	0.00	0.00	98.30	15.64	1.32	0.75	1.70	0.00	2.15	0.00
	200M		1.70	0.00	2.15	0.00	100.00	15.38	1.34	0.74	1.70	0.00	2.15	0.00

Refuse Coal Data

This fraction = 8.7% of the feed

	30M	16.20	19.38	1.10	0.65	16.20	19.38	1.10	0.65	100.00	20.77	1.21	0.64
30M	60M	74.40	21.14	1.10	0.65	90.60	20.83	1.10	0.65	83.80	21.03	1.23	0.64
60M	100M	8.10	23.44	1.90	0.60	98.70	21.04	1.17	0.65	9.40	20.20	2.22	0.52
100M	150M	0.90	0.00	4.30	0.00	99.60	20.85	1.19	0.64	1.30	0.00	4.24	0.00
150M	200M	0.00	0.00	0.00	0.00	99.60	20.85	1.19	0.64	0.40	0.00	4.10	0.00
200M		0.40	0.00	4.10	0.00	100.00	20.77	1.21	0.64	0.40	0.00	4.10	0.00

Composit Data

This fraction = 100.0% of the feed

	30M	6.47	10.46	1.32	0.76	6.47	10.46	1.32	0.76	100.00	10.65	1.41	0.85
30M	60M	50.59	10.46	1.32	0.78	57.07	10.46	1.32	0.78	93.53	10.66	1.41	0.86
60M	100M	22.42	9.58	1.51	0.93	79.49	10.21	1.37	0.82	42.93	10.89	1.53	0.95
100M	150M	9.19	9.73	1.63	0.89	88.68	10.16	1.40	0.83	20.51	12.32	1.54	0.96
150M	200M	0.78	11.30	1.60	0.90	89.46	10.17	1.40	0.83	11.32	14.42	1.47	1.03
200M		10.54	14.66	1.46	1.04	100.00	10.65	1.41	0.85	10.54	14.66	1.46	1.04

Table 11. Evaluation of DryFlo Separator Data for Test 13 (PSOC-85 Anthracite)

Gravity Separation of Test Products							Misplaced Material (Weight % - Feed Basis)					
	Size M	Separation Gravity	% Float	% Ash Float calc.	% Ash Sink	% Ash Size Fraction	Refuse in Clean Coal	Refuse in Mids	True Refuse in Refuse	Clean Coal in Mids	Clean Coal in Refuse	True Clean Coal in Clean Coal
<u>Clean Coal Product</u>	+30	1.55	88.7	3.70	37.00	7.46	0.50					3.93
	30x60	1.56	88.0	4.34	37.52	8.32	4.93					36.17
	60x100	1.57	91.6	4.41	58.19	8.93	1.77					19.35
	100x150	1.58	89.8	4.34	58.71	9.89	0.92					8.12
	150x200	1.60	90.6	6.11	61.24	11.30	0.07					0.71
	-200	1.65	86.0	5.57	71.60	14.81	1.46					8.97
							9.65(1)					77.25(2)
<u>Middling Product</u>	+30	1.67	88.3	4.01	68.69	11.53		0.07		0.56		
	30x60	1.67	88.8	9.68	73.00	16.73		0.34		2.68		
	60x100	1.67	86.9	6.74	78.59	16.15		0.08		0.52		
								0.49(3)		0.10		
										3.86(4)		
<u>Refuse Product</u>	+30	1.71	82.5	7.53	75.28	19.33			0.25		1.16	
	30x60	1.74	79.3	7.11	74.87	21.14			1.34		5.13	
	60x100	1.78	76.7	7.14	77.08	23.44			0.16		0.54	
									1.75(5)		0.08	
											6.91(6)	
Maximum Potential Clean Coal		88.1% with 4.85% Ash										
Refuse		11.9% with 53.57% Ash			> 20.9% Misplaced Material							
Maximum Potential Premium Clean Coal		77.3% with 4.48% Ash										
Mid Coal		10.8% with 7.52% Ash			> 17.1% Misplaced Material							
Refuse		11.9% with 53.57% Ash(7)										

- (1) 48.70% Ash - 11.1% of Clean Coal Product
 (2) 4.48% Ash - 88.9% of Clean Coal Product
 (3) 73.47% Ash - 11.2% of Middling Product
 (4) 8.29% Ash - 87.8% of Middling Product

- (5) 74.88% Ash - 21.5% of Refuse
 (6) 7.01% Ash - 79.5% of Refuse
 (7) Further recovery possible at sacrifice of middling quality

TERMINAL SETTLING VELOCITIES OF PARTICLES CONSIDERED IN DRYFLO SEPARATOR
TEST 13 - PSOC-85 - SEPARATION CHARACTERISTICS

THEORETICAL TERMINAL SETTLING VELOCITIES
(Lapple, et al., "Fluid and Particle Mechanics", Univ. Delaware, 1951, p. 292)

Figure 4. TERMINAL SETTLING VELOCITIES

FACET IV-A: REACTOR DEVELOPMENT AND OPERATION

EVALUATION OF THE GASIFICATION POTENTIAL OF COALS

Introduction

The final design of the pressurized laminar-flow isothermal reactor is nearly complete, although now two months behind schedule. Complete engineering drawings have been submitted by the subcontractor, Autoclave Engineers, Inc., for our review. A meeting to finalize the plans was held March 17th. Immediate approval of all design aspects and components is anticipated except for the coal feed and venturi system, and the separator vessel, both of which require further design study. Autoclave Engineers has reconfirmed the quoted date of delivery of the equipment. The job planning diagram provided by Autoclave indicates the present progress toward completion of this project (Figure 5).

Experimental

Values of reaction rates in coke beds have been calculated from experiments with a fixed bed shaft gasifier (combustion pot), assuming diffusion dominated reaction in the oxidation region and chemical kinetic controlled reaction in the gasification region.

In the second quarterly report the analysis of the bed assumed equal (diffusional) rate constants for the two heterogeneous reactions of this three-reaction sequence: carbon reacting heterogeneously with oxygen and carbon dioxide to form carbon monoxide, with carbon monoxide reacting homogeneously with oxygen in the pores of the bed to form carbon dioxide, permitting an analytical solution. However, the experimental results showed this to be less than adequate as evidence by the graph presented. Now, using different rate constants for the two heterogeneous reactions, it follows that the equation for the variation of gas composition with time in the bed is

$$(Y_1 + 1/2Y_2)/(1 - 1/2Y_3) = Ae^{-n_1t} + Be^{-n_2t} + C \quad (1)$$

where Y_1 , Y_2 , and Y_3 are mole fractions of oxygen, carbon dioxide, and carbon monoxide respectively, n_1 and n_2 are modified rate constants for the two heterogeneous reactions, and A, B, and C are constants.

Experimental verification of the developed equation is still underway, but useful conclusions have been drawn from the data collected so far in experiments using coke beds. Using this expression, we have determined the diffusional rate constants n_1 from the slopes of semi-logarithmic plots (Figure 6). Data for the curves were collected at

Figure 5. JOB PLANNING DIAGRAM FOR CONSTRUCTION OF ISOTHERMAL REACTOR
(Autoclave Engineers, Inc.)

Figure 6. VARIATION OF $\ln(Y_1 + \frac{1}{2}Y_2) / (1 - \frac{1}{2}Y_3)$ WITH TIME FOR (0.75-1.25") SIZE COKE BED

five different flow rates (5, 10, 15, 20, and 40 SCFM). A representative curve is approximated by two intersecting straight lines. All the curves originate at 21 percent on the ordinate as evidenced by the equation (at $t = 0$, $Y_2 = Y_3 = 0$, and $Y_1 = Y_1^0$, the initial percentage of oxygen). They decline with a slope n_1 to the point where oxygen virtually vanishes. Beyond a narrow transition region they continue to decline with slope n_2 until the temperature is below the point where any further reduction of carbon dioxide to carbon monoxide is possible.

The values of n_1 and n_2 are found to increase with velocity and/or temperature. Interpreting n_1 as the mass transfer rate constant, a log-log plot of n_1 vs velocity gives a straight line with slope 0.76 (Figure 7). This is in good agreement with the value 0.7 given in the literature.¹⁰

In addition, the Reynolds numbers through the bed pores are in the laminar range with highest values about 200. These results support the diffusion dominance mechanism in the oxidation region of the combustion pot.

The transition to a second region of linear decline of $\ln(Y_1 + 1/2Y_2)/(1 - 1/2Y_3)$ with time suggests a chemical kinetic dominance region. In that case a chemical rate constant n_2 is expected to depend more on temperature than on velocity, and the changes in slope may be attributed actually to temperature variations. (Of course the velocity and temperature are interdependent since burning rate, and hence the temperature of the bed, increases with velocity).

As reported in the second quarterly report the temperature measurements have been started (Figures 8 and 9). Over all experiments average temperatures ranged from 1200°C to 1500°C. The temperature varied with porosity (particle size) and velocity; but in a given experiment temperature at any point varied little throughout the experimental run (Figure 9). Furthermore, the temperature was approximately uniform throughout the bed, rising very rapidly in the first half to one inch above the cold grate. There was a peak in most experiments about the middle of the oxygen depletion region, with temperature falling slightly toward the top of the bed, mostly by less than 250°C.

Conclusion

The results obtained so far show support of a diffusion dominance mechanism in the oxidation region of a combustion pot and a chemical kinetic mechanism in the gasification region. Work is underway to study the influence of particle size and velocity and temperature on the diffusional rate.

Figure 7. LOG - LOG PLOT OF VELOCITY VS DIFFUSIONAL RATE CONSTANT

Figure 8. WALL TEMPERATURE VS HEIGHT FOR FOUR RUNS

Figure 9. VARIATION OF TEMPERATURE OVER AN EXTENDED RUN (0.25–0.5'' COKE AT 5 SCFM)

CHARACTERISTICS OF CHARS PRODUCED UPON RAPID DEVOLATILIZATION OF NORTH DAKOTA LIGNITE

Introduction

The first quarter of 1976 was devoted to three major research tasks. First a large amount of North Dakota lignite (PSOC-246) originally size-graded to 140x200 mesh was devolatilized in a laminar flow reactor under the experimental conditions specified in the ERDA Quarterly Report of December 1975. The resulting char collected after a transit distance of 30.48 cm was subsequently recycled into the reaction zone. This recycling process was continued four times, giving a cumulative isothermal decomposition time of about one second.

Next, the extent of thermal decomposition (i.e. weight loss or simply volatile matter release) of the char before each recycling was determined, using ash as a tracer.

Finally, each of these chars was subjected to behavior characterization techniques, in order to determine its structure and physical properties (e.g. porosity, mercury and helium densities, nitrogen and carbon dioxide surface areas, etc.).

The results from these studies show that: (1) weight loss is a strong function of isothermal decomposition (τ_{iso}), (2) physical properties such as nitrogen and carbon dioxide surface areas, mercury and helium densities, porosities, etc., also vary significantly with τ_{iso} , (3) weight loss contributes to the development of nitrogen and carbon dioxide surface areas, and (4) x-ray diffraction patterns show a rather sharp peak at $\sim 26.6^\circ$ in 2θ angles. It is believed that this peak is due to impure silicon dioxide (SiO_2), not to carbon.

Experimental

The cases under study are shown in Table 11, namely:

Case I is for the raw coal.

Case II is for char collected after a transit distance of 30.48 cm.

Case III is for char recycled one time at a transit distance of 30.48 cm.

Case IV is for char recycled two times at a transit distance of 30.48 cm.

Case V is for char recycled three times at a transit distance of 30.48 cm.

Case VI is for char recycled four times at a transit distance of 30.48 cm.

The raw coal as well as all of the chars were subjected to studies for weight loss and characteristics as shown below.

Table 11. Dependence of Weight Loss (ΔW) on Residence Time (τ)
for PSOC-246 Originally Sized to 140x200 Mesh ($\bar{X} = 86\mu\text{m}$)

Case	Residence Time (τ), sec			% Ash (dry)	ΔW (% of Original daf coal)
	Heating	Isothermal	Total		
I	-	-	-	7.29	-
II	0.095	0.205	0.300	9.56	25.18
III	0.190	0.410	0.600	10.32	31.67
IV	0.285	0.615	0.900	10.82	35.19
V	0.380	0.820	1.200	11.44	39.13
VI	0.475	1.025	1.500	11.99	42.28

Weight loss (ΔW) was determined using ash as a tracer (as specified in the December 1975 ERDA Report). The data obtained from these determinations (Table 11), are used in plotting weight loss vs isothermal decomposition time (Figure 10). The solid curves in this figure are predicted by Badzioch and Hawksley equation.¹¹ It is seen here that experimental results from the 140x200 mesh size grade deviate quite drastically at longer isothermal decomposition times. The deviations for the other two size grades (70x100 and 200x270 mesh) are less serious. Comparison between experimental and theoretical (i.e. predicted by the Badzioch and Hawksley equation) results are better illustrated in Figure 11. The deviation from the 140x200 mesh size fraction is again reflected in this figure.

The samples referred to in Table 11 have also been subjected to various characterization techniques (see report of January 1975). Due to the incompleteness of these studies, only a limited amount of data will be presented here.

Nitrogen and carbon dioxide surface area data (Table 12) are plotted vs isothermal decomposition time (Figure 12).

Appropriate data in Tables 12 and 13 are then used to correlate nitrogen and carbon dioxide surface areas with weight loss. The correlation shows (Figure 13) that volatile matter release during devolatilization contributes rather significantly to the development of nitrogen and carbon dioxide surface areas.

The samples in Table 11 and the other ones (Table 13) were subjected to x-ray diffraction studies. The aim was to see whether appreciable crystallinity of the materials develops under our devolatilization conditions, since coal devolatilization is indeed a graphitization process.

Figure 10. DEPENDENCE OF WEIGHT LOSS ON RESIDENCE TIME FOR PSOC-246

Figure 11. WEIGHT LOSS (ΔW): PREDICTED VS EXPERIMENTAL FOR PSOC-246

Table 12. Dependence of Nitrogen and Carbon Dioxide
Surface Areas on Residence Time (τ) for PSOC-246
Originally Sized to 140x200 Mesh ($\bar{X} = 86\mu\text{m}$)

Case	% Ash (dry)	$\text{N}_2 (\text{m}^2/\text{g})$			$\text{CO}_2 (\text{m}^2/\text{g})$		
		Dry	Dry	Ash Free	Dry	Dry	Ash Free
I	7.29	<1		<1	184		199
II	9.56	1.7		1.9	194		215
III	10.32	3.9		4.3	218		243
IV	10.82	12.9		14.5	252		283
V	11.44	16.3		18.4	269		304
VI	11.99	32.2		36.6	340		386

Table 13. X-ray Data

Case	70x100 mesh ($\bar{X} = 179\mu\text{m}$)		100x140 mesh ($\bar{X} = 127\mu\text{m}$)		140x200 mesh ($\bar{X} = 86\mu\text{m}$)		200x270 mesh ($\bar{X} = 64\mu\text{m}$)	
	d(101)	L(101)	d(101)	L(101)	d(101)	L(101)	d(101)	L(101)
I	3.36	241	3.36	241	3.36	241	3.36	241
II	3.36	285	-	-	3.36	274	3.36	285
III	3.35	352	-	-	3.36	285	3.36	352
IV	3.37	352	-	-	3.36	285	3.35	285
V	3.37	352	-	-	3.35	285	3.35	285
VI	3.37	443	-	-	3.36	530	-	-
VII	3.35	285	3.35	285	3.35	285	3.35	285
	2.03	300	2.03	300	2.03	300	2.03	300

Case VII is for chars obtained in a fluid bed.

The (002) reflection at $\sim 26.6^\circ$ in 2θ angles was scanned to characterize the carbon structure. The peak found in this region was generally sharper for chars than for raw lignite. The Bragg equation has been used to determine its interlayer spacing, i.e.

$$d_{(hkl)} = \frac{\lambda \text{CuK}_\alpha}{2 \sin \theta_{(hkl)}} \quad (2)$$

Figure 12. CHANGE OF SURFACE AREAS WITH ISOTHERMAL DECOMPOSITION TIME FOR PSOC-246 ORIGINALLY SIZED TO 140x200 MESH

Figure 13. CORRELATION BETWEEN SURFACE AREAS AND WEIGHT LOSS FOR PSOC-246 ORIGINALLY SIZED TO 140x200 MESH

where $d_{(hkl)}$ is the interlayer spacing and $\lambda_{CuK_{\alpha}} = 1.54812\text{\AA}$. The average d-spacing (Table 13) is about 3.36Å. This value, coupled with the sharpness of the peak indicates that this peak was due to a mineral rather than to carbon. Demineralization of the raw sample and one of the chars (Case VI for the 140x200 mesh size grade) with hydrochloric acid and hydrofluoric acid caused complete disappearance of the peak, thus supporting our hypothesis. A survey of the ASTM data file narrowed the choices to α -quartz and impure silicon dioxide. Further evidence suggests that the peak is the result of a (101) reflection from impure silicon dioxide.

The other peak found in fluid bed chars only at $\sim 44.6^\circ$ in 2θ angles (i.e. $d_{(hkl)} = 2.03\text{\AA}$) is believed to be due to a yet unidentified mineral. An LTA sample is in the process of being submitted to the Mineral Constitution Laboratory of The Pennsylvania State University for major elements analysis.

The crystallite size was determined from Scherrer equation.¹² In order to determine accurate crystallite size, two corrections are made: θ and instrument time broadening. Using a sodium chloride internal standard, we found that there was no need for θ correction. The correction for the time line broadening, β , due only to crystallite size was carried out using quartz as an internal standard. Next the method of Klug and Alexander¹³ was used to obtain the correct β value in radians. This value was then substituted in the Scherrer equation.¹²

$$L_{(101)} = \frac{K \lambda_{CuK_{\alpha}}}{\beta \cos \theta_{(101)}} \quad (3)$$

where $L_{(101)}$ is the crystallite size and K = shape factor ≈ 1 . All x-ray data are given in Table 13.

Since devolatilization is also a decarboxylation process, it should be of interest to see whether our experimental conditions are such that the carboxylic groups of PSOC-246 are altered. In conjunction with this, a Fourier Transform Infra-red Spectroscopy (FTIR) study of some of the samples presented in Table 11 is underway.

FACET IV-B: COKES AND CHARs

REACTIVITIES OF AMERICAN COAL CHARs IN AIR

Introduction

Reactivity of a char increases with increase in partial pressure of oxygen. Effect of particle size on char reactivity will be discussed.

Reactivity of the most reactive char (PSOC-91) has been studied at 405°C in different mixtures of oxygen and nitrogen. The char reactivity increases with increase in partial pressure of oxygen. Effect of particle size on char reactivity has been studied in the case of two chars: a low volatile bituminous char (PSOC-127) and a lignite char (PSOC-87). Reduction in particle size increases the reactivity of both raw and demineralized PSOC-127 char. However, in the case of raw and demineralized PSOC-87 chars reactivities are almost independent of particle size. Relative reactivities of various chars in air and carbon dioxide are the same.

Experimental

In the last ERDA Report, it was reported that reactivity of a char increases with increase in partial pressure in oxygen. These reactivity runs were made at 500°C. However, it was subsequently discovered that due to high exothermicity of the carbon-oxygen reaction, char reactivities were not independent of bed height. Reactivities were found to be independent of bed height at 405°C. Therefore, the effect of the partial pressure of oxygen on reactivity of PSOC-91 (the most reactive char) was studied at 405°C. The results are listed in Table 14. It is significant to note that R_0 increases almost 4.6 fold upon increasing the proportion of oxygen from 2 to 21 percent with the relationship R_0 proportional to (oxygen pressure)^{0.71} as seen in Figure 14. Partial pressure of oxygen also has a marked effect on reactivity profiles (Figure 15). It is noteworthy that all of the reactivity plots in Figure 15 coincide if the data are normalized (Figure 16). Normalization was done in the following manner. In each case, time corresponding to 50 percent burn-off was noted. These times were found to be in the ratio 1.45:1.0:0.34 for the reaction in oxygen-nitrogen mixtures containing 2, 4, and 21 percent oxygen, respectively. For normalizing the data, time corresponding to a given burn-off in the 2 and 21 percent runs was divided by 1.45 and 0.34 respectively. The normalized curves plotted in Figure 16 suggest that although gasification rates increase with increase in partial pressure of oxygen, the mechanism of gasification of a given char in air is independent of the partial pressure of oxygen.

Table 14. Influence of Oxygen Partial Pressure on Reactivity
of PSOC-91 Char at 405°C

O ₂ in O ₂ -N ₂ Mixture (%)	Reactivity (R _o) (mg hr ⁻¹ mg ⁻¹)
2	0.60
4	0.94
10	1.9
15	2.5
21	2.7

The effect of particle size on the reactivity of a lignite char (PSOC-87) and a low volatile bituminous char (PSOC-127) is illustrated by the data listed in Table 15. An increase in reactivity upon reduction of particle size of a carbon indicates that gasification rate is partly diffusion-controlled. In the case of PSOC-87 raw char, reactivity decreases slightly upon particle size reduction from 40x100 to 100x150 mesh and increases upon further reduction to 200x325 mesh. The decrease in reactivity with decrease in particle size is contrary to expectations. It is suggested that the decrease is due to separation of beneficial catalytic mineral matter from the coal matrix during grinding or to different particle size fractions having different maceral composition. In this context, Davis and Reynolds¹⁴ have previously reported that different particle size cuts derived from the same coke had different mineral matter contents. Reactivities of various size fractions of the PSOC-87 demineralized char are about the same and are invariably less than those of the corresponding size fractions of the raw char.

A decrease in particle size of PSOC-127 from 40x100 to 200x325 mesh leads to an increase in char reactivity of almost two-fold. This increase is significantly greater than that observed in the case of PSOC-87 raw char. This is presumably because of the lower nitrogen surface (feeder porosity) of the PSOC-127 char. It is noteworthy that, for each particle size, the reactivity of the PSOC-127 demineralized char is almost 10 times higher than that of the raw char. Such increases have previously been attributed to the opening of feeder pores; the increase in porosity resulting in a substantial decrease in mass transport control of gasification.¹⁵

It is significant that reactivities of the 200x325 mesh fractions of the PSOC-87 and 127 demineralized chars are about the same although reactivity of the former char is twice that of the latter for the 40x100 mesh fraction.

Figure 14. INFLUENCE OF OXYGEN PARTIAL PRESSURE
(TOTAL PRESSURE 1 ATM) ON THE REACTIVITY OF PSOC-91 CHAR AT 405°C

Figure 15. INFLUENCE OF OXYGEN CONCENTRATION ON REACTIVITY OF PSOC-91 CHAR AT 405°C

A - 21% O₂
 B - 15% O₂
 C - 10% O₂
 D - 4% O₂
 E - 2% O₂

Figure 16. NORMALIZED BURN-OFF VS TIME PLOTS FOR DIFFERENT PARTIAL PRESSURES OF OXYGEN FOR PSOC-91 CHAR AT 405°C

- 21% O₂ in N₂ (Times Multiplied by 2.86)
- 4% O₂ in N₂ (Times as Such)
- △ 2% O₂ in N₂ (Times Multiplied by 0.68)

Table 15. Influence of Particle Size on Reactivity of Chars

Particle Size Mesh	Reactivity ($\text{mg hr}^{-1} \text{mg}^{-1}$)			
	R_o	R_i	R_o	R_i
<u>PSOC-87 Char</u>				
	<u>Raw</u>		<u>Demineralized</u>	
40x100	1.1	1.1	0.23	0.12
100x150	0.85	0.8	0.25	0.23
200x325	1.2	1.2	0.24	0.21
<u>PSOC-127 Char</u>				
40x100	0.016	0.027	0.11	0.025
100x150	0.025	0.025	0.19	0.06
200x325	0.031	0.031	0.28	0.12

Walker *et al.*^{15,16} have previously measured reactivities of several chars in air at 500°C and carbon dioxide at 900°C. The chars studied were prepared from the same set of coals which were used for the preparation of chars in the present study. These workers observed that reactivity of a given char in air at 500°C was essentially the same as in carbon dioxide at 900°C. However, it was discussed in the earlier ERDA Reports that these results were not obtained in 1 atm of air and carbon dioxide. In the present study, reactivities of various chars in air at 405°C are compared with those in carbon dioxide at 900°C determined by Tomita,¹⁷ using an upward flow system (Table 16). Although absolute reactivity parameters for various chars determined in carbon dioxide are generally higher than those in air (Table 16), normalized reactivities are the same in carbon dioxide and air (Figure 17).

REACTIVITIES OF AMERICAN COAL CHARS IN STEAM

Introduction

Reactivities of American coal chars in steam are being studied. Preliminary results of these investigations are presented in this report.

Reactivities of chars in air and carbon dioxide have previously been shown to be predominantly determined by the nature of the parent coal and mineral matter composition. In order to make a valid comparison of reactivities of chars in steam with those in air at 405°C and carbon

Table 16. Comparison Between Air Reactivity at 405°C and Carbon Dioxide Reactivity at 900°C for American Coal Chars

PSOC Char No.	Reactivity R_0 in CO ₂ at 900°C mg hr ⁻¹ mg ⁻¹	Reactivity R_0 in air at 405°C mg hr ⁻¹ mg ⁻¹
91	6.3	2.7
87	-	1.07
140	3.4	1.3
138	1.9	0.53
98	1.3	0.60
101	4.6	1.84
26	0.18	0.30
22	0.59	0.34
24	1.3	0.46
67	0.15	0.27
171	0.08	0.082
4	0.20	0.26
137	0.09	0.11
114	0.07	0.016
127	0.07	0.016
81	0.13	0.11
177	0.04	0.075

dioxide at 900°C, chars used in the air and carbon dioxide reactivity work have been used in the present work. Methods of preparation of chars have been reported in earlier ERDA Progress Reports. However, it may be pertinent to briefly outline the experimental procedure. Various coals were charred at 1000°C in a nitrogen atmosphere; heating rate was 10°C/min and soak time at 1000°C was 2 hr. In order to study the effect of mineral matter removal on reactivity, a few selected coals, prior to their carbonization, were acid-washed with hydrochloric acid and/or demineralized hydrochloric-hydrofluoric acid mixture.

The effect of particle size on reactivity is being studied for two chars, namely PSOC-127, a relatively unreactive low volatile bituminous char and PSOC-87, a highly reactive lignite char. Both chars were prepared from the parent raw coals. The demineralized coals are being studied also. Particle size fractions chosen for this study were 40x100, 100x150, and 200x325 mesh.

The Fisher Thermo Gravimetric Analyzer (TGA); Model 300, has been used for measurements of reactivity. The TGA technique enables continuous weight measurement to be made on a sample while it undergoes thermal treatment in a flowing controlled atmosphere.

Figure 17. CORRELATION BETWEEN NORMALIZED VALUES OF R_0 FOR AIR AT 405°C AND CO_2 AT 900°C

The major difference in experimental operation from the previous studies is the change in the oxidant gas from air and carbon dioxide to steam and a consequent change in reaction temperature.

The sample temperature is measured by the TGA thermocouple. Before the TGA technique can be used to measure quantitatively the weight changes during reaction, it is imperative to measure accurately the sample temperature.

For calibration purposes, decomposition temperatures for calcium oxalate, corresponding to the following changes, were measured in a nitrogen flow (60 cc/min) using a heating rate of 10°C/min.

Temperatures corresponding to the maximum reaction rates for the above three reactions are given in Table 17. These temperatures are very close to those reported in the last ERDA Report.

Before reactivities of the chars could be studied, it was essential to decide on a suitable temperature for reactivity measurements. Since the carbon-steam reaction is a much slower reaction than the carbon-air reaction, it must be carried out at a much higher temperature to obtain the same reaction rate. A temperature of 910°C was selected at which the rate of reaction of the more reactive lignite, PSOC-91 (40x100 mesh), in steam corresponded closely to its reactivities in air at 405°C (Table 18).

The chosen reaction temperature should be such that reactivity is independent of bed height. That is, there should be no resistance to diffusion of reactant molecules down through the bed.

To ensure that the effect of diffusion through the bed was negligible, a small weight of char was used. Table 19 lists char reactivities of 40x100 mesh PSOC-91 at various bed weights. For starting weights less than 3 mg reactivity is almost constant. Therefore, in the present study reactivity measurements were made on 3 mg weights of chars.

Reactivity measurements were made at 910°C in steam in the Fisher TGA unit. About 3 mg of char contained in a platinum pan were heated in an upward nitrogen flow (350 cc/min) up to 1000°C at a heating rate of 20°C/min. Heating was continued until the char weight became constant. The sample was then cooled to the reaction temperature (910°C) and held at this temperature for 20 min for temperature stabilization. After this, nitrogen was replaced by a nitrogen-water vapor mixture (350 cc/min).

Table 17. Temperatures for the Decomposition of Calcium Oxalate

Sample wt = 4 mg Atmosphere = N ₂ (60cc/min) Heating Rate = 10°C/min		
Decomposition Temperatures (maximum), °C		
1st reaction	2nd reaction	3rd reaction
$\text{CaC}_2\text{O}_4 \cdot \text{H}_2\text{O} \rightarrow \text{CaC}_2\text{O}_4 + \text{H}_2\text{O}$	$\text{CaC}_2\text{O}_4 \rightarrow \text{CaCO}_3 + \text{CO}$	$\text{CaCO}_3 \rightarrow \text{CaO} + \text{CO}_2$
110	417	680

Table 18. Reactivity of PSOC-91 Char in Steam at Different Temperatures

Sample wt = 3 mg Flow = ~300cc/min				
Reactant Gas	Reactivity, R _o (mg hr ⁻¹ mg ⁻¹)			
	Reaction Temperatures °C			
	405	900	910	930
Steam	-	2.4	2.9	3.5
Air	2.7	-	-	-

Table 19. Effect of Starting Bed Weight on Reactivity of PSOC-91 Char in Steam at 910°C

Starting Weight (mg)	Reactivity, R _o mg hr ⁻¹ mg ⁻¹
4.0	2.6
3.5	2.7
3.0	2.9
2.5	2.9

Partial pressure of the water vapor in the mixture was 17 torr. This pressure was generated by bubbling nitrogen through deaerated, demineralized water at 20°C.

Reactivities of the chars were calculated by the following equation

$$R_o = \frac{1}{W} \frac{dW}{dt} \quad (7)$$

where R_o is the reactivity of the char ($\text{mg hr}^{-1} \text{ mg}^{-1}$); W is the weight of the initial char on a dry-ash-free basis (mg), and dW/dt is the change in char weight with time (mg hr^{-1}).

Figure 18 is a typical reactivity plot, where burn-off is calculated on a dry-ash-free basis. The reactivity plot has a rectilinear portion, in which maximum reactivity is observed and from which the reactivity parameter (R_o) is calculated by equation (7).

Values of R_o obtained for various chars studied are listed in Table 20. The corresponding reactivities in air are also included in Table 20 for comparison. The data for the four char samples studied indicate that char reactivities in steam differ from those in air.

Char reactivity decreases with mineral matter removal, suggesting that mineral matter (some inorganic impurities) acts as gasification catalysts (Table 21).

Future plans include determination in steam of reactivities of twenty chars prepared from coals of different rank. The effect of particle size and mineral matter on char reactivity will also be investigated.

REACTIVITY OF ION-EXCHANGED LIGNITE CHARS TO STEAM

Introduction

Reactivities of variously treated chars made from PSOC-140, a Darco Texas lignite, have been measured at three reaction temperatures, 650°C, 700°C, and 750°C. Preliminary results show that 1) reactivity decreases as heat treatment temperature increases, 2) raw coal chars are approximately ten times more reactive than the demineralized coal char for all reaction temperatures, and 3) reactivities of chars made from demineralized coals, which had been ion exchanged with about 5 percent by weight calcium⁺⁺, were ten times greater than reactivities of raw coal char at a reaction temperature of 650°C, but were only twice as great at a reaction temperature of 700°C, and only slightly greater at a reaction temperature of 750°C.

Figure 18. BURN-OFF CURVES (ON A DRY ASH-FREE BASIS) IN STEAM AT 910°C FOR 1000°C CHARS FROM PSOC-91(□), PSOC-87(○), AND PSOC-101(Δ)

Table 20. Reactivity of Coal Chars in Steam at 910°C.

PSOC Sample No.	Reactivity R_o ($\text{mg hr}^{-1} \text{mg}^{-1}$)	
	Steam at 910°C	Air at 405°C
91	2.9	2.7
87	2.8	1.7
101	2.5	1.8
140	1.5	1.3

Table 21. Influence of Mineral Matter Removal on Reactivity of Chars

PSOC Char No.	Reactivity, R_o ($\text{mg hr}^{-1} \text{mg}^{-1}$)
87	2.8
87 Dem ‡	0.38
101	2.5
101 A.W. †	0.35

† acid-washed
‡ demineralized

In addition to reactivities, helium densities, mercury densities, and carbon dioxide surface areas for some of the coals, chars, and reacted chars have been measured. Results show that helium densities increase slowly as burn-off increases (more of the pore system is opened as burn-off is increased). Mercury densities decrease at a linear rate for a 10-55 percent burn-off range measured in one coal char. Carbon dioxide areas go through a maximum at 10 percent burn-off for that same char. Ash and moisture contents have been measured.

Experimental

The activation apparatus can be considered in three parts, a gas inlet, a gas outlet, and a reactor. The gas inlet stream consists of a nitrogen line with monitoring accessories and a steam feed system. Helium is bubbled through the pressurized water feed tank to remove oxygen. The purified water is fed from the feed tank to the steam generator. The amount and pressure of the steam from the generator is controlled by

limiting the power supply to the generator. From the steam generator gases flow through a preheater held at 600°C, and on to the reactor inlet tube.

The reactor inlet tube, 7mm diameter Vycor, is wrapped around the main body of the reactor, 35mm diameter Vycor. Gas flows from the inlet tube through a fritted disk, which supports the bed of particles. A chromelalumel thermocouple, protected by a Vycor shield, measures temperature at the axial center of the bed about one cm from the fritted disk. The Vycor shield is attached to the reactor cap. Gases leave through the reactor cap and enter the gas outlet line.

The gases enter a condensor where most of the water is removed. The product gases and water pass a sampling port and are separated in a trap. The gases leave through the top of the trap and pass through a wet test meter and out to an exhaust fan. Carbon dioxide and carbon monoxide are analyzed in a Fisher bas partitioner and hydrogen is analyzed in a Hewlett-Packard chromatograph.

In the activation procedure, a weighed amount of char is placed in the reactor. The reactor and particle bed are purged for five minutes with nitrogen before the furnace preheater and steam generator are turned on. The reactor and bed of particles is brought to reaction temperature. After thermal equilibrium is achieved, nitrogen flow is stopped and steam is added. The volume of gas passing the wet test meter and time are recorded. Samples of gas are taken and analyzed for carbon monoxide, carbon dioxide, and hydrogen. Calculations of burn-offs are made by knowing total gas volume and the concentration of carbon monoxide and carbon dioxide. Burn-off percentages versus time are plotted for all runs. Reactivities are calculated from the burn-off curves. Reactivities of the chars were calculated using the following equation

$$R = \frac{1}{W_0} \frac{dW}{dt} \quad (8)$$

where W_0 equals the original weight on a dry-ash-free basis (G), dW/dt equals the change in weight per unit time (g hr^{-1}) and R equals the reactivity ($\text{g hr}^{-1} \text{g}^{-1}$).

Reactivities reported in Table 22 were calculated by drawing a tangent to the burn-off curves of the chars at 10 percent burn-off. Other methods of calculating reactivity will be explored and evaluated in the future.

The ion exchange procedure is outlined below.

1) Half of a 1 molar solution of calcium acetate (or other solution of interest) and 100 g of coal are placed in a one l plastic beaker.

Table 22. Reactivity of Chars at 10% Burn-off

Heat Treatment Temperature, °C	Mesh Size	Reaction Temperature, °C	Reactivity (10% Burn-off) g hr ⁻¹ g ⁻¹ , (daf)		
			Raw	Dem.	5% Ca I.E.
700	28x48	650	0.057	0.0062	0.68
800	28x48	650	0.050	n.d.	0.43
800	28x48	700	0.352	0.032	0.85
800	28x48	750	0.956	0.078	1.03
900	28x48	650	0.020	0.0046	n.d.
900	28x48	700	0.151	0.020	0.68
900	28x48	750	0.456	0.038	n.d.

2) A precalculated amount of standardized base (sodium hydroxide) is added to the mixture. The amount of base added is determined by the amount of calcium⁺⁺ desired to be exchanged on the coal.

3) The pH is monitored as a function of time.

4) The pH of the solution is allowed to adjust for one day at room temperature. If the pH does not reach 8.4, the solution can be heated by placing a plastic beaker inside a glass beaker partially filled with water. The glass beaker is then placed on a hot plate. (At increased temperatures ion exchange is increased for a certain pH level.)

5) The solution is removed after 1 hr and allowed to cool.

6) The pH is measured. If the pH is not lower than 8.4 the procedure is repeated. The calcium ion exchanged coal used in experiments this quarter was only adjusted to a 9.5 pH. A coal will be produced with a similar concentration of calcium at a pH of 8.4. Also, an attempt will be made to make a 5 percent calcium ion exchange char with an end point pH of about 11. The effect of end point pH on reactivity will be explored.

Results and Discussion

Reactivity has been studied for a wide range of chars for the carbon dioxide-carbon¹⁸ and oxygen-carbon¹⁵ reactions. The results indicate that chars made from lower rank coals are much more reactive. Comparatively little work has been done on the steam-carbon reaction, but probably the same factors will affect reactivity of chars to steam. Highly dispersed cations exchanged on the low rank coal are believed to cause the high reactivity.

Reactivity measurements are usually limited to about 50°C below the highest temperature the char has seen. Limiting the temperature prevents change of the thermal structure of the char during reaction.

Two reactions are of primary concern in this study. They are the carbon-steam and water-gas shift reactions. The carbon-carbon dioxide reaction takes place but is slower and should not be important at the temperature studied. The carbon-hydrogen reaction is very slow under reaction conditions being studied. No evidence has been found which indicates methane formation.

Figure 19 is a typical burn-off curve for the reaction of a char made from PSOC-140 in steam. It can be seen that a slow but steady decrease in rate occurs. This decrease may be the result of a slow deactivation of the catalysts in the char or a decrease in active surface available for the reaction.

Table 22 lists reactivities of chars made from raw, demineralized, and ion exchanged coals. Reactivities of chars made from all three types of coal decrease as heat treatment temperature increases even though ash concentration increases with heat treatment. The more concentrated catalysts in the char on a unit weight basis would be expected to increase reactivity. However, the catalysts may agglomerate at higher heat treatment temperatures and become less effective. In addition, a change in structure of the char as heat treatment temperature increases may also cause a decrease in reactivity. The two effects may also be of equal importance. Differences in burn-off due to particle size are small and ambiguous. Only the chars made from the raw coal have been reacted in the smaller particle sizes. Problems with heavy loss of fines for smaller particle size make reactivity measurements inaccurate. Activation energies measured are a complex function of diffusion and catalytic effects. The activation energy for the gasification of 800°C char derived from the raw coal is about 55 ± 10 kcal/mole of carbon on a daf basis. The activation energy for the gasification of the 800°C char derived from the ion exchange coal is about 20 ± 10 kcal/mole on a daf basis.

In general, helium densities increase and mercury densities decrease with burn-off. Carbon dioxide areas maximize and fall off slowly with burn-off. The calculations of the amount of calcium ion exchanged from pH readings and the calculated amount of calcium in the ash of the ion exchanged coal agree. The actual amount will be measured by atomic absorption.

Future plans include the study of:

- 1) Ion exchange of demineralized coal with calcium and other cations will continue.

- 2) Demineralization of a 900°C raw coal char made from the 28x48 mesh size fraction of the coal will be prepared.

Figure 19. TYPICAL BURN-OFF CURVE FOR A 28x48 MESH CHAR REACTED AT 700°C

- 3) More chars will be made from the ion exchange coals.
- 4) The 900°C char that was demineralized will be treated with nitric acid to add carboxyl groups destroyed by charring.
- 5) That char will be ion exchanged with calcium and a reaction of the ion exchanged calcium char with steam at several reaction temperatures below 900°C will be followed to determine the effect of reaction and heat treatment on calcium dispersal and its consequential effect on catalytic efficiency.
- 6) New samples will be characterized as required.

EFFECT OF HEAT TREATMENT CONDITIONS ON

REACTIVITY OF CHARS TO AIR

Introduction

The effect of various modes of heat treatment on char reactivity in air at 500°C has been studied. Reactivities have been shown to be maximized by keeping the maximum heat treatment temperature as low as possible, the heating rate as high as possible, and allowing no soak time at the maximum temperature. It has been observed that aging of chars in dry air has little or no effect on subsequent reactivity. Heat treatment of chars in different atmospheres (nitrogen, carbon dioxide, hydrogen) to the same temperature has no significant effect on subsequent char reactivity.

Experimental

In previous ERDA Reports, we reported the results of the effect of heat treatment temperature, soak time and aging in air on the reactivity of Exxon Wyodak, Exxon bituminous, and Bureau of Mines chars. The effect of heating rate and rapid devolatilization on char reactivity were reported for the Exxon chars only. In this report we are presenting results of the effect of heating rate and rapid devolatilization on the reactivity of the Bureau of Mines and the FMC (COED) chars. In addition to these, results are reported on the determination of temperature seen by the char during rapid devolatilization. Results on the effect of preheating in different atmospheres (nitrogen, carbon dioxide, and hydrogen) to the same temperature on subsequent reactivity of Exxon Wyodak char in air are also presented. For the sake of comparison, results which were previously reported are included in this report.

Reactivity parameters reported here were reproducible within ± 2 percent.

The experimental procedure was the same as outlined in previous reports. Maximum reactivities of four commercial chars heat treated to different temperatures prior to measuring their reactivities to air at 500°C are listed in Table 23. In each case the reactivity decreases after a certain heat treatment temperature (HTT). The thermal history of a char, that is, heating rate, atmosphere, maximum temperature, and soak time at maximum temperature used during preparation of the char, profoundly affects its structure, porosity, and surface areas, and hence, its reactivity. When reactivity of a char, whose thermal history during preparation is not known, is studied as a function of HTT (prior to reactivity measurement), it is expected that the reactivity will remain constant up to the maximum HTT reached by the char during its preparation, and decrease thereafter. It can be concluded from Table 23 and Figure 20 that both Exxon Wyodak and Exxon bituminous chars had reached a temperature of 725°C during their preparation whereas the corresponding temperatures for the Bureau of Mines and FMC (COED) chars were 700°C and 750°C, respectively.

For any HTT up to about 750°C reactivity of the Exxon Wyodak char is higher than that of any of the other three chars. It is suspected that Exxon Wyodak was prepared from a subbituminous coal, whereas the other chars were derived from bituminous coals. It has previously been reported by Walker and co-workers that chars prepared from subbituminous coals are more reactive than those prepared from bituminous coals.

The effect of soak time at maximum HTT (above which char reactivity starts decreasing) on reaction rate in air at 500°C is shown by the data listed in Table 24. The results for Exxon Wyodak, Exxon bituminous, and Bureau of Mines chars were presented and discussed in the last report. In the case of the FMC (COED) char, soak time at maximum HTT appears to be about 20 min. That is, reactivity falls off sharply for longer soak times.

Table 25 shows results for the effect of heating rate on reactivity. In each case reactivity increases with increase in heating rate.

In the last report results were presented for the Exxon Wyodak and Exxon bituminous chars. In this report we are presenting the results for the other two chars in Table 26. Reactivities of the rapidly devolatilized samples are appreciably higher than those of the samples which were heat treated at lower heating rates. The effect of rapid devolatilization was also examined in the case of PSOC-246 char. The raw coal was heated at a rate of 10°C/min in a fluidized bed reactor up to 800°C with no soak time at this temperature. The resultant char was then rapidly devolatilized at 800°C in the isothermal reactor. The rapidly devolatilized char has a higher reactivity than the char prepared in the fluidized bed (Table 26).

During rapid devolatilization, chars were heated to 800°C at the rate of 10³°C/sec. Residence time at 800°C was of the order of 200-300

Figure 20. EFFECT OF HEAT TREATMENT TEMPERATURE ON CHAR REACTIVITY TO AIR AT 500°C

Table 23. Effect of Heat Treatment Temperature on
Reactivity of Chars

Temp., °C	R_T (mg hr ⁻¹ mg ⁻¹)			
	Exxon Wyodak	Exxon Bit.	Bureau of Mines	FMC (COED)
500	4.06	3.43	2.96	2.25
600	3.95	3.39	2.97	2.20
650	-	-	2.96	-
675	-	-	2.96	-
700	3.90	3.38	2.91	-
725	3.90	3.37	2.80	2.21
735	3.72	3.30	-	2.20
750	3.69	3.14	2.71	2.20
800	3.12	3.00	2.50	1.90
870	2.46	-	-	-
900	2.06	2.70	2.42	1.80
1000	1.92	2.50	2.16	1.60

Table 24. Effect of Soak Time on Reactivity of Various Chars

Soak Time (min.)	R_T (mg hr ⁻¹ mg ⁻¹)			
	Exxon Wyodak	Exxon Bit.	Bureau of Mines	FMC (COED)
0	3.95	3.39	2.96	2.20
15	3.85	3.37	2.91	2.20
20	-	-	-	2.00
30	3.02	3.00	2.90	1.55
60	-	3.00	2.04	1.53
120	3.03	3.00	2.02	1.53

In using such fast heating rates and low residence times, there may be significant temperature gradients between the surface and interior of the char particles. In order to see if such is the case, reactivity of the rapidly devolatilized Exxon Wyodak char was determined after heat treatment in the TGA unit to different temperatures at the rate of 10°C/min. In each case, following heat treatment at a given temperature (no soak time) the sample was cooled in nitrogen to 500°C and its reactivity measured at 500°C in air. The relevant data are listed in Table 27; char reactivity starts decreasing when HTT exceeds 780°C.

Table 25. Effect of Heating Rate on Reactivity of Chars*

Heating Rate (°C/min)	R_T (mg hr ⁻¹ mg ⁻¹)			
	Exxon Wyodak	Exxon Bit.	Bureau of Mines	FMC (COED)
5	3.68	3.25	2.65	2.11
10	3.90	3.43	2.96	2.20
20	4.12	3.50	3.10	2.30
25	4.21	3.58	3.21	2.35

*Heat treatment temperature prior to reactivity measurement = 500°C

Table 26. Effect of Rapid Devolatilization to 800°C on Reactivity

Sample	R_T (mg hr ⁻¹ mg ⁻¹)	
	Slow Heating (10°C/min)	Rapid Devolatilization
Exxon Wyodak	3.12	5.68
Exxon bituminous	3.00	4.11
Bureau of Mines	2.50	3.67
FMC (COED)	1.90	3.08
PSOC-246 char	2.79	3.10

Table 27. Determination of Maximum Temperature of
Exxon Wyodak Char During Rapid Heating

Temp., °C	R_T (mg hr ⁻¹ mg ⁻¹)
500	5.00
600	5.00
700	4.98
750	4.98
775	4.94
780	4.93
790	4.83
800	4.80

These results thus indicate that char particles during rapid devolatilization had reached a temperature of about 780°C. This temperature is quite close to 792°C, the figure calculated theoretically by Nsakala ya Nsakala. Thus, it can be concluded that during rapid heating the center of the char particle reaches essentially the same temperature as the surface of the particle.

It was thought of interest to study if the gaseous atmosphere used during heat treatment of chars has any effect on subsequent reactivity in air. For this study Exxon Wyodak char was heated to 725°C at the rate of 10°C/min in nitrogen, carbon dioxide, and hydrogen atmospheres. In each case, as soon as the temperature reached 725°C, heating was stopped and the sample cooled to 500°C at the rate of 10°C/min. Its reactivity was then determined at 500°C in air. Data listed in Table 28 show that the reactivity values are essentially independent of the atmosphere used during heat treatment of the chars prior to reactivity measurements.

SMALL ANGLE X-RAY STUDIES ON COAL CHARs

Introduction

The prime objective of this study is to evaluate the applicability of small angle x-ray scattering (SAXS) in characterizing the pore structures of coal chars. Preliminary data indicates that such an approach shows promise. For a series of coals heated to 1050°C the primary SAXS structural parameter ℓ_m (range of inhomogeneity) varies systematically with the rank of the parent coal. From a knowledge of this primary parameter and the volume fraction of pores it is possible to evaluate a mean pore size (a dimension characterizing the length of the carbonaceous matrix between pores and the surface area). The most important advantage in using SAXS is that it is not limited by closed porosity, but is a measure of the total porosity.

Experimental

In previous reports it was reported that raw SAXS data had been obtained for a series of coal chars. Figure 21 is a typical scattering curve obtained for a char prepared from a demineralized coal char (demineralized PSOC-213 heated to 1050°C). This plot is of $\log J$ (intensity) versus $\log s$ ($s = 2\theta/\lambda$, where 2θ is the scattering angle and λ is the wavelength of x-radiation-CuK $_{\alpha}$). At very small angles the plot is a curve which at higher angles inflects and then follows a linear function. This linear portion should ideally have a -3 slope. Since it does not a correction needs to be made. The deviation from ideal behavior is due mainly to density fluctuations in the solid matrix (carbonaceous phase).

Figure-21. SAXS CURVE FOR DEMINERALIZED PSOC-213 HEATED TO 1050°C

Table 28. Effect of Gaseous Atmosphere During Heat Treatment of Exxon Wyodak Char on Subsequent Reactivity in Air at 500°C

Atmosphere	R_T (mg hr ⁻¹ mg ⁻¹)
N ₂	3.90
CO ₂	3.84
H ₂	4.00

From the corrected data it is possible to calculate several structural parameters. However, it has been suggested¹⁶ that only one primary parameter (ℓ_m) can be considered as unambiguous for a dense system.

For some of the other parameters the exact meaning in such a system is very much in question. The parameter ' ℓ_m ' is very useful since there are three secondary parameters which can be estimated from it. The three secondary parameters are:

a) surface area

$$SA = 4 \times 10^4 C (1-C) / \ell_m \rho_{Hg}, \text{m}^2/\text{gm} \quad (9)$$

where C is the volume fraction of pores, estimated from density measurements, and ρ_{Hg} is the density of the particles as measured in mercury.

b) d_{voids} , defined as the average dimension of segments in the voids

$$d_{\text{voids}} = \ell_m / (1-C) \quad (10)$$

c) d_{solid} , defined as a measure of the average distance between pore walls within the carbonaceous matrix

$$d_{\text{solid}} = \ell_m / C \quad (11)$$

In the last report we described how ℓ_m was evaluated. This has been completed for the samples listed in Table 29. The values have been plotted versus percent carbon (daf) of the parent coal (Figure 22). All coals were demineralized prior to heat treatment. For the chars produced around 1050°C there is a systematic variation with rank of the parent coal. For the 1500°C chars the trend is somewhat different in that it increases with increasing rank, although the values of ℓ_m are all quite similar for this series of samples. The value of ℓ_m for the only char produced at 1150°C falls between the two curves. It is interesting to note that further heat treatment temperature has had no effect on this parameter for charred PSOC-88.

Figure 22. VARIATION OF $\ln$ WITH CARBON CONTENT OF PARENT COAL

Table 29. SAXS Parameter ℓ_m for Chars Prepared at
Various Heat Treatment Temperatures

PSOC No.	ASTM Rank	%C (daf) Parent Coal	HTT °C	ℓ_m Å
88	Lignite	71.9	1050	6.45
			1500	6.42
138	Subbit C	74.3	1050	5.74
			1500	6.42
213	HVB	78.9	1050	5.33
102	HVA	83.4	1025	5.14
			1150	5.79
			1500	7.04
80	Anthracite	90.8	1000	5.42
			1050	5.31
			1500	7.16

At the present time we are getting values for the volume fraction of pores so that we can calculate the secondary parameters described previously. In addition, the surface area of the chars are being measured by carbon dioxide adsorption so that comparisons can be made.

FACET IV-F: DIFFERENTIAL SCANNING CALORIMETRY

DIFFERENTIAL SCANNING CALORIMETRY STUDIES ON COALS AND CHARS

Introduction

The DSC technique has been used to study the thermal effects involved during chemisorption of oxygen on Saran carbon. Saran carbon resembles coal chars but is of high purity. The existence of different kinetic stages corresponding to adsorption on different active sites is indicated. The rate of heat released during chemisorption is proportional to the square root of oxygen partial pressure.

Experimental

This report describes further studies on oxygen chemisorption on Saran carbon using the DSC technique. Experimental procedure and methods of calculation were described in the last ERDA Report. The Saran carbon sample used in the present work was hand-crushed in a lab mortar and a 150x250 mesh fraction was used for studying the thermal effects involved during chemisorption of oxygen. The iron content of this sample was 14-22 ppm. The carbon sample was heated in the DSC cell up to 600°C in the manner described in the last ERDA Report and then cooled to room temperature. After this, the sample was heated to the desired reaction temperature and held at this temperature for 30 min in a nitrogen flow (45cc/min). Air was then introduced to replace nitrogen and the DSC scan started. Values of Q (cal/g C) were calculated from the thermograms at different time intervals. The plots of Q vs $\log t$ (Elovich plots) are shown in Figure 23. Below 202°C, no significant thermal effects were observed. Therefore, in order to study the discontinuities in the Elovich plots at lower temperatures, an activated Saran carbon sample was used. The Saran carbon was activated in a fluid bed reactor in air at 425°C for 10 hr to 63.8 percent carbon burn-off. The thermograms for the activated sample were obtained in the temperature range 100-202°C. Plots Q vs $\log t$ are shown in Figure 24. These plots as well as those in Figure 23 are discontinuous straight lines. This behavior indicates the existence of different kinetic stages during chemisorption of oxygen. Each of these stages corresponds to a different group of active sites. Increase in reaction temperature results in an earlier appearance of any one kinetic stage. At lower temperatures, the rate of heat released is slow and probably chemisorption occurs at the most active sites. As the temperature increases, chemisorption occurs on less active sites. With the DSC technique, it is difficult to detect thermal changes below 100°C. Attempts were made to examine variation in the activation energy (E_a) for the chemisorption process as a function of Q . Figure 25 shows the Arrhenius plots obtained at different selected values of Q or different

Figure 23. Q VS LOG T PLOTS FOR UNACTIVATED SARAN (150 x 250)

Figure 24. Q VS LOG T PLOTS FOR AIR-ACTIVATED SAP (150 x 250)

Figure 25. ARRHENIUS PLOTS FOR AIR ACTIVATED SARAN CARBON

active sites. In the case of the activated Saran carbon, E_a for chemisorption on the most active site is 5.6 kcal/mole. This value increases with increase in Q liberated, that is when chemisorption occurs at less active sites. Finally E_a becomes constant at 16.9-17.1 kcal/mole for the least active sites. However, in the case of the unactivated sample, the value of E_a remained almost constant (16.2-18.7 kcal/mole) and was independent of Q . It is probable that for the unactivated sample, although different active sites have the same value of E_a , they have different values of heats of chemisorption. When this sample was activated to 63.8 percent burn-off, more active sites were created involving less activation energy during chemisorption of oxygen.

In studying the order of the chemisorption process with respect to partial pressure of oxygen, a few experiments were performed on the unactivated sample at 227°C. For each run, a mixture of oxygen and nitrogen of different proportions was passed over the sample. The sum of flow rates of both gases was kept constant at 45cc/min. Partial pressure of oxygen in the mixture was calculated from the relative flow rates of the two gases. One additional run was made using air. The partial pressure of oxygen in various oxygen-nitrogen mixtures was varied from 0.1 to 1.0 atm. Differential and integral rates of heat released were calculated. The differential rates were calculated by dividing the increment of heat released by the corresponding time interval ($\Delta Q/\Delta t$). The integral heat was calculated by dividing the total (cumulative) Q released by time t required to reach that value. Both rates were computed at 10, 15, 20, and 25 min. Plots of these rates vs partial pressure of oxygen are shown in Figure 26. The straight lines obtained have slopes ranging between 0.47-0.51 and are independent of time. This indicates that the order of chemisorption of oxygen on Saran carbon is a function of the square root of oxygen partial pressure.

Adsorption and desorption runs were next made to study the extent of surface coverage during chemisorption of oxygen at different temperatures. DSC scans were first obtained for chemisorption of oxygen at different temperatures. At the end of a given scan, the sample was heated to 600°C in a nitrogen flow and held at this temperature for 3-1/2 hr. This was followed by cooling the sample in a nitrogen atmosphere at the same flow rate. A second adsorption scan (resorption) was then obtained on the same sample at the same temperature as used in the first adsorption run. The amount of heat released Q_2 (cal/g C) during any resorption run was lower than that released during the first adsorption run. This indicates that when desorption is performed at 600°C, only a part of the chemisorbed oxygen is desorbed, so that a part of the chemisorbed oxygen is still retained on the surface. The ratio $[Q_2/Q_1]_{600}$ is defined here as the fraction of the surface regenerated after heating the sample at 600°C for 3-1/2 hr. Table 30 lists the values of Q , Q_2 , and other relevant data. As the adsorption temperature increases, the

Figure 26. EFFECT OF PARTIAL PRESSURE OF O_2 ON HEAT OF CHEMISORPTION

Table 30. Thermal Effects Involved During Chemisorption of Oxygen

Adsorption Temp. (°C)	177	202	227	254	281
Q_1 (cal/g C)	6.25	10.45	17.27	25.38	41.14
Q_2 (cal/g C)	3.48	6.18	11.12	16.98	29.12
$[Q_2/Q_1]_{600}$ (%)	55.7	59.2	64.4	66.9	70.8
(Q_1-Q_2) (cal/g C)	2.77	4.27	6.15	8.40	12.03

value of Q liberated is higher both for the first as well as the subsequent adsorption run. The fraction of the surface regenerated after desorption increases with increase in the adsorption temperature. Thus a surface which is initially covered with more oxygen would desorb more oxygen. This indicates that at elevated adsorption temperatures, most of the chemisorbed oxygen is attached to less active sites. On the other hand, at lower adsorption temperatures, oxygen is strongly attached to the surface, and consequently the fraction of surface regenerated during desorption is less.

The effect of desorption temperature on the regeneration of carbon surface was also investigated. An adsorption experiment was first done at 227°C. This was followed by heating the carbon sample in nitrogen to a certain temperature in the range 450-600°C. The sample was held at the chosen maximum temperature for 3-1/2 hr and then cooled to room temperature. Resorption of oxygen was carried out on the sample at 227°C. Table 31 lists the values of Q_1 , Q_2 , and Q_1/Q_2 obtained after desorption at 600, 550, 520, 500, and 450°C. It can be seen that the reaction of surface regenerated at higher desorption temperatures is greater than that regenerated at lower temperatures. The ratio Q_2/Q_1 is constant at temperatures below 450°C, showing that there is no significant effect of desorption temperature below 450°C on the extent of surface regenerated for subsequent oxygen chemisorption.

Table 31. Effect of Desorption Temperature on Heat of Chemisorption of Oxygen at 227°C

Desorption Temp. (°C)	600	550	520	500	450
Q_1 , (cal/g C)	17.27	17.48	17.39	17.38	17.32
Q_2 , (cal/g C)	11.12	8.05	7.36	6.79	6.58
(Q_2/Q_1) , (cal/g C)	64.4	46.1	42.3	39.1	38.0
(Q_1-Q_2) , (cal/g C)	6.15	9.43	10.03	10.59	10.74

FACET V-A: COMBUSTION OF CHARs AND LOW VOLATILE FUELS

COAL COMBUSTION RESEARCH; LOW VOLATILE FUELS--COMBUSTION OF CHAR AND ANTHRACITE COAL IN LARGE UTILITY BOILERS

Introduction

Most of our work to date has been focused on the development of computer models to analyze and explain past experiments and to design future ones. A model which considers only the stable combustion of a pulverized char flame in an infinite parallel plane geometry (properties varying only along the direction of flow) is a logical and valid starting point toward further three dimensional modeling. The model does permit examination of the detailed structure of pulverized char flames simply, yet realistically.

Experimental

Presented in this section is a computer analysis of the ignition behavior of a pulverized char and air mixture when a hot wall ignition source is used. Using the infinite parallel plane computer model, the procedure was to fix the exit permeable wall at some temperature considerably above ambient, and to solve for the resulting combustor temperature profile from the entrance through the "left" permeable wall (fixed at ambient temperature) to the exit or "right" permeable wall (fixed at elevated temperatures). Points A through K of Figure 27 are the resulting completeness of combustion values plotted against the corresponding values of the constrained exit wall temperature. Points A through C correspond to low exit wall temperatures and less than one percent combustion. As the exit wall temperature is elevated above 1400°C, the completeness of combustion starts to rise appreciably until, near point K, changes in the hot exit wall temperature of only several degrees varies the completeness of combustion by 5 or 6 percent. As the hot wall temperature increases toward 1558°C, the completeness of combustion increases toward 75 percent (-25 percent "excess" air condition). For wall temperatures in excess of 1558°C, points such as point M are typical, with combustion being nearly complete.

With the exit wall temperature reduced through 1558°C, the conditions corresponding to points N through R are obtained, with completeness of combustion ranging just under 75 percent. With further reduction in exit wall temperature (below point R value of 1227°C), the only stable condition is one of essentially zero combustion and to the left of point A. The processes outlined above are ignition, stable (combustion) operation, and extinction in the context of a hot wall ignition source. Once the hot wall temperature exceeds around 1558°C, the system has only one possible stable state (combustion), e.g., point M. Points L through R represent stable combustion

Figure 27. COMPLETENESS OF COMBUSTION VS EXIT WALL TEMPERATURE
(Infinite Parallel Plane Model Results)

(ignited) states, while points A through K represent stable slow oxidation (unignited) states. Thus, if the hot wall temperature is below 1227°C, only one state exists; if the temperature is between 1227°C and 1558°C, two states exist; and above 1558°C only one state exists again.

As an example of the two possible states for one set of boundary conditions, Figure 28 shows two combustor temperature profiles for exactly identical boundary and operating conditions. For both temperature profiles, the hot wall temperature is 1299°C. The ignited profile corresponds to point P in Figure 27 (completeness of combustion 74.74 percent) and the unignited profile corresponds to point A (0.04 percent). The method of obtaining the ignited or unignited solution in the two-solution region is to use either high or low initial estimates for the iterative solution scheme.

Therefore, with respect to a hot wall ignition source, ignition and extinction (wall) temperatures can be defined, as well as the stable range of combustor performance. These temperatures are functions of fuel reactivity, inlet flow conditions, and stoichiometry.

With the submission of the second quarterly report the infinite parallel plane model was limited to equal nodal spacings of the distance between the two end walls and a constant cloud radiation absorption coefficient. A major revision has removed these restrictions. That these restrictions were of a serious nature can be seen in Figure 29. The combustor temperature profiles are plotted versus distance from the entrance to exit permeable walls. The only variation in run conditions is that of the dust cloud radiation absorption coefficient. Unlike the study reported above, here the exit (hot) wall temperature is iteratively solved for by heat balance conditions. Profiles for absorption coefficients of 3.33m^{-1} and 6.67m^{-1} appear in Figure 29. The absorption coefficient does have an appreciable effect on the temperature profile.

In reality, the dust cloud absorption coefficient should be directly proportional to the particle concentration and the square of the particle diameter according to the simple black geometric interceptor theory. For a system where gas temperatures vary from 300°K to about 2200°K, the particle cloud concentration can vary by more than a factor of seven. Thus, a constant "mean" absorption coefficient is actually quite crude. At 300°K, the cloud absorption coefficient could range from about 10m^{-1} to as much as 30 to 40m^{-1} depending on particle size, particle density, and fuel/air ratio. In the study plotted in Figure 29, when the absorption coefficient used exceeded 6.67m^{-1} the program predicted only unignited solutions. Much below 3.33m^{-1} the same sort of problem is present. It had been suspected for some time that the inability of the model to predict fast temperature rises was due to the use of a low uniform absorption coefficient. This suspicion has proven to be correct.

Another point can be seen from examining the 6.67m^{-1} curve in Figure 29. This fact is, as is true of the plane flame furnace experimental

Figure 28. GAS TEMPERATURE VS NORMALIZED DISTANCE FROM LEFT WALL TO RIGHT WALL
Actual Wall Separation: 75 cm

Figure 29. GAS TEMPERATURE VS DISTANCE FROM LEFT WALL
DUST CLOUD RADIATION ABSORPTION COEFFICIENT VARIATION
(Infinite Parallel Plane Model Results)
Actual Wall Separation: 75 cm

results, that half, or more than half, of the chamber is essentially isothermal. Unequal nodal spacing would allow more "fine grained" detail in the flame front region, for equal computation times, if much larger nodal spacings were used in the isothermal "tail" region. Thus, both unequal nodal point spacings and variable absorption coefficient were incorporated into the infinite parallel plane model.

Figure 30 shows two temperature profiles plotted versus distance from the entrance wall to the exit wall for a rather high base value ($T = 300^\circ\text{K}$, original 20μ diameter) of absorption coefficient: 41.6m^{-1} . This high value was chosen because it simulates a char of extremely small density (abnormally macroporous), as the two Exxon chars are believed to be. The typically fast temperature rises attainable with this high absorption coefficient caused numerical instabilities earlier, when only uniform nodal spacing was available. The distance of the primary reaction zone from the cold inlet wall is seen as being about 10 percent of the 0.75m total inter-wall distance, or about 7.5cm . This compares favorably with the distances found experimentally for the reactive chars at fuel rich conditions. The temperature profile was solved for iteratively with the absorption coefficient continually being updated during every other iteration for temperature and particle size effects (constant density burnoff assumed). After each complete absorption coefficient update, the radiative transfer matrix is also recalculated. A total of 76 nodal points were used for the calculation plotted in Figure 30. From node one (entrance) to node 41, a unit spacing was used; from node 41 to node 46 a spacing twice as large was used; and from node 46 to 76 three times the unit spacing was used. As stated above, the uneven nodal spacing allows a much finer detailed solution to be obtained in the regions of large temperature gradients. No instabilities occurred in the computational process, even though quite large temperature gradients were present. Therefore, the combination of variable absorption coefficient and uneven nodal spacing appears to function as desired.

For the same operating conditions as were used in the Figure 30 calculation, the char combustion kinetics of Field¹⁹ were employed to see if actually measured char kinetics would predict "reasonable" results for a reportedly high reactive char. Field's expressions for the surface reaction rate are

$$R_s = 8710 \exp(-35,700/RT) \frac{\text{gm}}{\text{cm}^2 \text{ sec atm } O_2} \quad (12)$$

$$\text{for } T \leq 1277^\circ\text{K},$$

and

$$R_s = -0.09 - 1.26 \times 10^{-4}T + 1.58 \times 10^{-7}T^2 \frac{\text{gm}}{\text{cm}^2 \text{ sec atm } O_2} \quad (13)$$

$$\text{for } T > 1277^\circ\text{K}$$

where R_s is the rate of particle mass depletion per unit external surface

Figure 30. GAS TEMPERATURE VS DISTANCE FROM LEFT WALL

BASE ABSORPTION COEFFICIENT 41.6 m^{-1}
(Infinite Parallel Plane Model Results)

Actual Wall Separation: 75 cm

area, per unit time and per unit atmosphere of oxygen (first order in oxygen assumed). The combustor temperature profile, using the above Field kinetics, is plotted versus distance from inlet wall to outlet wall in Figure 31. Here, again as in Figure 30, the base absorption coefficient is 41.6m^{-1} . This figure would be justified since Field's kinetics were obtained for a usually quite porous low rank char, and since fine grinds (normally 45 percent smaller than 44mm by weight) are used in the plane flame furnace. It can be seen in Figure 31 that for a wall separation of 0.75m, the flame front would be somewhere around 6cm or so from the coal inlet wall. The peak temperature obtained here is about 2040°C and the "tail" temperature is around 1420°C , both reasonable enough figures considering that in the infinite parallel plane model no heat can be lost in directions perpendicular to the direction of flow (normal to the walls). A nonuniform nodal spacing scheme and an absorption coefficient dependent on temperature and diameter were used here as in the Figure 30 calculation. Thus, a measured set of kinetics has yielded physically reasonable results in the infinite parallel plane model.

Work remaining to be done on the infinite parallel plane model includes the incorporation of a heat transfer equation to account for local particle/gas temperature differences, and the use of more detailed kinetics involving particulate physical structure (surface area, pore size distribution, etc.) and carbon monoxide/carbon dioxide conversion. During the next quarter, work on the three dimensional model will be revived to reach the ultimate modeling goals of this project. Samples of the Exxon, Illinois, and Wyodak chars, the FMC-COED char and the ultra-fine anthracite were sent to Micromeritics Corporation early in January, 1976 for complete particulate characterization analysis (surface areas, pore volumes, densities, pore size distributions, and particle size analysis). A report of these analyses will be forthcoming.

Conclusions

The following conclusions have been reached as a result of the work accomplished to date:

1. Low volatile chars and coals can be suitable fuels if adequate available internal surface area is present.
2. The low and high reactivity fuels show quite different combustion behavior in the plane flame furnace.
3. Computer modeling can predict combustion performance, "ignition" temperatures, and detailed heat transfer and chemical reaction couplings even with an infinite parallel plane model.

Figure 31. GAS TEMPERATURE VS DISTANCE FROM LEFT WALL

FIELD CHAR COMBUSTION KINETICS

(Infinite Parallel Plane Model Results)

Actual Wall Separation: 75 cm

FACET V-B: COMBUSTION OF COAL-OIL EMULSIONS

COMBUSTION OF COAL-OIL EMULSIONS

Introduction

This quarter work centered on the evaluation of data acquired since June, 1975 and the preparation of a paper for presentation at the Central States Section of the Combustion Institute at Batelle-Columbus Laboratories. Entitled "Smoke Point and Heat Transfer Characteristics of Oil/Water/Air Emulsions Without and With Coal Addition in a Hot Wall Furnace", it is included as Appendix B to this report. In addition to those investigators contractors by ERDA, the paper was co-authored by several "outside" scientists, since the research discussed is part of an on-going project which commenced prior to inception of the ERDA contract.

Experimental

The furnace was a refractory wall unit of internal dimensions 2 ft x 2 ft x 10 ft with 17 water-cooled tubes on its floor to simulate the load of a continuous industrial thermal processing furnace. The burner was a split jet-can (perforated wall) type of combustor with air so supplied that it produced a double vortex mixing pattern. An impact atomizer with large clearances to accomodate the coal was used in the burner; flame stability and turn down were very good.

The main observations and conclusions reported within the paper deal with the applications of emulsions of oil/water/air mixtures. The analysis of the effects of coal additions from traces to only one percent has been included. In summary the emulsions without coal additions (Number 2 oil, water and air, generated by a Sebba (6) emulsifier, fired in a hot wall furnace at 1.25 million BTU/hr) were found to reduce excess air requirements at the smoke point, to remove carbon buildup at the burner, and to reduce the flame emissivity (and, therefore, thermal efficiency). Flame emissivity was restored to its original value or better by addition of coal at concentrations ranging from traces to one percent or by addition of inert magnesia (or by permitting operation with medium to heavy smoke). The experiments suggest that the principal combustion reactions and the smoke formation reactions are effectively independent of each other, with smoke influenced by, and combustion uninfluenced by water. The reduced radiation with water suggests that these emulsions would be appropriate for substitution of gas by oil where oil radiation can cause problems of overheating and burn out, for example, in radiant tube furnaces.

Attention has also been given to the technical problem encountered in dispersing significantly greater amounts of coal into the emulsions. In addition the next quarter requires consideration of design modifications for the burner atomizer to avoid fouling problems otherwise expected when higher coal concentrations are used.

CONCLUSIONS

1. Early comparisons indicate a mathematical relationship between average random reflectance as recorded by the Rapid Scan and the mean-maximum reflectance as obtained by standard reflectance analysis.
2. The results obtained so far show support of a diffusion dominance mechanism in the oxidation region of a combustion pot and a chemical kinetic mechanism in the gasification region. Work is underway to study the influence of particle size and velocity and temperature on the diffusional rate.
3. Values of reaction rates in coke beds have been calculated from experiments with a fixed bed shaft gasifier (combustion pot), assuming diffusion dominated reaction in the oxidation region and chemical kinetic controlled reaction in the gasification region. The equation for the variation of gas composition with time in the bed is:

$$(Y_1 + 1/2Y_2)/L - 1/2Y_3 = Ae^{-n_1t} + Be^{-n_2t} + C$$

where Y_1 , Y_2 and Y_3 are mole fractions of O_2 , CO_2 and CO respectively, n_1 and n_2 are modified rate constants for the two heterogeneous reactions and A , B , and C are constants. The experimental results obtained are in support of the assumed mechanisms.

4. Devolatilization of a North Dakota lignite in a laminar flow reactor and subsequent treatment of the resulting char has shown that weight loss is strongly dependent upon the isothermal decomposition time (τ_{iso}). Physical properties such as nitrogen and carbon dioxide surface areas change appreciably with τ_{iso} . Weight loss contributes to the development of nitrogen and carbon dioxide surface areas. The x-ray diffraction peak found at $\sim 26.6^\circ C$ in 2θ angles is believed to be from a (101) reflection of impure silicon dioxide. The crystallite size of impure silicon dioxide is smaller for the raw coal than it is for the chars.
5. The reactivity of chars in air was found to increase with increase in oxygen pressure, with the relationship R_o proportional to (oxygen pressure) $^{0.71}$. Burn-off versus time plots obtained for a given char in different oxygen-nitrogen mixtures can be normalized indicating that although gasification rates increase with increase in partial pressure of oxygen the mechanism for gasification of a given char is independent of partial pressure of oxygen. Normalized reactivities in air at $405^\circ C$ of the seventeen American chars studied correlate with reactivities in carbon dioxide at $900^\circ C$, determined previously. Reduction in particle size increased the reactivity in air of both raw and demineralized low volatile bituminous char (PSOC-127). In the case of demineralized lignite char (PSOC-87 Dem), reduction in particle size did not show any appreciable effect on reactivity.

6. Preliminary studies on reactivities of chars in steam at 910°C have been reported. No significant conclusions can be drawn from the limited data presently available. However, the results indicated that reactivities of chars follow a different trend than that observed previously in air and carbon dioxide. Removal of mineral matter from coals prior to their carbonization decreases subsequent char reactivity. This indicates that mineral matter catalyzes the char gasification in steam.
7. Study of the reactivity of ion-exchanged lignite chars to steam shows that increased heat treatment decreases reactivity; ion exchange increases reactivity; particle size change between 28x48 and 60x100 mesh has only a small effect on reactivity; helium densities increase and mercury densities decrease during burn-off; and chars become more porous as burn-off increases.
8. Reactivities of four chars have been determined under different heat treatment conditions. Reactivity of a char is determined by heat treatment temperature, heating rate, soak time at maximum temperature, and is essentially independent of the gaseous atmosphere used during heat treatment. Reactivity of a char prepared by rapid devolatilization is appreciably higher than that prepared by heat treatment at lower heating rates.
9. Use of the DSC technique to study the thermal effects involved during chemisorption of oxygen on Saran carbon has yielded the results which follow.

In the temperature range 100-200°C, the Saran carbon activated to 63.8 percent of carbon burn-off showed the existence of different groups of active sites. The unactivated sample showed similar behavior in the temperature range 202-208°C. The activation energy (E_a) for chemisorption of oxygen increases with increase in thermal effects involved at reaction temperatures up to 202°C. Above this temperature, E_a remains almost constant. The rate of heat released during chemisorption is proportional to square root of oxygen partial pressure. The fraction of carbon surface regenerated after desorption increases with increase in adsorption or desorption temperatures.

10. The use of SAXS to characterize heat treated coals shows much promise. Systematic variations of a primary structural parameter are noted with variations in heat treatment temperature and the rank of the parent coal.
11. Work on the infinite parallel plane char combustion computer model has determined that low volatile chars and coals can be suitable fuels if adequate available internal surface area is present. Low and high reactivity fuels show quite different combustion behavior in the plane flame furnace. Computer modeling can predict combustion performance, "ignition" temperatures, and detailed heat transfer and chemical reaction couplings even with an infinite parallel plane model.

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APPENDIX A

DATA FOR DRYFLO SEPARATION TESTS.

ANALYTICAL DATA

DATA FOR DRYFLO SEPARATION TEST # 1

FIGURES FROM ELLIOT FEED SAMPLE.

DATA FOR - PRODUCT COAL

THIS FRACTION CONSTITUTES 66.9 PERCENT OF THE FEED.

SIZE		-----DIRECT VALUES-----				-----CUMULATIVE RETAINED-----				-----CUMULATIVE PASSED-----			
FRACTION		WEIGHT	ASH	SULFUR	MOISTURE	WEIGHT	ASH	SULFUR	MOISTURE	WEIGHT	ASH	SULFUR	MOISTURE
PASSED	RETAINED	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT
	30M	0.60	6.60	1.04	0.75	0.60	6.60	1.04	0.75	100.00	10.22	2.78	0.61
30M	60M	50.50	8.14	1.51	0.55	51.10	8.12	1.50	0.55	99.40	10.24	2.79	0.61
60M	100M	24.70	9.56	2.46	0.60	75.80	8.59	1.82	0.57	48.90	12.41	4.12	0.67
100M		24.20	15.31	5.81	0.75	100.00	10.22	2.78	0.61	24.20	15.31	5.81	0.75

DATA FOR - MIDDLING COAL

THIS FRACTION CONSTITUTES 10.7 PERCENT OF THE FEED.

SIZE		-----DIRECT VALUES-----				-----CUMULATIVE RETAINED-----				-----CUMULATIVE PASSED-----			
FRACTION		WEIGHT	ASH	SULFUR	MOISTURE	WEIGHT	ASH	SULFUR	MOISTURE	WEIGHT	ASH	SULFUR	MOISTURE
PASSED	RETAINED	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT
	30M	7.50	10.97	2.21	0.60	7.50	10.97	2.21	0.60	100.00	12.33	3.29	0.64
30M	60M	77.40	10.22	2.21	0.65	84.90	10.29	2.21	0.65	92.50	12.44	3.38	0.64
60M	100M	12.00	21.49	7.30	0.65	96.90	11.67	2.84	0.65	15.10	23.83	9.35	0.61
100M		3.10	32.90	17.27	0.45	100.00	12.33	3.29	0.64	3.10	32.90	17.27	0.45

DATA FOR - REFUSE COAL

THIS FRACTION CONSTITUTES 22.4 PERCENT OF THE FEED.

SIZE		-----DIRECT VALUES-----				-----CUMULATIVE RETAINED-----				-----CUMULATIVE PASSED-----			
FRACTION		WEIGHT	ASH	SULFUR	MOISTURE	WEIGHT	ASH	SULFUR	MOISTURE	WEIGHT	ASH	SULFUR	MOISTURE
PASSED	RETAINED	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT
	30M	15.70	32.86	6.17	0.50	15.70	32.86	6.17	0.50	100.00	28.29	8.64	0.50
30M	60M	74.60	25.43	8.34	0.50	90.30	26.72	7.96	0.50	84.30	27.43	9.10	0.50
60M	100M	8.20	41.33	15.81	0.55	98.50	27.94	8.62	0.50	9.70	42.85	14.98	0.51
100M		1.50	51.15	10.46	0.30	100.00	28.29	8.64	0.50	1.50	51.15	10.46	0.30

ANALYTICAL DATA

DATA FOR DRYFLO SEPARATION TEST # 1

FIGURES FROM ELLIOT FEED SAMPLE.

DATA FOR -

* * COMPOSITE * *

THIS FRACTION CONSTITUTES 100.0 PERCENT OF THE FEED.

SIZE		-----DIRECT VALUES-----				-----CUMULATIVE RETAINED-----				-----CUMULATIVE PASSED-----			
FRACTION		WEIGHT	ASH	SULFUR	MOISTURE	WEIGHT	ASH	SULFUR	MOISTURE	WEIGHT	ASH	SULFUR	MOISTURE
PASSED	RETAINED	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT
	30M	4.72	26.91	5.06	0.54	4.72	26.91	5.06	0.54	100.00	14.49	4.15	0.59
30M	60M	58.78	13.35	3.55	0.55	63.50	14.36	3.66	0.55	95.28	13.88	4.10	0.59
60M	100M	19.65	13.31	4.02	0.60	83.14	14.11	3.75	0.56	36.50	14.72	5.00	0.66
100M		16.86	16.37	6.13	0.74	100.00	14.49	4.15	0.59	16.86	16.37	6.13	0.74

ANALYTICAL DATA

DATA FOR DRYFLO SEPARATION TEST # 2

FIGURES FROM ELLIOT FEED SAMPLE.

DATA FOR - PRODUCT COAL.

THIS FRACTION CONSTITUTES 68.3 PERCENT OF THE FEED.

SIZE FRACTION		DIRECT VALUES				CUMULATIVE RETAINED				CUMULATIVE PASSED			
PASSED	RETAINED	WEIGHT PERCENT	ASH PERCENT	SULFUR PERCENT	MOISTURE PERCENT	WEIGHT PERCENT	ASH PERCENT	SULFUR PERCENT	MOISTURE PERCENT	WEIGHT PERCENT	ASH PERCENT	SULFUR PERCENT	MOISTURE PERCENT
	30M	1.20	10.05	1.31	0.45	1.20	10.05	1.31	0.45	100.00	10.56	2.38	0.52
30M	60M	51.90	8.84	1.67	0.45	53.10	8.87	1.66	0.45	98.80	10.56	2.40	0.52
60M	100M	26.00	10.56	1.46	0.60	79.10	9.42	1.60	0.50	46.90	12.47	3.20	0.60
100M		20.90	14.84	5.36	0.60	100.00	10.56	2.38	0.52	20.90	14.84	5.36	0.60

DATA FOR - MIDDLING COAL

THIS FRACTION CONSTITUTES 12.9 PERCENT OF THE FEED.

SIZE FRACTION		DIRECT VALUES				CUMULATIVE RETAINED				CUMULATIVE PASSED			
PASSED	RETAINED	WEIGHT PERCENT	ASH PERCENT	SULFUR PERCENT	MOISTURE PERCENT	WEIGHT PERCENT	ASH PERCENT	SULFUR PERCENT	MOISTURE PERCENT	WEIGHT PERCENT	ASH PERCENT	SULFUR PERCENT	MOISTURE PERCENT
	30M	11.40	13.22	1.66	0.50	11.40	13.22	1.66	0.50	100.00	14.66	3.47	0.49
30M	60M	74.70	12.66	2.63	0.50	86.10	12.73	2.50	0.50	88.60	14.85	3.70	0.49
60M	100M	11.40	24.26	7.81	0.45	97.50	14.08	3.12	0.49	13.90	26.59	9.46	0.45
100M		2.50	37.22	17.01	0.45	100.00	14.66	3.47	0.49	2.50	37.22	17.01	0.45

DATA FOR - REFUSE COAL.

THIS FRACTION CONSTITUTES 18.8 PERCENT OF THE FEED.

SIZE FRACTION		DIRECT VALUES				CUMULATIVE RETAINED				CUMULATIVE PASSED			
PASSED	RETAINED	WEIGHT PERCENT	ASH PERCENT	SULFUR PERCENT	MOISTURE PERCENT	WEIGHT PERCENT	ASH PERCENT	SULFUR PERCENT	MOISTURE PERCENT	WEIGHT PERCENT	ASH PERCENT	SULFUR PERCENT	MOISTURE PERCENT
	30M	15.60	39.10	7.30	0.50	15.60	39.10	7.30	0.50	100.00	32.98	10.32	0.38
30M	60M	74.10	29.60	10.33	0.35	89.70	31.25	9.80	0.38	84.40	31.85	10.88	0.35
60M	100M	8.80	47.49	14.74	0.40	98.50	32.70	10.24	0.38	10.30	48.02	14.82	0.39
100M		1.50	51.15	15.27	0.30	100.00	32.98	10.32	0.38	1.50	51.15	15.27	0.30

ANALYTICAL DATA

DATA FOR DRYFLO SEPARATION TEST # 2

FIGURES FROM ELLIOT FEED SAMPLE.

DATA FOR -

* * COMPOSITE * *

THIS FRACTION CONSTITUTES 100.0 PERCENT OF THE FEED.

SIZE FRACTION		DIRECT VALUES				CUMULATIVE RETAINED				CUMULATIVE PASSED			
PASSED	RETAINED	WEIGHT PERCENT	ASH PERCENT	SULFUR PERCENT	MOISTURE PERCENT	WEIGHT PERCENT	ASH PERCENT	SULFUR PERCENT	MOISTURE PERCENT	WEIGHT PERCENT	ASH PERCENT	SULFUR PERCENT	MOISTURE PERCENT
	30M	5.22	27.25	4.77	0.49	5.22	27.25	4.77	0.49	100.00	15.30	4.01	0.49
30M	60M	59.01	14.36	3.87	0.43	64.24	15.41	3.94	0.44	94.78	14.64	3.97	0.49
60M	100M	20.88	14.45	2.96	0.57	85.12	15.18	3.70	0.47	35.76	15.10	4.14	0.58
100M		14.88	16.01	5.80	0.59	100.00	15.30	4.01	0.49	14.88	16.01	5.80	0.59

ANALYTICAL DATA

DATA FOR DRYFLO SEPARATION TEST # 3

FIGURES FROM ELLIOT FEED SAMPLE.

DATA FOR - PRODUCT COAL

THIS FRACTION CONSTITUTES 57.3 PERCENT OF THE FEED.

SIZE		-----DIRECT VALUES-----				-----CUMULATIVE RETAINED-----				-----CUMULATIVE PASSED-----			
FRACTION		WEIGHT	ASH	SULFUR	MOISTURE	WEIGHT	ASH	SULFUR	MOISTURE	WEIGHT	ASH	SULFUR	MOISTURE
PASSED	RETAINED	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT
	30M	3.30	7.90	1.21	0.65	3.30	7.90	1.21	0.65	100.00	9.34	2.36	0.56
30M	60M	59.70	7.69	1.60	0.55	63.00	7.70	1.58	0.56	96.70	9.39	2.40	0.56
60M	100M	22.40	10.52	2.39	0.65	85.40	8.44	1.79	0.58	37.00	12.14	3.69	0.57
100M		14.60	14.62	5.68	0.45	100.00	9.34	2.36	0.56	14.60	14.62	5.68	0.45

DATA FOR - MIDDLING COAL

THIS FRACTION CONSTITUTES 21.9 PERCENT OF THE FEED.

SIZE		-----DIRECT VALUES-----				-----CUMULATIVE RETAINED-----				-----CUMULATIVE PASSED-----			
FRACTION		WEIGHT	ASH	SULFUR	MOISTURE	WEIGHT	ASH	SULFUR	MOISTURE	WEIGHT	ASH	SULFUR	MOISTURE
PASSED	RETAINED	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT
	30M	16.90	16.91	2.10	0.65	16.90	16.91	2.10	0.65	100.00	15.58	3.75	0.57
30M	60M	66.20	13.73	2.91	0.55	83.10	14.38	2.75	0.57	83.10	15.30	4.09	0.55
60M	100M	13.60	17.96	5.90	0.60	96.70	14.88	3.19	0.57	16.90	21.47	8.69	0.56
100M		3.30	35.94	20.19	0.40	100.00	15.58	3.75	0.57	3.30	35.94	20.19	0.40

DATA FOR - REFUSE COAL

THIS FRACTION CONSTITUTES 20.8 PERCENT OF THE FEED.

SIZE		-----DIRECT VALUES-----				-----CUMULATIVE RETAINED-----				-----CUMULATIVE PASSED-----			
FRACTION		WEIGHT	ASH	SULFUR	MOISTURE	WEIGHT	ASH	SULFUR	MOISTURE	WEIGHT	ASH	SULFUR	MOISTURE
PASSED	RETAINED	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT
	30M	22.20	40.16	8.73	0.40	22.20	40.16	8.73	0.40	100.00	31.50	10.06	0.33
30M	60M	65.90	27.00	9.30	0.25	88.10	30.32	9.16	0.29	77.80	29.03	10.44	0.31
60M	100M	10.20	38.50	16.20	0.65	98.30	31.17	9.89	0.33	11.90	40.26	16.73	0.61
100M		1.70	50.80	19.89	0.40	100.00	31.50	10.06	0.33	1.70	50.80	19.89	0.40

ANALYTICAL DATA

DATA FOR DRYFLO SEPARATION TEST # 3

FIGURES FROM ELLIOT FEED SAMPLE.

DATA FOR -

* * COMPOSITE * *

THIS FRACTION CONSTITUTES 100.0 PERCENT OF THE FEED.

SIZE		-----DIRECT VALUES-----				-----CUMULATIVE RETAINED-----				-----CUMULATIVE PASSED-----			
FRACTION		WEIGHT	ASH	SULFUR	MOISTURE	WEIGHT	ASH	SULFUR	MOISTURE	WEIGHT	ASH	SULFUR	MOISTURE
PASSED	RETAINED	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT
	30M	10.21	25.76	4.93	0.54	10.21	25.76	4.93	0.54	100.00	15.32	4.27	0.51
30M	60M	62.41	13.33	3.60	0.48	72.62	15.08	3.78	0.49	89.79	14.13	4.19	0.51
60M	100M	17.94	15.07	4.61	0.64	90.56	15.08	3.95	0.52	27.38	15.94	5.54	0.57
100M		9.44	17.61	7.32	0.44	100.00	15.32	4.27	0.51	9.44	17.61	7.32	0.44

ANALYTICAL DATA

DATA FOR DRYFLO SEPARATION TEST # 4

FIGURES FROM ELLIOT FEED SAMPLE.

DATA FOR - PRODUCT COAL

THIS FRACTION CONSTITUTES 53.0 PERCENT OF THE FEED.

SIZE FRACTION		-----DIRECT VALUES-----				-----CUMULATIVE RETAINED-----				-----CUMULATIVE PASSED-----			
PASSED	RETAINED	WEIGHT PERCENT	ASH PERCENT	SULFUR PERCENT	MOISTURE PERCENT	WEIGHT PERCENT	ASH PERCENT	SULFUR PERCENT	MOISTURE PERCENT	WEIGHT PERCENT	ASH PERCENT	SULFUR PERCENT	MOISTURE PERCENT
	30M	2.20	7.34	1.32	0.55	2.20	7.34	1.32	0.55	100.00	9.07	2.43	0.55
30M	60M	50.80	7.18	1.48	0.45	53.00	7.19	1.47	0.45	97.80	9.11	2.45	0.55
60M	100M	30.70	9.46	2.16	0.60	83.70	8.02	1.73	0.51	47.00	11.19	3.51	0.65
100M		16.30	14.46	6.04	0.75	100.00	9.07	2.43	0.55	16.30	14.46	6.04	0.75

DATA FOR - MIDDLING COAL

THIS FRACTION CONSTITUTES 20.9 PERCENT OF THE FEED.

SIZE FRACTION		-----DIRECT VALUES-----				-----CUMULATIVE RETAINED-----				-----CUMULATIVE PASSED-----			
PASSED	RETAINED	WEIGHT PERCENT	ASH PERCENT	SULFUR PERCENT	MOISTURE PERCENT	WEIGHT PERCENT	ASH PERCENT	SULFUR PERCENT	MOISTURE PERCENT	WEIGHT PERCENT	ASH PERCENT	SULFUR PERCENT	MOISTURE PERCENT
	30M	14.80	13.73	1.62	0.55	14.80	13.73	1.62	0.55	100.00	13.62	2.96	0.66
30M	60M	69.90	11.73	2.22	0.70	84.70	12.08	2.12	0.67	85.20	13.61	3.19	0.68
60M	100M	12.60	18.97	5.69	0.65	97.30	12.97	2.58	0.67	15.30	22.17	7.61	0.61
100M		2.70	37.12	16.56	0.45	100.00	13.62	2.96	0.66	2.70	37.12	16.56	0.45

DATA FOR - REFUSE COAL

THIS FRACTION CONSTITUTES 26.1 PERCENT OF THE FEED.

SIZE FRACTION		-----DIRECT VALUES-----				-----CUMULATIVE RETAINED-----				-----CUMULATIVE PASSED-----			
PASSED	RETAINED	WEIGHT PERCENT	ASH PERCENT	SULFUR PERCENT	MOISTURE PERCENT	WEIGHT PERCENT	ASH PERCENT	SULFUR PERCENT	MOISTURE PERCENT	WEIGHT PERCENT	ASH PERCENT	SULFUR PERCENT	MOISTURE PERCENT
	30M	21.80	39.70	7.46	0.50	21.80	39.70	7.46	0.50	100.00	29.40	8.97	0.57
30M	60M	67.50	24.14	8.10	0.60	89.30	27.94	7.94	0.58	78.20	26.53	9.40	0.59
60M	100M	9.00	39.57	17.65	0.55	98.30	29.00	8.83	0.57	10.70	41.61	17.57	0.52
100M		1.70	52.38	17.16	0.35	100.00	29.40	8.97	0.57	1.70	52.38	17.16	0.35

ANALYTICAL DATA

DATA FOR DRYFLO SEPARATION TEST # 4

FIGURES FROM ELLIOT FEED SAMPLE.

DATA FOR -

* * COMPOSITE * *

THIS FRACTION CONSTITUTES 100.0 PERCENT OF THE FEED.

SIZE FRACTION		-----DIRECT VALUES-----				-----CUMULATIVE RETAINED-----				-----CUMULATIVE PASSED-----			
PASSED	RETAINED	WEIGHT PERCENT	ASH PERCENT	SULFUR PERCENT	MOISTURE PERCENT	WEIGHT PERCENT	ASH PERCENT	SULFUR PERCENT	MOISTURE PERCENT	WEIGHT PERCENT	ASH PERCENT	SULFUR PERCENT	MOISTURE PERCENT
	30M	9.95	27.83	4.92	0.52	9.95	27.83	4.92	0.52	100.00	15.33	4.25	0.58
30M	60M	59.15	13.36	3.63	0.56	69.10	15.44	3.82	0.55	90.05	13.95	4.17	0.58
60M	100M	21.25	13.97	4.31	0.60	90.35	15.09	3.94	0.56	30.90	15.08	5.20	0.64
100M		9.65	17.53	7.17	0.71	100.00	15.33	4.25	0.58	9.65	17.53	7.17	0.71

ANALYTICAL DATA

DATA FOR DRYFLO SEPARATION TEST # 5.

FIGURES FROM PSOC 233 FEED SAMPLE.

DATA FOR - PRODUCT COAL.

THIS FRACTION CONSTITUTES 68.5 PERCENT OF THE FEED.

SIZE FRACTION		-----DIRECT VALUES-----				-----CUMULATIVE RETAINED-----				-----CUMULATIVE PASSED-----			
PASSED	RETAINED	WEIGHT PERCENT	ASH PERCENT	SULFUR PERCENT	MOISTURE PERCENT	WEIGHT PERCENT	ASH PERCENT	SULFUR PERCENT	MOISTURE PERCENT	WEIGHT PERCENT	ASH PERCENT	SULFUR PERCENT	MOISTURE PERCENT
	30M	1.30	6.67	0.60	6.25	1.30	6.67	0.60	6.25	100.00	7.09	0.60	6.79
30M	60M	46.30	6.60	0.55	6.80	47.60	6.60	0.55	6.78	98.70	7.10	0.60	6.80
60M	100M	26.20	6.72	0.65	7.00	73.80	6.64	0.59	6.86	52.40	7.53	0.64	6.80
100M		26.20	8.35	0.64	6.60	100.00	7.09	0.60	6.79	26.20	8.35	0.64	6.60

DATA FOR - MIDDLING COAL.

THIS FRACTION CONSTITUTES 19.0 PERCENT OF THE FEED.

SIZE FRACTION		-----DIRECT VALUES-----				-----CUMULATIVE RETAINED-----				-----CUMULATIVE PASSED-----			
PASSED	RETAINED	WEIGHT PERCENT	ASH PERCENT	SULFUR PERCENT	MOISTURE PERCENT	WEIGHT PERCENT	ASH PERCENT	SULFUR PERCENT	MOISTURE PERCENT	WEIGHT PERCENT	ASH PERCENT	SULFUR PERCENT	MOISTURE PERCENT
	30M	7.70	7.24	0.52	6.10	7.70	7.24	0.52	6.10	100.00	7.78	0.58	6.30
30M	60M	71.10	7.68	0.56	6.30	78.80	7.64	0.56	6.28	92.30	7.83	0.58	6.32
60M	100M	16.00	7.97	0.60	6.55	94.80	7.69	0.56	6.33	21.20	8.32	0.65	6.38
100M		5.20	9.40	0.80	5.85	100.00	7.78	0.58	6.30	5.20	9.40	0.80	5.85

DATA FOR - REFUSE COAL.

THIS FRACTION CONSTITUTES 12.5 PERCENT OF THE FEED.

SIZE FRACTION		-----DIRECT VALUES-----				-----CUMULATIVE RETAINED-----				-----CUMULATIVE PASSED-----			
PASSED	RETAINED	WEIGHT PERCENT	ASH PERCENT	SULFUR PERCENT	MOISTURE PERCENT	WEIGHT PERCENT	ASH PERCENT	SULFUR PERCENT	MOISTURE PERCENT	WEIGHT PERCENT	ASH PERCENT	SULFUR PERCENT	MOISTURE PERCENT
	30M	9.00	9.78	0.58	5.90	9.00	9.78	0.58	5.90	100.00	9.71	0.64	5.89
30M	60M	79.30	9.51	0.61	5.90	88.30	9.54	0.61	5.90	91.00	9.70	0.65	5.89
60M	100M	10.10	10.90	0.82	5.95	98.40	9.68	0.63	5.91	11.70	11.00	0.91	5.85
100M		1.60	11.60	1.48	5.20	100.00	9.71	0.64	5.89	1.60	11.60	1.48	5.20

ANALYTICAL DATA

DATA FOR DRYFLO SEPARATION TEST # 5.

FIGURES FROM PSOC 233 FEED SAMPLE.

DATA FOR -

* * COMPOSITE * *

THIS FRACTION CONSTITUTES 100.0 PERCENT OF THE FEED.

SIZE FRACTION		-----DIRECT VALUES-----				-----CUMULATIVE RETAINED-----				-----CUMULATIVE PASSED-----			
PASSED	RETAINED	WEIGHT PERCENT	ASH PERCENT	SULFUR PERCENT	MOISTURE PERCENT	WEIGHT PERCENT	ASH PERCENT	SULFUR PERCENT	MOISTURE PERCENT	WEIGHT PERCENT	ASH PERCENT	SULFUR PERCENT	MOISTURE PERCENT
	30M	3.48	7.92	0.56	6.07	3.48	7.92	0.56	6.07	100.00	7.55	0.60	6.59
30M	60M	55.14	7.39	0.56	6.52	58.62	7.42	0.56	6.49	96.52	7.54	0.60	6.61
60M	100M	22.25	7.13	0.65	6.88	80.86	7.34	0.59	6.60	41.38	7.73	0.65	6.73
100M		19.13	8.44	0.66	6.55	100.00	7.55	0.60	6.59	19.13	8.44	0.66	6.55

ANALYTICAL DATA

DATA FOR DRYFLC SEPARATION TEST # 6

FIGURES FROM PSOC 233.

DATA FOR - PRODUCT COAL.

THIS FRACTION CONSTITUTES 80.7 PERCENT OF THE FEED.

SIZE FRACTION		-----DIRECT VALUES-----				-----CUMULATIVE RETAINED-----				-----CUMULATIVE PASSED-----			
PASSED	RETAINED	WEIGHT PERCENT	ASH PERCENT	SULFUR PERCENT	MOISTURE PERCENT	WEIGHT PERCENT	ASH PERCENT	SULFUR PERCENT	MOISTURE PERCENT	WEIGHT PERCENT	ASH PERCENT	SULFUR PERCENT	MOISTURE PERCENT
	30M	2.40	6.77	0.56	7.00	2.40	6.77	0.56	7.00	100.00	7.19	0.58	7.20
30M	60M	54.70	6.95	0.57	7.25	57.10	6.94	0.57	7.24	97.60	7.20	0.58	7.21
60M	100M	24.40	7.00	0.61	7.20	81.50	6.96	0.58	7.23	42.90	7.51	0.60	7.16
100M		18.50	8.18	0.58	7.10	100.00	7.19	0.58	7.20	18.50	8.18	0.58	7.10

DATA FOR - MIDDLING COAL.

THIS FRACTION CONSTITUTES 9.7 PERCENT OF THE FEED.

SIZE FRACTION		-----DIRECT VALUES-----				-----CUMULATIVE RETAINED-----				-----CUMULATIVE PASSED-----			
PASSED	RETAINED	WEIGHT PERCENT	ASH PERCENT	SULFUR PERCENT	MOISTURE PERCENT	WEIGHT PERCENT	ASH PERCENT	SULFUR PERCENT	MOISTURE PERCENT	WEIGHT PERCENT	ASH PERCENT	SULFUR PERCENT	MOISTURE PERCENT
	30M	7.70	7.70	0.53	5.80	7.70	7.70	0.53	5.80	100.00	7.71	0.58	6.21
30M	60M	69.60	7.90	0.55	6.30	77.30	7.88	0.55	6.25	92.30	7.71	0.59	6.24
60M	100M	16.40	6.40	0.64	6.20	93.70	7.62	0.56	6.24	22.70	7.11	0.70	6.08
100M		6.30	8.97	0.84	5.75	100.00	7.71	0.58	6.21	6.30	8.97	0.84	5.75

DATA FOR - REFUSE COAL.

THIS FRACTION CONSTITUTES 9.6 PERCENT OF THE FEED.

SIZE FRACTION		-----DIRECT VALUES-----				-----CUMULATIVE RETAINED-----				-----CUMULATIVE PASSED-----			
PASSED	RETAINED	WEIGHT PERCENT	ASH PERCENT	SULFUR PERCENT	MOISTURE PERCENT	WEIGHT PERCENT	ASH PERCENT	SULFUR PERCENT	MOISTURE PERCENT	WEIGHT PERCENT	ASH PERCENT	SULFUR PERCENT	MOISTURE PERCENT
	30M	8.80	9.84	0.62	5.50	8.80	9.84	0.62	5.50	100.00	10.31	0.66	5.86
30M	60M	77.00	10.41	0.62	5.90	85.80	10.35	0.62	5.86	91.20	10.35	0.67	5.89
60M	100M	11.80	9.94	0.83	5.95	97.60	10.30	0.65	5.87	14.20	10.03	0.93	5.86
100M		2.40	10.47	1.42	5.40	100.00	10.31	0.66	5.86	2.40	10.47	1.42	5.40

ANALYTICAL DATA

DATA FOR DRYFLO SEPARATION TEST # 6

FIGURES FROM PSOC 233.

DATA FOR -

* * COMPOSITE * *

THIS FRACTION CONSTITUTES 100.0 PERCENT OF THE FEED.

SIZE FRACTION		-----DIRECT VALUES-----				-----CUMULATIVE RETAINED-----				-----CUMULATIVE PASSED-----			
PASSED	RETAINED	WEIGHT PERCENT	ASH PERCENT	SULFUR PERCENT	MOISTURE PERCENT	WEIGHT PERCENT	ASH PERCENT	SULFUR PERCENT	MOISTURE PERCENT	WEIGHT PERCENT	ASH PERCENT	SULFUR PERCENT	MOISTURE PERCENT
	30M	3.53	7.70	0.57	6.39	3.53	7.70	0.57	6.39	100.00	7.54	0.59	6.98
30M	60M	58.29	7.50	0.57	6.97	61.81	7.51	0.57	6.94	96.47	7.53	0.59	7.00
60M	100M	22.41	7.11	0.62	7.07	84.23	7.40	0.59	6.97	38.19	7.58	0.61	7.05
100M		15.77	8.24	0.60	7.02	100.00	7.54	0.59	6.98	15.77	8.24	0.60	7.02

ANALYTICAL DATA

DATA FOR DRYFLO SEPARATION TEST #7 * X-RAY SULFUR *

FIGURES FROM PSOC # 233 FEED.

DATA FOR - PRODUCT COAL.

THIS FRACTION CONSTITUTES 73.4 PERCENT OF THE FEED.

SIZE		-----DIRECT VALUES-----				-----CUMULATIVE RETAINED-----				-----CUMULATIVE PASSED-----			
FRACTION		WEIGHT	ASH	SULFUR	MOISTURE	WEIGHT	ASH	SULFUR	MOISTURE	WEIGHT	ASH	SULFUR	MOISTURE
PASSED	RETAINED	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT
	30M	2.30	6.97	0.55	5.30	2.30	6.97	0.55	5.30	100.00	7.34	0.53	5.69
30M	60M	56.60	7.08	0.50	5.40	58.90	7.08	0.50	5.40	97.70	7.34	0.53	5.70
60M	100M	26.20	7.33	0.55	6.55	85.10	7.15	0.52	5.75	41.10	7.71	0.57	6.10
100M	150M	10.50	7.35	0.60	5.40	95.60	7.18	0.53	5.71	14.90	8.38	0.61	5.32
150M	200M	1.50	8.44	0.70	5.25	97.10	7.20	0.53	5.71	4.40	10.83	0.63	5.12
200M		2.90	12.06	0.60	5.05	100.00	7.34	0.53	5.69	2.90	12.06	0.60	5.05

DATA FOR - MIDDLING COAL.

THIS FRACTION CONSTITUTES 19.0 PERCENT OF THE FEED.

SIZE		-----DIRECT VALUES-----				-----CUMULATIVE RETAINED-----				-----CUMULATIVE PASSED-----			
FRACTION		WEIGHT	ASH	SULFUR	MOISTURE	WEIGHT	ASH	SULFUR	MOISTURE	WEIGHT	ASH	SULFUR	MOISTURE
PASSED	RETAINED	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT
	30M	5.60	7.54	0.65	4.50	5.60	7.54	0.65	4.50	100.00	7.67	0.52	5.38
30M	60M	64.90	7.45	0.45	5.35	70.50	7.46	0.47	5.28	94.40	7.67	0.51	5.43
60M	100M	22.10	8.02	0.60	5.85	92.60	7.59	0.50	5.42	29.50	8.16	0.64	5.61
100M	150M	5.60	8.12	0.70	5.20	98.20	7.62	0.51	5.41	7.40	8.59	0.77	4.89
150M	200M	0.90	8.40	0.85	4.15	99.10	7.63	0.51	5.39	1.80	10.06	1.00	3.93
200M		0.90	11.73	1.15	3.70	100.00	7.67	0.52	5.38	0.90	11.73	1.15	3.70

DATA FOR - REFUSE COAL.

THIS FRACTION CONSTITUTES 7.6 PERCENT OF THE FEED.

SIZE		-----DIRECT VALUES-----				-----CUMULATIVE RETAINED-----				-----CUMULATIVE PASSED-----			
FRACTION		WEIGHT	ASH	SULFUR	MOISTURE	WEIGHT	ASH	SULFUR	MOISTURE	WEIGHT	ASH	SULFUR	MOISTURE
PASSED	RETAINED	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT
	30M	7.80	10.51	0.85	4.35	7.80	10.51	0.85	4.35	100.00	10.14	0.56	5.01
30M	60M	76.00	9.91	0.50	5.10	83.80	9.97	0.53	5.03	92.20	10.11	0.54	5.07
60M	100M	14.00	11.02	0.65	5.15	97.80	10.12	0.55	5.05	16.20	11.02	0.73	4.93
100M	150M	1.40	11.01	1.15	3.80	99.20	10.13	0.56	5.03	2.20	11.05	1.20	3.51
150M	200M	0.00	0.00	0.00	0.00	99.20	10.13	0.56	5.03	0.80	11.13	1.30	3.00
200M		0.80	11.13	1.30	3.00	100.00	10.14	0.56	5.01	0.80	11.13	1.30	3.00

ANALYTICAL DATA

DATA FOR DRYFLO SEPARATION TEST #7 * X-RAY SULFUR *

FIGURES FROM PSOC # 233 FEED.

DATA FOR -

* * COMPOSITE * *

THIS FRACTION CONSTITUTES 100.0 PERCENT OF THE FEED.

SIZE		-----DIRECT VALUES-----				-----CUMULATIVE RETAINED-----				-----CUMULATIVE PASSED-----			
FRACTION		WEIGHT	ASH	SULFUR	MOISTURE	WEIGHT	ASH	SULFUR	MOISTURE	WEIGHT	ASH	SULFUR	MOISTURE
PASSED	RETAINED	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT
	30M	3.34	7.78	0.63	4.88	3.34	7.78	0.63	4.88	100.00	7.61	0.53	5.58
30M	60M	59.65	7.43	0.49	5.36	63.00	7.45	0.50	5.33	96.65	7.61	0.53	5.60
60M	100M	24.49	7.61	0.56	6.37	87.49	7.49	0.52	5.62	37.00	7.89	0.59	5.99
100M	150M	8.88	7.49	0.62	5.36	96.37	7.49	0.53	5.60	12.51	8.44	0.64	5.24
150M	200M	1.27	8.43	0.72	5.10	97.64	7.51	0.53	5.59	3.63	10.76	0.68	4.97
200M		2.36	12.01	0.66	4.90	100.00	7.61	0.53	5.58	2.36	12.01	0.66	4.90

ANALYTICAL DATA

DATA FOR DRYFLO SEPARATION TEST # 8

FIGURES FROM PSOC # 233 FEED SAMPLE.

DATA FOR - PRODUCT COAL.

THIS FRACTION CONSTITUTES 73.1 PERCENT OF THE FEED.

SIZE FRACTION		-----DIRECT VALUES-----				-----CUMULATIVE RETAINED-----				-----CUMULATIVE PASSED-----			
PASSED	RETAINED	WEIGHT PERCENT	ASH PERCENT	SULFUR PERCENT	MOISTURE PERCENT	WEIGHT PERCENT	ASH PERCENT	SULFUR PERCENT	MOISTURE PERCENT	WEIGHT PERCENT	ASH PERCENT	SULFUR PERCENT	MOISTURE PERCENT
	30M	1.80	6.97	0.53	4.55	1.80	6.97	0.53	4.55	100.00	6.98	0.59	5.62
30M	60M	49.50	6.62	0.56	5.55	51.30	6.63	0.56	5.51	98.20	6.98	0.59	5.64
60M	100M	29.80	6.85	0.57	5.85	81.10	6.71	0.56	5.64	48.70	7.34	0.63	5.73
100M	150M	12.20	7.15	0.61	5.60	93.30	6.77	0.57	5.63	18.90	8.12	0.72	5.53
150M	200M	2.80	8.35	0.75	5.40	96.10	6.82	0.57	5.63	6.70	9.89	0.92	5.40
200M		3.90	10.99	1.04	5.40	100.00	6.98	0.59	5.62	3.90	10.99	1.04	5.40

DATA FOR - MIDDLING COAL.

THIS FRACTION CONSTITUTES 17.8 PERCENT OF THE FEED.

SIZE FRACTION		-----DIRECT VALUES-----				-----CUMULATIVE RETAINED-----				-----CUMULATIVE PASSED-----			
PASSED	RETAINED	WEIGHT PERCENT	ASH PERCENT	SULFUR PERCENT	MOISTURE PERCENT	WEIGHT PERCENT	ASH PERCENT	SULFUR PERCENT	MOISTURE PERCENT	WEIGHT PERCENT	ASH PERCENT	SULFUR PERCENT	MOISTURE PERCENT
	30M	6.90	7.68	0.56	4.90	6.90	7.68	0.56	4.90	100.00	7.86	0.60	5.36
30M	60M	65.80	7.62	0.58	5.50	72.70	7.63	0.58	5.44	93.10	7.87	0.61	5.39
60M	100M	19.90	8.15	0.62	5.50	92.60	7.74	0.59	5.46	27.30	8.47	0.67	5.13
100M	150M	4.80	8.66	0.74	4.20	97.40	7.78	0.59	5.39	7.40	9.33	0.82	4.13
150M	200M	0.90	8.77	0.44	3.65	98.30	7.79	0.59	5.38	2.60	10.57	0.96	4.01
200M		1.70	11.53	1.23	4.20	100.00	7.86	0.60	5.36	1.70	11.53	1.23	4.20

DATA FOR - REFUSE COAL.

THIS FRACTION CONSTITUTES 9.1 PERCENT OF THE FEED.

SIZE FRACTION		-----DIRECT VALUES-----				-----CUMULATIVE RETAINED-----				-----CUMULATIVE PASSED-----			
PASSED	RETAINED	WEIGHT PERCENT	ASH PERCENT	SULFUR PERCENT	MOISTURE PERCENT	WEIGHT PERCENT	ASH PERCENT	SULFUR PERCENT	MOISTURE PERCENT	WEIGHT PERCENT	ASH PERCENT	SULFUR PERCENT	MOISTURE PERCENT
	30M	11.00	10.79	0.85	4.10	11.00	10.79	0.85	4.10	100.00	10.24	0.76	4.81
30M	60M	73.70	9.90	0.71	5.05	84.70	10.02	0.73	4.93	89.00	10.17	0.75	4.89
60M	100M	11.00	11.83	0.92	4.50	95.70	10.22	0.75	4.88	15.30	11.46	0.91	4.15
100M	150M	2.50	11.15	1.55	4.00	98.20	10.25	0.77	4.86	4.30	10.51	0.90	3.25
150M	200M	0.90	7.40	0.00	1.35	99.10	10.22	0.76	4.82	1.80	9.63	0.00	2.20
200M		0.90	11.86	0.00	3.05	100.00	10.24	0.76	4.81	0.90	11.86	0.00	3.05

ANALYTICAL DATA

DATA FOR DRYFLO SEPARATION TEST # 8

FIGURES FROM PSOC # 233 FEED SAMPLE.

DATA FOR -

* * COMPOSITE * *

THIS FRACTION CONSTITUTES 100.0 PERCENT OF THE FEED.

SIZE FRACTION		-----DIRECT VALUES-----				-----CUMULATIVE RETAINED-----				-----CUMULATIVE PASSED-----			
PASSED	RETAINED	WEIGHT PERCENT	ASH PERCENT	SULFUR PERCENT	MOISTURE PERCENT	WEIGHT PERCENT	ASH PERCENT	SULFUR PERCENT	MOISTURE PERCENT	WEIGHT PERCENT	ASH PERCENT	SULFUR PERCENT	MOISTURE PERCENT
	30M	3.54	8.29	0.63	4.54	3.54	8.29	0.63	4.54	100.00	7.43	0.61	5.50
30M	60M	54.60	7.24	0.58	5.48	58.15	7.30	0.59	5.42	96.45	7.40	0.61	5.53
60M	100M	26.33	7.21	0.59	5.75	84.48	7.27	0.59	5.52	41.85	7.61	0.64	5.60
100M	150M	10.00	7.37	0.64	5.44	94.48	7.28	0.59	5.52	15.52	8.28	0.73	5.35
150M	200M	2.29	8.35	0.70	5.13	96.76	7.31	0.60	5.51	5.52	9.94	0.89	5.19
200M		3.24	11.06	1.03	5.23	100.00	7.43	0.61	5.50	3.24	11.06	1.03	5.23

ANALYTICAL DATA

DATA FOR DRYFLO SEPARATION TEST # 9

FIGURES FROM PSOC # 233 FEED SAMPLE.

DATA FOR - PRODUCT COAL.

THIS FRACTION CONSTITUTES 83.9 PERCENT OF THE FEED.

SIZE		-----DIRECT VALUES-----				-----CUMULATIVE RETAINED-----				-----CUMULATIVE PASSED-----			
FRACTION		WEIGHT	ASH	SULFUR	MOISTURE	WEIGHT	ASH	SULFUR	MOISTURE	WEIGHT	ASH	SULFUR	MOISTURE
PASSED	RETAINED	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT
	30M	2.60	7.26	0.54	5.70	2.60	7.26	0.54	5.70	100.00	7.25	0.59	5.17
30M	60M	60.00	6.85	0.57	5.05	62.60	6.87	0.57	5.08	97.40	7.25	0.60	5.16
60M	100M	23.90	7.56	0.58	5.40	86.50	7.06	0.57	5.17	37.40	7.90	0.64	5.32
100M	150M	9.40	7.55	0.63	5.35	95.90	7.11	0.58	5.18	13.50	8.49	0.74	5.19
150M	200M	0.70	8.75	0.72	4.00	96.60	7.12	0.58	5.18	4.10	10.66	0.99	4.83
200M		3.40	11.05	1.04	5.00	100.00	7.25	0.59	5.17	3.40	11.05	1.04	5.00

DATA FOR - MIDDLING COAL.

THIS FRACTION CONSTITUTES 8.1 PERCENT OF THE FEED.

SIZE		-----DIRECT VALUES-----				-----CUMULATIVE RETAINED-----				-----CUMULATIVE PASSED-----			
FRACTION		WEIGHT	ASH	SULFUR	MOISTURE	WEIGHT	ASH	SULFUR	MOISTURE	WEIGHT	ASH	SULFUR	MOISTURE
PASSED	RETAINED	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT
	30M	6.10	8.20	0.58	3.60	6.10	8.20	0.58	3.60	100.00	8.10	0.61	4.56
30M	60M	64.60	7.86	0.56	4.60	70.70	7.89	0.56	4.51	93.90	8.09	0.61	4.62
60M	100M	20.80	8.25	0.66	4.90	91.50	7.97	0.58	4.60	29.30	8.61	0.71	4.66
100M	150M	5.40	8.66	0.72	4.15	96.90	8.01	0.59	4.58	8.50	9.49	0.84	4.07
150M	200M	0.80	8.25	0.00	4.90	97.70	8.01	0.59	4.58	3.10	10.94	1.06	3.94
200M		2.30	11.88	1.43	3.60	100.00	8.10	0.61	4.56	2.30	11.88	1.43	3.60

DATA FOR - REFUSE COAL.

THIS FRACTION CONSTITUTES 8.0 PERCENT OF THE FEED.

SIZE		-----DIRECT VALUES-----				-----CUMULATIVE RETAINED-----				-----CUMULATIVE PASSED-----			
FRACTION		WEIGHT	ASH	SULFUR	MOISTURE	WEIGHT	ASH	SULFUR	MOISTURE	WEIGHT	ASH	SULFUR	MOISTURE
PASSED	RETAINED	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT
	30M	7.80	11.45	0.89	3.90	7.80	11.45	0.89	3.90	100.00	9.89	0.72	4.54
30M	60M	71.30	9.75	0.69	4.60	79.10	9.92	0.71	4.53	92.20	9.76	0.70	4.60
60M	100M	16.30	9.56	0.77	4.85	95.40	9.86	0.72	4.59	20.90	9.79	0.75	4.59
100M	150M	3.10	10.03	1.02	3.80	98.50	9.86	0.73	4.56	4.60	10.61	0.69	3.69
150M	200M	0.00	0.00	0.00	0.00	98.50	9.86	0.73	4.56	1.50	11.81	0.00	3.45
200M		1.50	11.81	0.00	3.45	100.00	9.89	0.72	4.54	1.50	11.81	0.00	3.45

ANALYTICAL DATA

DATA FOR DRYFLO SEPARATION TEST # 9

FIGURES FROM PSOC # 233 FEED SAMPLE.

DATA FOR -

* * COMPOSITE * *

THIS FRACTION CONSTITUTES 100.0 PERCENT OF THE FEED.

SIZE		-----DIRECT VALUES-----				-----CUMULATIVE RETAINED-----				-----CUMULATIVE PASSED-----			
FRACTION		WEIGHT	ASH	SULFUR	MOISTURE	WEIGHT	ASH	SULFUR	MOISTURE	WEIGHT	ASH	SULFUR	MOISTURE
PASSED	RETAINED	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT
	30M	3.30	8.19	0.61	5.05	3.30	8.19	0.61	5.05	100.00	7.53	0.61	5.07
30M	60M	61.28	7.21	0.58	4.97	64.58	7.26	0.58	4.97	96.70	7.51	0.60	5.07
60M	100M	23.04	7.72	0.60	5.33	87.62	7.38	0.59	5.07	35.42	8.03	0.65	5.25
100M	150M	8.57	7.68	0.65	5.24	96.19	7.41	0.59	5.08	12.38	8.61	0.74	5.08
150M	200M	0.65	8.70	0.65	4.09	96.84	7.41	0.59	5.08	3.81	10.71	0.96	4.73
200M		3.16	11.13	1.02	4.86	100.00	7.53	0.61	5.07	3.16	11.13	1.02	4.86

ANALYTICAL DATA

DATA FOR DRYFLO SEPARATION TEST # 10

FIGURES FROM PSOC # 233 FEED SAMPLE.

DATA FOR - PRODUCT COAL.

THIS FRACTION CONSTITUTES 84.8 PERCENT OF THE FEED.

SIZE FRACTION		-----DIRECT VALUES-----				-----CUMULATIVE RETAINED-----				-----CUMULATIVE PASSED-----			
PASSED	RETAINED	WEIGHT PERCENT	ASH PERCENT	SULFUR PERCENT	MOISTURE PERCENT	WEIGHT PERCENT	ASH PERCENT	SULFUR PERCENT	MOISTURE PERCENT	WEIGHT PERCENT	ASH PERCENT	SULFUR PERCENT	MOISTURE PERCENT
	30M	2.80	7.09	0.57	4.75	2.80	7.09	0.57	4.75	100.00	7.24	0.57	5.09
30M	60M	52.60	7.12	0.55	5.15	55.40	7.12	0.55	5.13	97.20	7.25	0.58	5.10
60M	100M	28.50	6.90	0.53	5.05	83.90	7.04	0.54	5.10	44.60	7.39	0.60	5.03
100M	150M	10.80	7.38	0.62	5.10	94.70	7.08	0.55	5.10	16.10	8.26	0.74	5.00
150M	200M	1.00	8.07	0.69	4.00	95.70	7.09	0.55	5.09	5.30	10.07	0.97	4.81
200M		4.30	10.53	1.04	5.00	100.00	7.24	0.57	5.09	4.30	10.53	1.04	5.00

DATA FOR - MIDDLING COAL.

THIS FRACTION CONSTITUTES 7.8 PERCENT OF THE FEED.

SIZE FRACTION		-----DIRECT VALUES-----				-----CUMULATIVE RETAINED-----				-----CUMULATIVE PASSED-----			
PASSED	RETAINED	WEIGHT PERCENT	ASH PERCENT	SULFUR PERCENT	MOISTURE PERCENT	WEIGHT PERCENT	ASH PERCENT	SULFUR PERCENT	MOISTURE PERCENT	WEIGHT PERCENT	ASH PERCENT	SULFUR PERCENT	MOISTURE PERCENT
	30M	6.30	8.29	0.59	3.55	6.30	8.29	0.59	3.55	100.00	8.00	0.62	4.40
30M	60M	65.00	7.76	0.60	4.60	71.30	7.81	0.60	4.51	93.70	7.98	0.62	4.45
60M	100M	21.70	8.01	0.59	4.45	93.00	7.85	0.60	4.49	28.70	8.48	0.67	4.12
100M	150M	4.90	9.08	0.74	3.10	97.90	7.92	0.60	4.42	7.00	9.94	0.92	3.09
150M	200M	0.00	0.00	0.00	0.00	97.90	7.92	0.60	4.42	2.10	11.96	1.34	3.05
200M		2.10	11.96	1.34	3.05	100.00	8.00	0.62	4.40	2.10	11.96	1.34	3.05

DATA FOR - REFUSE COAL.

THIS FRACTION CONSTITUTES 7.4 PERCENT OF THE FEED.

SIZE FRACTION		-----DIRECT VALUES-----				-----CUMULATIVE RETAINED-----				-----CUMULATIVE PASSED-----			
PASSED	RETAINED	WEIGHT PERCENT	ASH PERCENT	SULFUR PERCENT	MOISTURE PERCENT	WEIGHT PERCENT	ASH PERCENT	SULFUR PERCENT	MOISTURE PERCENT	WEIGHT PERCENT	ASH PERCENT	SULFUR PERCENT	MOISTURE PERCENT
	30M	6.60	10.86	1.05	3.30	6.60	10.86	1.05	3.30	100.00	9.57	0.73	4.31
30M	60M	70.80	9.32	0.70	4.50	77.40	9.45	0.73	4.40	93.40	9.48	0.71	4.38
60M	100M	17.50	9.59	0.75	4.10	94.90	9.48	0.73	4.34	22.60	9.97	0.74	4.01
100M	150M	3.60	10.56	1.01	3.85	98.50	9.52	0.74	4.32	5.10	11.26	0.71	3.69
150M	200M	0.00	0.00	0.00	0.00	98.50	9.52	0.74	4.32	1.50	12.93	0.00	3.30
200M		1.50	12.93	0.00	3.30	100.00	9.57	0.73	4.31	1.50	12.93	0.00	3.30

ANALYTICAL DATA

DATA FOR DRYFLO SEPARATION TEST # 10

FIGURES FROM PSOC # 233 FEED SAMPLE.

DATA FOR -

* * COMPOSITE * *

THIS FRACTION CONSTITUTES 100.0 PERCENT OF THE FEED.

SIZE FRACTION		-----DIRECT VALUES-----				-----CUMULATIVE RETAINED-----				-----CUMULATIVE PASSED-----			
PASSED	RETAINED	WEIGHT PERCENT	ASH PERCENT	SULFUR PERCENT	MOISTURE PERCENT	WEIGHT PERCENT	ASH PERCENT	SULFUR PERCENT	MOISTURE PERCENT	WEIGHT PERCENT	ASH PERCENT	SULFUR PERCENT	MOISTURE PERCENT
	30M	3.35	7.81	0.64	4.36	3.35	7.81	0.64	4.36	100.00	7.47	0.59	4.98
30M	60M	54.91	7.39	0.57	5.04	58.27	7.41	0.57	5.00	96.65	7.46	0.59	5.00
60M	100M	27.16	7.10	0.54	4.97	85.42	7.31	0.56	4.99	41.73	7.55	0.61	4.94
100M	150M	9.81	7.53	0.64	4.99	95.23	7.34	0.57	4.99	14.58	8.40	0.74	4.90
150M	200M	0.85	8.07	0.69	4.00	96.08	7.34	0.57	4.98	4.77	10.20	0.96	4.72
200M		3.92	10.66	1.02	4.87	100.00	7.47	0.59	4.98	3.92	10.66	1.02	4.87

ANALYTICAL DATA

DATA FOR DRYFLO SEPARATION TEST # 11

FIGURES FROM PSOC # 233 FEED SAMPLE.

DATA FOR - PRODUCT COAL.

THIS FRACTION CONSTITUTES 70.4 PERCENT OF THE FEED.

SIZE		-----DIRECT VALUES-----				-----CUMULATIVE RETAINED-----				-----CUMULATIVE PASSED-----			
FRACTION		WEIGHT	ASH	SULFUR	MOISTURE	WEIGHT	ASH	SULFUR	MOISTURE	WEIGHT	ASH	SULFUR	MOISTURE
PASSED	RETAINED	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT
	30M	1.99	6.85	0.55	4.35	1.99	6.85	0.55	4.35	100.00	7.19	0.60	5.10
30M	60M	52.12	6.83	0.58	4.85	54.11	6.83	0.58	4.83	98.01	7.20	0.60	5.12
60M	100M	27.90	6.93	0.54	5.50	82.01	6.86	0.57	5.06	45.89	7.62	0.63	5.42
100M	150M	11.75	7.57	0.61	5.55	93.76	6.95	0.57	5.12	17.99	8.69	0.77	5.29
150M	200M	0.41	8.33	0.75	4.00	94.17	6.96	0.57	5.12	6.24	10.81	1.08	4.79
200M		5.83	10.98	1.10	4.85	100.00	7.19	0.60	5.10	5.83	10.98	1.10	4.85

DATA FOR - MIDDLING COAL.

THIS FRACTION CONSTITUTES 19.6 PERCENT OF THE FEED.

SIZE		-----DIRECT VALUES-----				-----CUMULATIVE RETAINED-----				-----CUMULATIVE PASSED-----			
FRACTION		WEIGHT	ASH	SULFUR	MOISTURE	WEIGHT	ASH	SULFUR	MOISTURE	WEIGHT	ASH	SULFUR	MOISTURE
PASSED	RETAINED	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT
	30M	4.95	7.62	0.56	4.85	4.95	7.62	0.56	4.85	100.00	7.57	0.59	5.35
30M	60M	61.83	7.24	0.55	5.45	66.78	7.27	0.55	5.41	95.05	7.57	0.59	5.37
60M	100M	22.94	7.72	0.58	5.40	89.72	7.38	0.56	5.40	33.22	8.18	0.66	5.23
100M	150M	6.79	8.46	0.69	4.90	96.51	7.46	0.57	5.37	10.28	9.19	0.83	4.85
150M	200M	0.37	7.96	0.00	3.85	96.88	7.46	0.57	5.36	3.49	10.62	1.11	4.74
200M		3.12	10.93	1.24	4.85	100.00	7.57	0.59	5.35	3.12	10.93	1.24	4.85

DATA FOR - REFUSE COAL.

THIS FRACTION CONSTITUTES 10.0 PERCENT OF THE FEED.

SIZE		-----DIRECT VALUES-----				-----CUMULATIVE RETAINED-----				-----CUMULATIVE PASSED-----			
FRACTION		WEIGHT	ASH	SULFUR	MOISTURE	WEIGHT	ASH	SULFUR	MOISTURE	WEIGHT	ASH	SULFUR	MOISTURE
PASSED	RETAINED	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT
	30M	7.89	10.54	0.94	4.20	7.89	10.54	0.94	4.20	100.00	9.44	0.73	4.79
30M	60M	71.31	9.04	0.67	4.90	79.20	9.19	0.70	4.83	92.11	9.34	0.72	4.84
60M	100M	16.85	10.20	0.74	4.90	96.05	9.37	0.70	4.84	20.80	10.38	0.87	4.63
100M	150M	2.87	10.89	1.18	3.60	98.92	9.41	0.72	4.81	3.95	11.13	1.44	3.46
150M	200M	0.00	0.00	0.00	0.00	98.92	9.41	0.72	4.81	1.08	11.76	2.13	3.10
200M		1.08	11.76	2.13	3.10	100.00	9.44	0.73	4.79	1.08	11.76	2.13	3.10

ANALYTICAL DATA

DATA FOR DRYFLO SEPARATION TEST # 11

FIGURES FROM PSOC # 233 FEED SAMPLE.

DATA FOR -

* * COMPOSITE * *

THIS FRACTION CONSTITUTES 100.0 PERCENT OF THE FEED.

SIZE		-----DIRECT VALUES-----				-----CUMULATIVE RETAINED-----				-----CUMULATIVE PASSED-----			
FRACTION		WEIGHT	ASH	SULFUR	MOISTURE	WEIGHT	ASH	SULFUR	MOISTURE	WEIGHT	ASH	SULFUR	MOISTURE
PASSED	RETAINED	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT
	30M	3.16	8.01	0.65	4.47	3.16	8.01	0.65	4.47	100.00	7.49	0.61	5.12
30M	60M	55.94	7.20	0.58	4.99	59.10	7.24	0.59	4.96	96.84	7.47	0.61	5.14
60M	100M	25.82	7.28	0.56	5.44	84.93	7.26	0.58	5.11	40.90	7.85	0.65	5.35
100M	150M	9.89	7.79	0.64	5.41	94.81	7.31	0.59	5.14	15.07	8.82	0.80	5.18
150M	200M	0.36	8.26	0.60	3.97	95.18	7.31	0.59	5.13	5.18	10.80	1.10	4.75
200M		4.82	10.99	1.14	4.81	100.00	7.49	0.61	5.12	4.82	10.99	1.14	4.81

ANALYTICAL DATA

DATA FOR DRYFLO SEPARATION TEST # 12

FIGURES FROM PSOC # 233 FEED SAMPLE.

DATA FOR - PRODUCT COAL.

THIS FRACTION CONSTITUTES 72.4 PERCENT OF THE FEED.

SIZE FRACTION		DIRECT VALUES				CUMULATIVE RETAINED				CUMULATIVE PASSED			
PASSED	RETAINED	WEIGHT PERCENT	ASH PERCENT	SULFUR PERCENT	MOISTURE PERCENT	WEIGHT PERCENT	ASH PERCENT	SULFUR PERCENT	MOISTURE PERCENT	WEIGHT PERCENT	ASH PERCENT	SULFUR PERCENT	MOISTURE PERCENT
	30M	2.00	7.05	0.57	4.95	2.00	7.05	0.57	4.95	100.00	7.39	0.60	5.17
30M	60M	53.20	7.23	0.56	5.20	55.20	7.22	0.56	5.19	98.00	7.39	0.60	5.18
60M	100M	26.30	7.03	0.57	5.35	81.50	7.16	0.56	5.24	44.80	7.59	0.66	5.15
100M	150M	12.50	7.31	0.63	4.95	94.00	7.18	0.57	5.20	18.50	8.38	0.78	4.87
150M	200M	0.20	7.61	0.69	3.45	94.20	7.18	0.57	5.20	6.00	10.61	1.10	4.71
200M		5.80	10.71	1.11	4.75	100.00	7.39	0.60	5.17	5.80	10.71	1.11	4.75

DATA FOR - MIDDLING COAL.

THIS FRACTION CONSTITUTES 17.7 PERCENT OF THE FEED.

SIZE FRACTION		DIRECT VALUES				CUMULATIVE RETAINED				CUMULATIVE PASSED			
PASSED	RETAINED	WEIGHT PERCENT	ASH PERCENT	SULFUR PERCENT	MOISTURE PERCENT	WEIGHT PERCENT	ASH PERCENT	SULFUR PERCENT	MOISTURE PERCENT	WEIGHT PERCENT	ASH PERCENT	SULFUR PERCENT	MOISTURE PERCENT
	30M	4.90	7.55	0.59	4.60	4.90	7.55	0.59	4.60	100.00	7.72	0.63	5.25
30M	60M	59.90	7.49	0.60	5.25	64.80	7.49	0.60	5.20	95.10	7.73	0.64	5.28
60M	100M	24.00	7.63	0.60	5.60	88.80	7.53	0.60	5.31	35.20	8.13	0.70	5.34
100M	150M	7.80	8.30	0.71	4.85	96.60	7.59	0.61	5.27	11.20	9.19	0.90	4.77
150M	200M	0.00	0.00	0.00	0.00	96.60	7.59	0.61	5.27	3.40	11.22	1.35	4.60
200M		3.40	11.22	1.35	4.60	100.00	7.72	0.63	5.25	3.40	11.22	1.35	4.60

DATA FOR - REFUSE COAL.

THIS FRACTION CONSTITUTES 9.9 PERCENT OF THE FEED.

SIZE FRACTION		DIRECT VALUES				CUMULATIVE RETAINED				CUMULATIVE PASSED			
PASSED	RETAINED	WEIGHT PERCENT	ASH PERCENT	SULFUR PERCENT	MOISTURE PERCENT	WEIGHT PERCENT	ASH PERCENT	SULFUR PERCENT	MOISTURE PERCENT	WEIGHT PERCENT	ASH PERCENT	SULFUR PERCENT	MOISTURE PERCENT
	30M	7.50	10.58	1.06	4.05	7.50	10.58	1.06	4.05	100.00	9.69	0.77	4.74
30M	60M	70.20	9.62	0.68	4.90	77.70	9.71	0.72	4.82	92.50	9.62	0.74	4.79
60M	100M	17.20	9.48	0.83	4.55	94.90	9.67	0.74	4.77	22.30	9.62	0.94	4.45
100M	150M	3.70	9.42	1.15	4.45	98.60	9.66	0.75	4.76	5.10	10.08	1.29	4.11
150M	200M	0.00	0.00	0.00	0.00	98.60	9.66	0.75	4.76	1.40	11.83	1.66	3.20
200M		1.40	11.83	1.66	3.20	100.00	9.69	0.77	4.74	1.40	11.83	1.66	3.20

ANALYTICAL DATA

DATA FOR DRYFLO SEPARATION TEST # 12

FIGURES FROM PSOC # 233 FEED SAMPLE.

DATA FOR -

* * COMPOSITE * *

THIS FRACTION CONSTITUTES 100.0 PERCENT OF THE FEED.

SIZE FRACTION		DIRECT VALUES				CUMULATIVE RETAINED				CUMULATIVE PASSED			
PASSED	RETAINED	WEIGHT PERCENT	ASH PERCENT	SULFUR PERCENT	MOISTURE PERCENT	WEIGHT PERCENT	ASH PERCENT	SULFUR PERCENT	MOISTURE PERCENT	WEIGHT PERCENT	ASH PERCENT	SULFUR PERCENT	MOISTURE PERCENT
	30M	3.06	8.05	0.69	4.63	3.06	8.05	0.69	4.63	100.00	7.67	0.63	5.14
30M	60M	56.07	7.58	0.58	5.17	59.13	7.60	0.59	5.14	96.94	7.66	0.62	5.16
60M	100M	24.99	7.30	0.59	5.34	84.12	7.51	0.59	5.20	40.87	7.78	0.68	5.14
100M	150M	10.80	7.51	0.66	4.92	94.92	7.51	0.60	5.17	15.88	8.53	0.81	4.83
150M	200M	0.14	7.61	0.69	3.45	95.06	7.51	0.60	5.17	5.08	10.71	1.14	4.65
200M		4.94	10.80	1.15	4.69	100.00	7.67	0.63	5.14	4.94	10.80	1.15	4.69

ANALYTICAL DATA

DATA FOR DRYFLO SEPARATION TEST #13

FIGURES FROM PSOC #85 (ANTHRACITE) FEED.

DATA FOR - PRODUCT COAL.

THIS FRACTION CONSTITUTES 86.9 PERCENT OF THE FEED.

SIZE FRACTION		-----DIRECT VALUES-----				-----CUMULATIVE RETAINED-----				-----CUMULATIVE PASSED-----			
PASSED	RETAINED	WEIGHT PERCENT	ASH PERCENT	SULFUR PERCENT	MOISTURE PERCENT	WEIGHT PERCENT	ASH PERCENT	SULFUR PERCENT	MOISTURE PERCENT	WEIGHT PERCENT	ASH PERCENT	SULFUR PERCENT	MOISTURE PERCENT
	30M	5.10	7.46	1.40	0.80	5.10	7.46	1.40	0.80	100.00	9.39	1.43	0.88
30M	60M	47.30	8.32	1.35	0.80	52.40	8.24	1.35	0.80	94.90	9.50	1.43	0.88
60M	100M	24.30	8.93	1.50	0.95	76.70	8.46	1.40	0.85	47.60	10.67	1.51	0.96
100M	150M	10.40	9.89	1.60	0.90	87.10	8.63	1.42	0.85	23.30	12.48	1.52	0.98
150M	200M	0.90	11.30	1.60	0.90	88.00	8.65	1.43	0.85	12.90	14.57	1.46	1.04
200M		12.00	14.81	1.45	1.05	100.00	9.39	1.43	0.88	12.00	14.81	1.45	1.05

DATA FOR - MIDDLING COAL.

THIS FRACTION CONSTITUTES 4.4 PERCENT OF THE FEED.

SIZE FRACTION		-----DIRECT VALUES-----				-----CUMULATIVE RETAINED-----				-----CUMULATIVE PASSED-----			
PASSED	RETAINED	WEIGHT PERCENT	ASH PERCENT	SULFUR PERCENT	MOISTURE PERCENT	WEIGHT PERCENT	ASH PERCENT	SULFUR PERCENT	MOISTURE PERCENT	WEIGHT PERCENT	ASH PERCENT	SULFUR PERCENT	MOISTURE PERCENT
	30M	14.40	11.58	1.20	0.70	14.40	11.58	1.20	0.70	100.00	15.38	1.34	0.74
30M	60M	68.60	16.78	1.30	0.80	83.00	15.88	1.28	0.78	85.60	16.01	1.36	0.74
60M	100M	13.60	16.16	1.45	0.65	96.60	15.92	1.31	0.76	17.00	12.93	1.59	0.52
100M	150M	1.70	0.00	2.20	0.00	98.30	15.64	1.32	0.75	3.40	0.00	2.17	0.00
150M	200M	0.00	0.00	0.00	0.00	98.30	15.64	1.32	0.75	1.70	0.00	2.15	0.00
200M		1.70	0.00	2.15	0.00	100.00	15.38	1.34	0.74	1.70	0.00	2.15	0.00

DATA FOR - REFUSE COAL.

THIS FRACTION CONSTITUTES 8.7 PERCENT OF THE FEED.

SIZE FRACTION		-----DIRECT VALUES-----				-----CUMULATIVE RETAINED-----				-----CUMULATIVE PASSED-----			
PASSED	RETAINED	WEIGHT PERCENT	ASH PERCENT	SULFUR PERCENT	MOISTURE PERCENT	WEIGHT PERCENT	ASH PERCENT	SULFUR PERCENT	MOISTURE PERCENT	WEIGHT PERCENT	ASH PERCENT	SULFUR PERCENT	MOISTURE PERCENT
	30M	16.20	19.38	1.10	0.65	16.20	19.38	1.10	0.65	100.00	20.77	1.21	0.64
30M	60M	74.40	21.14	1.10	0.65	90.60	20.83	1.10	0.65	83.80	21.03	1.23	0.64
60M	100M	8.10	23.44	1.90	0.60	98.70	21.04	1.17	0.65	9.40	20.20	2.22	0.52
100M	150M	0.90	0.00	4.30	0.00	99.60	20.85	1.19	0.64	1.30	0.00	4.24	0.00
150M	200M	0.00	0.00	0.00	0.00	99.60	20.85	1.19	0.64	0.40	0.00	4.10	0.00
200M		0.40	0.00	4.10	0.00	100.00	20.77	1.21	0.64	0.40	0.00	4.10	0.00

ANALYTICAL DATA

DATA FOR DRYFLO SEPARATION TEST #13

FIGURES FROM PSOC #85 (ANTHRACITE) FEED.

DATA FOR -

* * COMPOSITE * *

THIS FRACTION CONSTITUTES 100.0 PERCENT OF THE FEED.

SIZE FRACTION		-----DIRECT VALUES-----				-----CUMULATIVE RETAINED-----				-----CUMULATIVE PASSED-----			
PASSED	RETAINED	WEIGHT PERCENT	ASH PERCENT	SULFUR PERCENT	MOISTURE PERCENT	WEIGHT PERCENT	ASH PERCENT	SULFUR PERCENT	MOISTURE PERCENT	WEIGHT PERCENT	ASH PERCENT	SULFUR PERCENT	MOISTURE PERCENT
	30M	6.47	10.46	1.32	0.76	6.47	10.46	1.32	0.76	100.00	10.65	1.41	0.85
30M	60M	50.59	10.46	1.32	0.78	57.07	10.46	1.32	0.78	93.53	10.66	1.41	0.86
60M	100M	22.42	9.58	1.51	0.93	79.49	10.21	1.37	0.82	42.93	10.89	1.53	0.95
100M	150M	9.19	9.73	1.63	0.89	88.68	10.16	1.40	0.83	20.51	12.32	1.54	0.96
150M	200M	0.78	11.30	1.60	0.90	89.46	10.17	1.40	0.83	11.32	14.42	1.47	1.03
200M		10.54	14.66	1.46	1.04	100.00	10.65	1.41	0.85	10.54	14.66	1.46	1.04

ANALYTICAL DATA

DATA FOR DRYFLO SEPARATION TEST #14

FIGURES FROM PSOC #85 (ANTHRACITE) FEED.

DATA FOR - PRODUCT COAL.

THIS FRACTION CONSTITUTES 88.2 PERCENT OF THE FEED.

SIZE FRACTION		-----DIRECT VALUES-----				-----CUMULATIVE RETAINED-----				-----CUMULATIVE PASSED-----			
PASSED	RETAINED	WEIGHT PERCENT	ASH PERCENT	SULFUR PERCENT	MOISTURE PERCENT	WEIGHT PERCENT	ASH PERCENT	SULFUR PERCENT	MOISTURE PERCENT	WEIGHT PERCENT	ASH PERCENT	SULFUR PERCENT	MOISTURE PERCENT
	30M	4.90	6.94	1.40	0.60	4.90	6.94	1.40	0.60	100.00	9.79	1.44	0.64
30M	60M	47.00	8.75	1.30	0.60	51.90	8.58	1.31	0.60	95.10	9.93	1.44	0.65
60M	100M	24.90	9.57	1.60	0.70	76.80	8.90	1.40	0.63	48.10	11.09	1.58	0.69
100M	150M	10.40	10.11	1.45	0.60	87.20	9.04	1.41	0.63	23.20	12.73	1.56	0.68
150M	200M	1.00	11.23	1.70	0.70	88.20	9.07	1.41	0.63	12.80	14.85	1.65	0.75
200M		11.80	15.16	1.65	0.75	100.00	9.79	1.44	0.64	11.80	15.16	1.65	0.75

DATA FOR - MIDDLING COAL.

THIS FRACTION CONSTITUTES 3.9 PERCENT OF THE FEED.

SIZE FRACTION		-----DIRECT VALUES-----				-----CUMULATIVE RETAINED-----				-----CUMULATIVE PASSED-----			
PASSED	RETAINED	WEIGHT PERCENT	ASH PERCENT	SULFUR PERCENT	MOISTURE PERCENT	WEIGHT PERCENT	ASH PERCENT	SULFUR PERCENT	MOISTURE PERCENT	WEIGHT PERCENT	ASH PERCENT	SULFUR PERCENT	MOISTURE PERCENT
	30M	15.90	13.47	1.20	0.55	15.90	13.47	1.20	0.55	100.00	14.52	1.29	0.54
30M	60M	68.20	15.38	1.25	0.55	84.10	15.02	1.24	0.55	84.10	14.72	1.31	0.53
60M	100M	12.10	15.59	1.40	0.60	96.20	15.09	1.26	0.56	15.90	11.86	1.57	0.46
100M	150M	1.90	0.00	1.85	0.00	98.10	14.80	1.27	0.55	3.80	0.00	2.12	0.00
150M	200M	0.00	0.00	0.00	0.00	98.10	14.80	1.27	0.55	1.90	0.00	2.40	0.00
200M		1.90	0.00	2.40	0.00	100.00	14.52	1.29	0.54	1.90	0.00	2.40	0.00

DATA FOR - REFUSE COAL.

THIS FRACTION CONSTITUTES 7.9 PERCENT OF THE FEED.

SIZE FRACTION		-----DIRECT VALUES-----				-----CUMULATIVE RETAINED-----				-----CUMULATIVE PASSED-----			
PASSED	RETAINED	WEIGHT PERCENT	ASH PERCENT	SULFUR PERCENT	MOISTURE PERCENT	WEIGHT PERCENT	ASH PERCENT	SULFUR PERCENT	MOISTURE PERCENT	WEIGHT PERCENT	ASH PERCENT	SULFUR PERCENT	MOISTURE PERCENT
	30M	15.30	21.56	0.95	0.50	15.30	21.56	0.95	0.50	100.00	22.78	1.21	0.65
30M	60M	75.00	22.90	1.10	0.65	90.30	22.67	1.07	0.62	84.70	22.99	1.26	0.67
60M	100M	8.30	27.73	2.05	1.00	98.60	23.10	1.16	0.66	9.70	23.73	2.52	0.86
100M	150M	0.90	0.00	5.30	0.00	99.50	22.89	1.19	0.65	1.40	0.00	5.30	0.00
150M	200M	0.00	0.00	0.00	0.00	99.50	22.89	1.19	0.65	0.50	0.00	5.30	0.00
200M		0.50	0.00	5.30	0.00	100.00	22.78	1.21	0.65	0.50	0.00	5.30	0.00

ANALYTICAL DATA

DATA FOR DRYFLO SEPARATION TEST #14

FIGURES FROM PSOC #85 (ANTHRACITE) FEED.

DATA FOR -

* * COMPOSITE * *

THIS FRACTION CONSTITUTES 100.0 PERCENT OF THE FEED.

SIZE FRACTION		-----DIRECT VALUES-----				-----CUMULATIVE RETAINED-----				-----CUMULATIVE PASSED-----			
PASSED	RETAINED	WEIGHT PERCENT	ASH PERCENT	SULFUR PERCENT	MOISTURE PERCENT	WEIGHT PERCENT	ASH PERCENT	SULFUR PERCENT	MOISTURE PERCENT	WEIGHT PERCENT	ASH PERCENT	SULFUR PERCENT	MOISTURE PERCENT
	30M	6.15	10.47	1.29	0.58	6.15	10.47	1.29	0.58	100.00	11.00	1.42	0.64
30M	60M	50.04	10.78	1.27	0.60	56.19	10.74	1.28	0.60	93.85	11.03	1.43	0.64
60M	100M	23.09	10.21	1.61	0.71	79.28	10.59	1.37	0.63	43.81	11.32	1.60	0.69
100M	150M	9.32	9.95	1.48	0.59	88.60	10.52	1.38	0.63	20.72	12.57	1.59	0.67
150M	200M	0.88	11.23	1.70	0.70	89.48	10.53	1.39	0.63	11.40	14.71	1.67	0.74
200M		10.52	15.00	1.67	0.74	100.00	11.00	1.42	0.64	10.52	15.00	1.67	0.74

ANALYTICAL DATA

DATA FOR DRYFLO SEPARATION TEST # 15

FIGURES FROM PSOC 102 FEED SAMPLE.

DATA FOR - PRODUCT COAL.

THIS FRACTION CONSTITUTES 88.2 PERCENT OF THE FEED.

SIZE		-----DIRECT VALUES-----				-----CUMULATIVE RETAINED-----				-----CUMULATIVE PASSED-----			
FRACTION		WEIGHT	ASH	SULFUR	MOISTURE	WEIGHT	ASH	SULFUR	MOISTURE	WEIGHT	ASH	SULFUR	MOISTURE
PASSED	RETAINED	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT
	30M	3.50	5.71	1.03	1.05	3.50	5.71	1.03	1.05	100.00	5.61	1.31	1.06
30M	60M	50.52	4.69	1.11	0.85	54.02	4.76	1.10	0.86	96.50	5.61	1.32	1.07
60M	100M	23.96	5.63	1.29	1.35	77.98	5.02	1.16	1.01	45.98	6.62	1.55	1.30
100M	150M	10.36	7.70	1.84	1.25	88.34	5.34	1.24	1.04	22.02	7.70	1.84	1.25
150M	200M	5.31	7.70	1.84	1.25	93.65	5.47	1.28	1.05	11.66	7.70	1.84	1.25
200M		6.35	7.70	1.84	1.25	100.00	5.61	1.31	1.06	6.35	7.70	1.84	1.25

DATA FOR - MIDDLING COAL

THIS FRACTION CONSTITUTES 5.3 PERCENT OF THE FEED.

SIZE		-----DIRECT VALUES-----				-----CUMULATIVE RETAINED-----				-----CUMULATIVE PASSED-----			
FRACTION		WEIGHT	ASH	SULFUR	MOISTURE	WEIGHT	ASH	SULFUR	MOISTURE	WEIGHT	ASH	SULFUR	MOISTURE
PASSED	RETAINED	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT
	30M	40.38	8.91	1.02	0.70	40.38	8.91	1.02	0.70	100.00	8.25	1.43	0.84
30M	60M	43.76	6.75	1.26	0.80	84.14	7.79	1.14	0.75	59.62	7.81	1.71	0.94
60M	100M	12.98	9.83	2.17	1.30	97.12	8.06	1.28	0.83	15.86	10.72	2.96	1.32
100M	150M	1.44	14.71	6.52	1.40	98.56	8.16	1.36	0.83	2.88	14.71	6.52	1.40
150M	200M	0.48	14.71	6.52	1.40	99.04	8.19	1.38	0.84	1.44	14.71	6.52	1.40
200M		0.96	14.71	6.52	1.40	100.00	8.25	1.43	0.84	0.96	14.71	6.52	1.40

DATA FOR - REFUSE COAL.

THIS FRACTION CONSTITUTES 6.5 PERCENT OF THE FEED.

SIZE		-----DIRECT VALUES-----				-----CUMULATIVE RETAINED-----				-----CUMULATIVE PASSED-----			
FRACTION		WEIGHT	ASH	SULFUR	MOISTURE	WEIGHT	ASH	SULFUR	MOISTURE	WEIGHT	ASH	SULFUR	MOISTURE
PASSED	RETAINED	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT
	30M	18.97	22.93	1.17	1.00	18.97	22.93	1.17	1.00	100.00	14.08	1.58	1.33
30M	60M	74.69	11.56	1.57	1.40	93.66	13.86	1.49	1.32	81.03	12.01	1.68	1.41
60M	100M	5.14	16.48	3.63	1.40	98.80	14.00	1.60	1.32	6.34	17.34	2.94	1.49
100M	150M	0.40	21.04	0.00	1.85	99.20	14.03	1.59	1.33	1.20	21.04	0.00	1.85
150M	200M	0.40	21.04	0.00	1.85	99.60	14.06	1.59	1.33	0.80	21.04	0.00	1.85
200M		0.40	21.04	0.00	1.85	100.00	14.08	1.58	1.33	0.40	21.04	0.00	1.85

ANALYTICAL DATA

DATA FOR DRYFLO SEPARATION TEST # 15

FIGURES FROM PSOC 102 FEED SAMPLE.

DATA FOR -

* * COMPOSITE * *

THIS FRACTION CONSTITUTES 100.0 PERCENT OF THE FEED.

SIZE		-----DIRECT VALUES-----				-----CUMULATIVE RETAINED-----				-----CUMULATIVE PASSED-----			
FRACTION		WEIGHT	ASH	SULFUR	MOISTURE	WEIGHT	ASH	SULFUR	MOISTURE	WEIGHT	ASH	SULFUR	MOISTURE
PASSED	RETAINED	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT
	30M	6.46	10.06	1.05	0.92	6.46	10.06	1.05	0.92	100.00	6.30	1.34	1.07
30M	60M	51.73	5.43	1.16	0.90	58.19	5.94	1.15	0.90	93.54	6.04	1.35	1.08
60M	100M	22.15	5.92	1.35	1.35	80.35	5.94	1.20	1.03	41.81	6.81	1.60	1.30
100M	150M	9.24	7.80	1.87	1.25	89.59	6.13	1.27	1.05	19.65	7.81	1.87	1.25
150M	200M	4.73	7.81	1.86	1.25	94.32	6.21	1.30	1.06	10.41	7.82	1.87	1.25
200M		5.68	7.82	1.87	1.25	100.00	6.30	1.34	1.07	5.68	7.82	1.87	1.25

ANALYTICAL DATA

DATA FOR DRYFLO SEPARATION TEST # 16.

FIGURES FROM PSOC # 102 FEED SAMPLE.

DATA FOR - PRODUCT COAL.

THIS FRACTION CONSTITUTES 89.8 PERCENT OF THE FEED.

SIZE FRACTION		-----DIRECT VALUES-----				-----CUMULATIVE RETAINED-----				-----CUMULATIVE PASSED-----			
PASSED	RETAINED	WEIGHT PERCENT	ASH PERCENT	SULFUR PERCENT	MOISTURE PERCENT	WEIGHT PERCENT	ASH PERCENT	SULFUR PERCENT	MOISTURE PERCENT	WEIGHT PERCENT	ASH PERCENT	SULFUR PERCENT	MOISTURE PERCENT
	30M	5.36	6.27	0.99	1.15	5.36	6.27	0.99	1.15	100.00	5.51	1.31	1.32
30M	60M	55.36	4.86	1.13	1.30	60.72	4.98	1.12	1.29	94.64	5.47	1.33	1.33
60M	100M	21.68	5.38	1.35	1.40	82.40	5.09	1.18	1.32	39.28	6.33	1.61	1.38
100M	150M	9.18	7.50	1.93	1.35	91.58	5.33	1.25	1.32	17.60	7.50	1.93	1.35
150M	200M	4.21	7.50	1.93	1.35	95.79	5.43	1.28	1.32	8.42	7.50	1.93	1.35
200M		4.21	7.50	1.93	1.35	100.00	5.51	1.31	1.32	4.21	7.50	1.93	1.35

DATA FOR - MIDDLING COAL.

THIS FRACTION CONSTITUTES 4.9 PERCENT OF THE FEED.

SIZE FRACTION		-----DIRECT VALUES-----				-----CUMULATIVE RETAINED-----				-----CUMULATIVE PASSED-----			
PASSED	RETAINED	WEIGHT PERCENT	ASH PERCENT	SULFUR PERCENT	MOISTURE PERCENT	WEIGHT PERCENT	ASH PERCENT	SULFUR PERCENT	MOISTURE PERCENT	WEIGHT PERCENT	ASH PERCENT	SULFUR PERCENT	MOISTURE PERCENT
	30M	21.98	11.33	1.00	1.15	21.98	11.33	1.00	1.15	100.00	8.67	1.30	0.89
30M	60M	69.78	7.56	1.26	0.75	91.76	8.46	1.20	0.85	78.02	7.92	1.39	0.82
60M	100M	6.04	11.40	2.23	1.30	97.80	8.64	1.26	0.87	8.24	10.93	2.47	1.38
100M	150M	1.10	9.65	3.13	1.60	98.90	8.66	1.28	0.88	2.20	9.65	3.13	1.60
150M	200M	0.55	9.65	3.13	1.60	99.45	8.66	1.29	0.89	1.10	9.65	3.13	1.60
200M		0.55	9.65	3.13	1.60	100.00	8.67	1.30	0.89	0.55	9.65	3.13	1.60

DATA FOR - REFUSE COAL.

THIS FRACTION CONSTITUTES 5.3 PERCENT OF THE FEED.

SIZE FRACTION		-----DIRECT VALUES-----				-----CUMULATIVE RETAINED-----				-----CUMULATIVE PASSED-----			
PASSED	RETAINED	WEIGHT PERCENT	ASH PERCENT	SULFUR PERCENT	MOISTURE PERCENT	WEIGHT PERCENT	ASH PERCENT	SULFUR PERCENT	MOISTURE PERCENT	WEIGHT PERCENT	ASH PERCENT	SULFUR PERCENT	MOISTURE PERCENT
	30M	22.34	24.77	1.24	0.70	22.34	24.77	1.24	0.70	100.00	16.25	1.65	1.02
30M	60M	73.10	13.13	1.63	1.10	95.44	15.85	1.54	1.01	77.66	13.79	1.77	1.11
60M	100M	3.55	24.38	3.49	1.35	98.99	16.16	1.61	1.02	4.56	24.43	4.01	1.35
100M	150M	0.51	24.60	5.84	1.35	99.50	16.20	1.63	1.02	1.01	24.60	5.84	1.35
150M	200M	0.00	24.60	5.84	1.35	99.50	16.20	1.63	1.02	0.50	24.60	5.84	1.35
200M		0.50	24.60	5.84	1.35	100.00	16.25	1.65	1.02	0.50	24.60	5.84	1.35

ANALYTICAL DATA

DATA FOR DRYFLO SEPARATION TEST # 16.

FIGURES FROM PSOC # 102 FEED SAMPLE.

DATA FOR -

* * COMPOSITE * *

THIS FRACTION CONSTITUTES 100.0 PERCENT OF THE FEED.

SIZE FRACTION		-----DIRECT VALUES-----				-----CUMULATIVE RETAINED-----				-----CUMULATIVE PASSED-----			
PASSED	RETAINED	WEIGHT PERCENT	ASH PERCENT	SULFUR PERCENT	MOISTURE PERCENT	WEIGHT PERCENT	ASH PERCENT	SULFUR PERCENT	MOISTURE PERCENT	WEIGHT PERCENT	ASH PERCENT	SULFUR PERCENT	MOISTURE PERCENT
	30M	7.07	10.14	1.03	1.07	7.07	10.14	1.03	1.07	100.00	6.24	1.33	1.29
30M	60M	57.01	5.58	1.17	1.25	64.08	6.09	1.16	1.23	92.93	5.94	1.35	1.30
60M	100M	19.95	5.65	1.38	1.40	84.03	5.98	1.21	1.27	35.92	6.50	1.64	1.38
100M	150M	8.32	7.57	1.95	1.35	92.36	6.13	1.28	1.28	15.97	7.57	1.95	1.35
150M	200M	3.81	7.52	1.94	1.35	96.17	6.18	1.30	1.28	7.64	7.57	1.95	1.35
200M		3.83	7.63	1.97	1.35	100.00	6.24	1.33	1.29	3.83	7.63	1.97	1.35

ANALYTICAL DATA

DATA FOR DRYFLO SEPARATION TEST # 17

FIGURES FROM PSOC # 102 HAMMER MILL FEED

DATA FOR - PRODUCT COAL.

THIS FRACTION CONSTITUTES 69.1 PERCENT OF THE FEED.

SIZE		-----DIRECT VALUES-----				-----CUMULATIVE RETAINED-----				-----CUMULATIVE PASSED-----			
FRACTION		WEIGHT	ASH	SULFUR	MOISTURE	WEIGHT	ASH	SULFUR	MOISTURE	WEIGHT	ASH	SULFUR	MOISTURE
PASSED	RETAINED	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT
	30M	10.30	6.84	1.21	1.16	10.30	6.84	1.21	1.16	100.00	5.84	1.21	1.24
30M	60M	57.40	5.02	1.06	1.20	67.70	5.30	1.08	1.19	89.70	5.73	1.21	1.24
60M	100M	19.40	6.58	1.25	1.30	87.10	5.58	1.12	1.22	32.30	6.98	1.47	1.32
100M		12.90	7.59	1.80	1.36	100.00	5.84	1.21	1.24	12.90	7.59	1.80	1.36

DATA FOR - MIDDLING COAL.

THIS FRACTION CONSTITUTES 22.4 PERCENT OF THE FEED.

SIZE		-----DIRECT VALUES-----				-----CUMULATIVE RETAINED-----				-----CUMULATIVE PASSED-----			
FRACTION		WEIGHT	ASH	SULFUR	MOISTURE	WEIGHT	ASH	SULFUR	MOISTURE	WEIGHT	ASH	SULFUR	MOISTURE
PASSED	RETAINED	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT
	30M	28.10	11.31	0.96	1.10	28.10	11.31	0.96	1.10	100.00	9.19	1.19	1.14
30M	60M	64.30	8.01	1.17	1.16	92.40	9.01	1.11	1.14	71.90	8.36	1.28	1.16
60M	100M	6.40	11.11	1.90	1.24	98.80	9.15	1.16	1.15	7.60	11.33	2.22	1.15
100M		1.20	12.48	3.93	0.67	100.00	9.19	1.19	1.14	1.20	12.48	3.93	0.67

DATA FOR - REFUSE COAL.

THIS FRACTION CONSTITUTES 8.5 PERCENT OF THE FEED.

SIZE		-----DIRECT VALUES-----				-----CUMULATIVE RETAINED-----				-----CUMULATIVE PASSED-----			
FRACTION		WEIGHT	ASH	SULFUR	MOISTURE	WEIGHT	ASH	SULFUR	MOISTURE	WEIGHT	ASH	SULFUR	MOISTURE
PASSED	RETAINED	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT
	30M	28.50	24.15	1.08	1.04	28.50	24.15	1.08	1.04	100.00	17.53	1.41	1.13
30M	60M	66.50	14.96	1.43	1.16	95.00	17.72	1.32	1.12	71.50	14.89	1.55	1.16
60M	100M	4.20	16.56	3.67	1.38	99.20	17.67	1.42	1.13	5.00	13.91	3.08	1.16
100M		0.80	0.00	0.00	0.00	100.00	17.53	1.41	1.13	0.80	0.00	0.00	0.00

ANALYTICAL DATA

DATA FOR DRYFLO SEPARATION TEST # 17

FIGURES FROM PSOC # 102 HAMMER MILL FEED

DATA FOR -

* * COMPOSITE * *

THIS FRACTION CONSTITUTES 100.0 PERCENT OF THE FEED.

SIZE		-----DIRECT VALUES-----				-----CUMULATIVE RETAINED-----				-----CUMULATIVE PASSED-----			
FRACTION		WEIGHT	ASH	SULFUR	MOISTURE	WEIGHT	ASH	SULFUR	MOISTURE	WEIGHT	ASH	SULFUR	MOISTURE
PASSED	RETAINED	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT
	30M	15.83	11.27	1.09	1.12	15.83	11.27	1.09	1.12	100.00	7.58	1.22	1.21
30M	60M	59.72	6.68	1.12	1.19	75.55	7.64	1.12	1.17	84.17	6.89	1.25	1.22
60M	100M	15.20	7.24	1.37	1.30	90.75	7.58	1.16	1.19	24.45	7.41	1.55	1.31
100M		9.25	7.68	1.85	1.33	100.00	7.58	1.22	1.21	9.25	7.68	1.85	1.33

ANALYTICAL DATA

DATA FOR DRYFLO SEPARATION TEST # 18

FIGURES FROM PSOC # 102 ROLL MILL FEED.

DATA FOR - PRODUCT COAL.

THIS FRACTION CONSTITUTES 76.1 PERCENT OF THE FEED.

SIZE FRACTION		DIRECT VALUES				CUMULATIVE RETAINED				CUMULATIVE PASSED			
PASSED	RETAINED	WEIGHT PERCENT	ASH PERCENT	SULFUR PERCENT	MOISTURE PERCENT	WEIGHT PERCENT	ASH PERCENT	SULFUR PERCENT	MOISTURE PERCENT	WEIGHT PERCENT	ASH PERCENT	SULFUR PERCENT	MOISTURE PERCENT
	30M	2.70	5.09	0.95	0.82	2.70	5.09	0.95	0.82	100.00	5.81	1.06	1.39
30M	60M	41.00	5.02	0.96	1.40	43.70	5.02	0.96	1.36	97.30	5.83	1.07	1.40
60M	100M	26.00	6.08	1.03	1.38	69.70	5.42	0.99	1.37	56.30	6.42	1.14	1.40
100M		30.30	6.72	1.24	1.42	100.00	5.81	1.06	1.39	30.30	6.72	1.24	1.42

DATA FOR - MIDDLING COAL.

THIS FRACTION CONSTITUTES 14.9 PERCENT OF THE FEED.

SIZE FRACTION		DIRECT VALUES				CUMULATIVE RETAINED				CUMULATIVE PASSED			
PASSED	RETAINED	WEIGHT PERCENT	ASH PERCENT	SULFUR PERCENT	MOISTURE PERCENT	WEIGHT PERCENT	ASH PERCENT	SULFUR PERCENT	MOISTURE PERCENT	WEIGHT PERCENT	ASH PERCENT	SULFUR PERCENT	MOISTURE PERCENT
	30M	13.70	7.42	0.98	1.30	13.70	7.42	0.98	1.30	100.00	8.32	1.08	1.36
30M	60M	73.90	8.05	1.03	1.38	87.60	7.95	1.02	1.37	86.30	8.46	1.09	1.37
60M	100M	10.50	11.01	1.29	1.40	98.10	8.28	1.05	1.37	12.40	10.93	1.47	1.32
100M		1.90	10.52	2.49	0.85	100.00	8.32	1.08	1.36	1.90	10.52	2.49	0.85

DATA FOR - REFUSE COAL.

THIS FRACTION CONSTITUTES 9.0 PERCENT OF THE FEED.

SIZE FRACTION		DIRECT VALUES				CUMULATIVE RETAINED				CUMULATIVE PASSED			
PASSED	RETAINED	WEIGHT PERCENT	ASH PERCENT	SULFUR PERCENT	MOISTURE PERCENT	WEIGHT PERCENT	ASH PERCENT	SULFUR PERCENT	MOISTURE PERCENT	WEIGHT PERCENT	ASH PERCENT	SULFUR PERCENT	MOISTURE PERCENT
	30M	11.30	18.82	1.10	1.24	11.30	18.82	1.10	1.24	100.00	16.17	1.32	1.16
30M	60M	79.60	15.89	1.28	1.16	90.90	16.25	1.26	1.17	88.70	15.83	1.35	1.15
60M	100M	7.60	18.34	2.39	1.24	98.50	16.42	1.34	1.18	9.10	15.32	2.00	1.04
100M		1.50	0.00	0.00	0.00	100.00	16.17	1.32	1.16	1.50	0.00	0.00	0.00

ANALYTICAL DATA

DATA FOR DRYFLO SEPARATION TEST # 18

FIGURES FROM PSOC # 102 ROLL MILL FEED.

DATA FOR -

* * COMPOSITE * *

THIS FRACTION CONSTITUTES 100.0 PERCENT OF THE FEED.

SIZE FRACTION		DIRECT VALUES				CUMULATIVE RETAINED				CUMULATIVE PASSED			
PASSED	RETAINED	WEIGHT PERCENT	ASH PERCENT	SULFUR PERCENT	MOISTURE PERCENT	WEIGHT PERCENT	ASH PERCENT	SULFUR PERCENT	MOISTURE PERCENT	WEIGHT PERCENT	ASH PERCENT	SULFUR PERCENT	MOISTURE PERCENT
	30M	5.11	8.75	0.99	1.10	5.11	8.75	0.99	1.10	100.00	7.12	1.09	1.36
30M	60M	49.38	7.27	1.02	1.36	54.49	7.41	1.02	1.34	94.89	7.03	1.09	1.38
60M	100M	22.03	6.81	1.09	1.38	76.52	7.24	1.04	1.35	45.51	6.77	1.17	1.39
100M		23.48	6.73	1.25	1.40	100.00	7.12	1.09	1.36	23.48	6.73	1.25	1.40

ANALYTICAL DATA

DATA FOR DRYFLO SEPARATION TEST #19

FIGURES FROM PSOC 102 ROLL MILL FEED.

DATA FOR - PRODUCT COAL.

THIS FRACTION CONSTITUTES 89.2 PERCENT OF THE FEED.

SIZE FRACTION		-----DIRECT VALUES-----				-----CUMULATIVE RETAINED-----				-----CUMULATIVE PASSED-----			
PASSED	RETAINED	WEIGHT PERCENT	ASH PERCENT	SULFUR PERCENT	MOISTURE PERCENT	WEIGHT PERCENT	ASH PERCENT	SULFUR PERCENT	MOISTURE PERCENT	WEIGHT PERCENT	ASH PERCENT	SULFUR PERCENT	MOISTURE PERCENT
	30M	4.00	5.66	0.93	1.16	4.00	5.66	0.93	1.16	100.00	5.95	1.06	1.40
30M	60M	46.40	5.66	0.99	1.38	50.40	5.66	0.99	1.36	96.00	5.96	1.07	1.41
60M	100M	24.60	5.85	1.03	1.42	75.00	5.72	1.00	1.38	49.60	6.25	1.14	1.43
100M		25.00	6.64	1.24	1.44	100.00	5.95	1.06	1.40	25.00	6.64	1.24	1.44

DATA FOR - MIDDLING COAL.

THIS FRACTION CONSTITUTES 5.2 PERCENT OF THE FEED.

SIZE FRACTION		-----DIRECT VALUES-----				-----CUMULATIVE RETAINED-----				-----CUMULATIVE PASSED-----			
PASSED	RETAINED	WEIGHT PERCENT	ASH PERCENT	SULFUR PERCENT	MOISTURE PERCENT	WEIGHT PERCENT	ASH PERCENT	SULFUR PERCENT	MOISTURE PERCENT	WEIGHT PERCENT	ASH PERCENT	SULFUR PERCENT	MOISTURE PERCENT
	30M	15.90	9.93	1.00	1.26	15.90	9.93	1.00	1.26	100.00	9.97	1.12	1.30
30M	60M	72.30	9.97	1.07	1.34	88.20	9.96	1.06	1.33	84.10	9.97	1.14	1.31
60M	100M	9.20	10.58	1.47	1.26	97.40	10.02	1.10	1.32	11.80	9.99	1.55	1.11
100M		2.60	7.91	1.83	0.59	100.00	9.97	1.12	1.30	2.60	7.91	1.83	0.59

DATA FOR - REFUSE COAL.

THIS FRACTION CONSTITUTES 5.6 PERCENT OF THE FEED.

SIZE FRACTION		-----DIRECT VALUES-----				-----CUMULATIVE RETAINED-----				-----CUMULATIVE PASSED-----			
PASSED	RETAINED	WEIGHT PERCENT	ASH PERCENT	SULFUR PERCENT	MOISTURE PERCENT	WEIGHT PERCENT	ASH PERCENT	SULFUR PERCENT	MOISTURE PERCENT	WEIGHT PERCENT	ASH PERCENT	SULFUR PERCENT	MOISTURE PERCENT
	30M	12.60	21.43	1.15	1.26	12.60	21.43	1.15	1.26	100.00	15.98	1.36	1.20
30M	60M	78.00	15.34	1.33	1.20	90.60	16.19	1.30	1.21	87.40	15.20	1.39	1.19
60M	100M	7.50	17.59	2.39	1.34	98.10	16.29	1.39	1.22	9.40	14.03	1.91	1.07
100M		1.90	0.00	0.00	0.00	100.00	15.98	1.36	1.20	1.90	0.00	0.00	0.00

ANALYTICAL DATA

DATA FOR DRYFLO SEPARATION TEST #19

FIGURES FROM PSOC 102 ROLL MILL FEED.

DATA FOR -

* * COMPOSITE * *

THIS FRACTION CONSTITUTES 100.0 PERCENT OF THE FEED.

SIZE FRACTION		-----DIRECT VALUES-----				-----CUMULATIVE RETAINED-----				-----CUMULATIVE PASSED-----			
PASSED	RETAINED	WEIGHT PERCENT	ASH PERCENT	SULFUR PERCENT	MOISTURE PERCENT	WEIGHT PERCENT	ASH PERCENT	SULFUR PERCENT	MOISTURE PERCENT	WEIGHT PERCENT	ASH PERCENT	SULFUR PERCENT	MOISTURE PERCENT
	30M	5.10	8.53	0.97	1.19	5.10	8.53	0.97	1.19	100.00	6.72	1.08	1.38
30M	60M	49.52	6.84	1.03	1.36	54.62	7.00	1.02	1.35	94.90	6.62	1.09	1.39
60M	100M	22.84	6.16	1.06	1.42	77.46	6.75	1.03	1.37	45.38	6.39	1.15	1.42
100M		22.54	6.62	1.24	1.43	100.00	6.72	1.08	1.38	22.54	6.62	1.24	1.43

ANALYTICAL DATA

DATA FOR DRYFLO SEPARATION TEST # 20

FIGURES FROM PSOC 102 ROLL MILL FEED.

DATA FOR - PRODUCT COAL.

THIS FRACTION CONSTITUTES 91.0 PERCENT OF THE FEED.

SIZE FRACTION		-----DIRECT VALUES-----				-----CUMULATIVE RETAINED-----				-----CUMULATIVE PASSED-----			
PASSED	RETAINED	WEIGHT PERCENT	ASH PERCENT	SULFUR PERCENT	MOISTURE PERCENT	WEIGHT PERCENT	ASH PERCENT	SULFUR PERCENT	MOISTURE PERCENT	WEIGHT PERCENT	ASH PERCENT	SULFUR PERCENT	MOISTURE PERCENT
	30M	4.30	5.48	0.98	1.30	4.30	5.48	0.98	1.30	100.00	5.86	1.10	1.34
30M	60M	49.40	5.65	1.02	1.32	53.70	5.64	1.02	1.32	95.70	5.87	1.10	1.34
60M	100M	22.70	5.92	1.06	1.44	76.40	5.72	1.03	1.35	46.30	6.11	1.19	1.36
100M		23.60	6.29	1.31	1.28	100.00	5.86	1.10	1.34	23.60	6.29	1.31	1.28

DATA FOR - MIDDLING COAL.

THIS FRACTION CONSTITUTES 3.8 PERCENT OF THE FEED.

SIZE FRACTION		-----DIRECT VALUES-----				-----CUMULATIVE RETAINED-----				-----CUMULATIVE PASSED-----			
PASSED	RETAINED	WEIGHT PERCENT	ASH PERCENT	SULFUR PERCENT	MOISTURE PERCENT	WEIGHT PERCENT	ASH PERCENT	SULFUR PERCENT	MOISTURE PERCENT	WEIGHT PERCENT	ASH PERCENT	SULFUR PERCENT	MOISTURE PERCENT
	30M	16.80	9.96	1.03	1.34	16.80	9.96	1.03	1.34	100.00	9.08	1.18	1.34
30M	60M	72.10	8.72	1.14	1.36	88.90	8.95	1.12	1.36	83.20	8.90	1.21	1.34
60M	100M	8.10	11.19	1.70	1.36	97.00	9.14	1.17	1.36	11.10	10.08	1.70	1.22
100M		3.00	7.07	1.69	0.84	100.00	9.08	1.18	1.34	3.00	7.07	1.69	0.84

DATA FOR - REFUSE COAL.

THIS FRACTION CONSTITUTES 5.2 PERCENT OF THE FEED.

SIZE FRACTION		-----DIRECT VALUES-----				-----CUMULATIVE RETAINED-----				-----CUMULATIVE PASSED-----			
PASSED	RETAINED	WEIGHT PERCENT	ASH PERCENT	SULFUR PERCENT	MOISTURE PERCENT	WEIGHT PERCENT	ASH PERCENT	SULFUR PERCENT	MOISTURE PERCENT	WEIGHT PERCENT	ASH PERCENT	SULFUR PERCENT	MOISTURE PERCENT
	30M	15.80	18.21	1.13	1.36	15.80	18.21	1.13	1.36	100.00	16.46	1.46	1.37
30M	60M	77.20	16.48	1.46	1.40	93.00	16.77	1.40	1.39	84.20	16.13	1.52	1.38
60M	100M	5.50	15.59	2.75	1.40	98.50	16.71	1.48	1.39	7.00	12.25	2.16	1.10
100M		1.50	0.00	0.00	0.00	100.00	16.46	1.46	1.37	1.50	0.00	0.00	0.00

ANALYTICAL DATA

DATA FOR DRYFLO SEPARATION TEST # 20

FIGURES FROM PSOC 102 ROLL MILL FEED.

DATA FOR -

* * COMPOSITE * *

THIS FRACTION CONSTITUTES 100.0 PERCENT OF THE FEED.

SIZE FRACTION		-----DIRECT VALUES-----				-----CUMULATIVE RETAINED-----				-----CUMULATIVE PASSED-----			
PASSED	RETAINED	WEIGHT PERCENT	ASH PERCENT	SULFUR PERCENT	MOISTURE PERCENT	WEIGHT PERCENT	ASH PERCENT	SULFUR PERCENT	MOISTURE PERCENT	WEIGHT PERCENT	ASH PERCENT	SULFUR PERCENT	MOISTURE PERCENT
	30M	5.37	7.96	1.01	1.31	5.37	7.96	1.01	1.31	100.00	6.53	1.12	1.34
30M	60M	51.71	6.65	1.06	1.33	57.08	6.78	1.06	1.33	94.63	6.45	1.12	1.34
60M	100M	21.25	6.13	1.09	1.44	78.33	6.60	1.07	1.36	42.92	6.20	1.20	1.35
100M		21.67	6.27	1.31	1.27	100.00	6.53	1.12	1.34	21.67	6.27	1.31	1.27

ANALYTICAL DATA

DATA FOR DRYFLO SEPARATION TEST # 21

FIGURES FROM ELLIOT FEED -100 MESH.

DATA FOR - PRODUCT COAL.

THIS FRACTION CONSTITUTES 61.7 PERCENT OF THE FEED.

SIZE		-----DIRECT VALUES-----				-----CUMULATIVE RETAINED-----				-----CUMULATIVE PASSED-----			
FRACTION	RETAINED	WEIGHT	ASH	SULFUR	MOISTURE	WEIGHT	ASH	SULFUR	MOISTURE	WEIGHT	ASH	SULFUR	MOISTURE
PASSED	RETAINED	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT
	30M	0.30	0.00	0.00	0.00	0.30	0.00	0.00	0.00	100.00	11.70	4.80	0.92
30M	60M	1.20	6.88	1.65	0.33	1.50	5.50	1.32	0.26	99.70	11.74	4.81	0.92
60M	100M	38.70	10.39	3.82	0.94	40.20	10.21	3.73	0.91	98.50	11.80	4.85	0.93
100M	150M	17.90	11.03	4.59	0.80	58.10	10.46	3.99	0.88	59.80	12.70	5.52	0.93
150M		41.90	13.42	5.92	0.98	100.00	11.70	4.80	0.92	41.90	13.42	5.92	0.98

DATA FOR - REFUSE COAL.

THIS FRACTION CONSTITUTES 38.3 PERCENT OF THE FEED.

SIZE		-----DIRECT VALUES-----				-----CUMULATIVE RETAINED-----				-----CUMULATIVE PASSED-----			
FRACTION	RETAINED	WEIGHT	ASH	SULFUR	MOISTURE	WEIGHT	ASH	SULFUR	MOISTURE	WEIGHT	ASH	SULFUR	MOISTURE
PASSED	RETAINED	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT
	30M	40.10	17.79	5.44	0.78	40.10	17.79	5.44	0.78	100.00	16.67	6.69	0.83
30M	60M	16.60	11.26	3.34	0.76	56.70	15.88	4.83	0.77	59.90	15.92	7.52	0.86
60M	100M	3.90	15.32	5.54	0.96	60.60	15.84	4.87	0.79	43.30	17.71	9.13	0.90
100M	150M	19.30	18.33	9.45	0.80	79.90	16.44	5.98	0.79	39.40	17.95	9.48	0.89
150M		20.10	17.58	9.51	0.98	100.00	16.67	6.69	0.83	20.10	17.58	9.51	0.98

DATA FOR -

* * COMPOSITE * *

THIS FRACTION CONSTITUTES 100.0 PERCENT OF THE FEED.

SIZE		-----DIRECT VALUES-----				-----CUMULATIVE RETAINED-----				-----CUMULATIVE PASSED-----			
FRACTION	RETAINED	WEIGHT	ASH	SULFUR	MOISTURE	WEIGHT	ASH	SULFUR	MOISTURE	WEIGHT	ASH	SULFUR	MOISTURE
PASSED	RETAINED	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT
	30M	15.54	17.58	5.38	0.77	15.54	17.58	5.38	0.77	100.00	13.60	5.52	0.89
30M	60M	7.10	10.80	3.16	0.72	22.64	15.45	4.68	0.75	84.46	12.87	5.55	0.91
60M	100M	25.37	10.68	3.92	0.94	48.01	12.93	4.28	0.85	77.36	13.06	5.77	0.92
100M	150M	18.44	13.96	6.54	0.80	66.45	13.22	4.91	0.84	51.99	14.23	6.67	0.92
150M		33.55	14.37	6.74	0.98	100.00	13.60	5.52	0.89	33.55	14.37	6.74	0.98

ANALYTICAL DATA

DATA FOR DRYFLO SEPARATION TEST # 22

FIGURES FROM ELLIOT FEED - 100 MESH.

DATA FOR - PRODUCT COAL.

THIS FRACTION CONSTITUTES 30.6 PERCENT OF THE FEED.

SIZE		-----DIRECT VALUES-----				-----CUMULATIVE RETAINED-----				-----CUMULATIVE PASSED-----			
FRACTION		WEIGHT	ASH	SULFUR	MOISTURE	WEIGHT	ASH	SULFUR	MOISTURE	WEIGHT	ASH	SULFUR	MOISTURE
PASSED	RETAINED	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT
	30M	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	100.00	11.34	4.58	0.94
30M	60M	0.50	0.00	0.00	0.00	0.50	0.00	0.00	0.00	100.00	11.34	4.58	0.94
60M	100M	4.90	9.33	2.40	0.84	5.40	8.47	2.18	0.76	99.50	11.40	4.61	0.95
100M	150M	30.60	9.18	3.24	0.90	36.00	9.07	3.08	0.88	94.60	11.51	4.72	0.95
150M		64.00	12.62	5.43	0.98	100.00	11.34	4.58	0.94	64.00	12.62	5.43	0.98

DATA FOR - REFUSE COAL.

THIS FRACTION CONSTITUTES 69.4 PERCENT OF THE FEED.

SIZE		-----DIRECT VALUES-----				-----CUMULATIVE RETAINED-----				-----CUMULATIVE PASSED-----			
FRACTION		WEIGHT	ASH	SULFUR	MOISTURE	WEIGHT	ASH	SULFUR	MOISTURE	WEIGHT	ASH	SULFUR	MOISTURE
PASSED	RETAINED	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT
	30M	12.90	18.77	6.05	0.76	12.90	18.77	6.05	0.76	100.00	14.51	5.97	0.86
30M	60M	6.80	12.60	4.00	0.80	19.70	16.64	5.34	0.77	87.10	13.88	5.96	0.87
60M	100M	30.80	12.87	5.10	0.82	50.50	14.34	5.19	0.80	80.30	13.99	6.12	0.88
100M	150M	12.20	15.44	7.01	0.78	62.70	14.55	5.55	0.80	49.50	14.69	6.76	0.92
150M		37.30	14.44	6.68	0.96	100.00	14.51	5.97	0.86	37.30	14.44	6.68	0.96

DATA FOR -

* * COMPOSITE * *

THIS FRACTION CONSTITUTES 100.0 PERCENT OF THE FEED.

SIZE		-----DIRECT VALUES-----				-----CUMULATIVE RETAINED-----				-----CUMULATIVE PASSED-----			
FRACTION		WEIGHT	ASH	SULFUR	MOISTURE	WEIGHT	ASH	SULFUR	MOISTURE	WEIGHT	ASH	SULFUR	MOISTURE
PASSED	RETAINED	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT
	30M	8.95	18.77	6.05	0.76	8.95	18.77	6.05	0.76	100.00	13.54	5.55	0.88
30M	60M	4.87	12.20	3.87	0.77	13.82	16.46	5.28	0.77	91.05	13.03	5.50	0.90
60M	100M	22.87	12.64	4.92	0.82	36.70	14.08	5.06	0.80	86.18	13.07	5.59	0.90
100M	150M	17.83	12.15	5.03	0.84	54.53	13.45	5.05	0.81	63.30	13.23	5.83	0.93
150M		45.47	13.66	6.14	0.97	100.00	13.54	5.55	0.88	45.47	13.66	6.14	0.97

ANALYTICAL DATA

DATA FOR DRYFLO SEPARATION TEST # 23

FIGURES FROM PSOC 5 ROLL MILL FEED.

DATA FOR - PRODUCT COAL.

THIS FRACTION CONSTITUTES 48.5 PERCENT OF THE FEED.

SIZE FRACTION		DIRECT VALUES				CUMULATIVE RETAINED				CUMULATIVE PASSED			
PASSED	RETAINED	WEIGHT PERCENT	ASH PERCENT	SULFUR PERCENT	MOISTURE PERCENT	WEIGHT PERCENT	ASH PERCENT	SULFUR PERCENT	MOISTURE PERCENT	WEIGHT PERCENT	ASH PERCENT	SULFUR PERCENT	MOISTURE PERCENT
	30M	3.20	3.14	1.06	1.08	3.20	3.14	1.06	1.08	100.00	3.35	1.29	1.25
30M	60M	38.30	2.94	1.08	1.16	41.50	2.96	1.08	1.15	96.80	3.35	1.30	1.25
60M	100M	26.30	2.98	1.17	1.20	67.80	2.96	1.11	1.17	58.50	3.62	1.44	1.31
100M	150M	13.50	3.25	1.37	1.40	81.30	3.01	1.16	1.21	32.20	4.15	1.67	1.40
150M		18.70	4.80	1.88	1.40	100.00	3.35	1.29	1.25	18.70	4.80	1.88	1.40

DATA FOR - MIDDLING COAL.

THIS FRACTION CONSTITUTES 26.5 PERCENT OF THE FEED.

SIZE FRACTION		DIRECT VALUES				CUMULATIVE RETAINED				CUMULATIVE PASSED			
PASSED	RETAINED	WEIGHT PERCENT	ASH PERCENT	SULFUR PERCENT	MOISTURE PERCENT	WEIGHT PERCENT	ASH PERCENT	SULFUR PERCENT	MOISTURE PERCENT	WEIGHT PERCENT	ASH PERCENT	SULFUR PERCENT	MOISTURE PERCENT
	30M	20.40	3.32	1.13	1.18	20.40	3.32	1.13	1.18	100.00	3.47	1.31	1.17
30M	60M	64.30	3.51	1.31	1.16	84.70	3.46	1.27	1.16	79.60	3.51	1.35	1.16
60M	100M	12.50	4.30	1.88	1.44	97.20	3.57	1.35	1.20	15.30	3.51	1.54	1.18
100M	150M	1.60	0.00	0.00	0.00	98.80	3.51	1.32	1.18	2.80	0.00	0.00	0.00
150M		1.20	0.00	0.00	0.00	100.00	3.47	1.31	1.17	1.20	0.00	0.00	0.00

DATA FOR - REFUSE COAL.

THIS FRACTION CONSTITUTES 25.0 PERCENT OF THE FEED.

SIZE FRACTION		DIRECT VALUES				CUMULATIVE RETAINED				CUMULATIVE PASSED			
PASSED	RETAINED	WEIGHT PERCENT	ASH PERCENT	SULFUR PERCENT	MOISTURE PERCENT	WEIGHT PERCENT	ASH PERCENT	SULFUR PERCENT	MOISTURE PERCENT	WEIGHT PERCENT	ASH PERCENT	SULFUR PERCENT	MOISTURE PERCENT
	30M	21.30	5.12	1.85	1.04	21.30	5.12	1.85	1.04	100.00	5.66	2.48	1.06
30M	60M	68.80	5.82	2.49	1.04	90.10	5.65	2.34	1.04	78.70	5.81	2.65	1.06
60M	100M	8.70	6.51	4.29	1.40	98.80	5.73	2.51	1.07	9.90	5.72	3.77	1.23
100M	150M	0.40	0.00	0.00	0.00	99.20	5.71	2.50	1.07	1.20	0.00	0.00	0.00
150M		0.80	0.00	0.00	0.00	100.00	5.66	2.48	1.06	0.80	0.00	0.00	0.00

ANALYTICAL DATA

DATA FOR DRYFLO SEPARATION TEST # 23

FIGURES FROM PSOC 5 ROLL MILL FEED.

DATA FOR -

* * COMPOSITE * *

THIS FRACTION CONSTITUTES 100.0 PERCENT OF THE FEED.

SIZE FRACTION		DIRECT VALUES				CUMULATIVE RETAINED				CUMULATIVE PASSED			
PASSED	RETAINED	WEIGHT PERCENT	ASH PERCENT	SULFUR PERCENT	MOISTURE PERCENT	WEIGHT PERCENT	ASH PERCENT	SULFUR PERCENT	MOISTURE PERCENT	WEIGHT PERCENT	ASH PERCENT	SULFUR PERCENT	MOISTURE PERCENT
	30M	12.28	4.08	1.43	1.11	12.28	4.08	1.43	1.11	100.00	3.96	1.59	1.18
30M	60M	52.81	4.06	1.61	1.12	65.10	4.06	1.58	1.12	87.72	3.94	1.62	1.19
60M	100M	18.24	3.64	1.67	1.27	83.34	3.97	1.60	1.15	34.90	3.76	1.62	1.29
100M	150M	7.07	3.01	1.27	1.30	90.41	3.90	1.57	1.16	16.66	3.89	1.56	1.31
150M		9.59	4.54	1.78	1.32	100.00	3.96	1.59	1.18	9.59	4.54	1.78	1.32

ANALYTICAL DATA

DATA FOR DRYFLO SEPARATION TEST # 24

FIGURES FROM PSOC 5 ROLL MILL FEED.

DATA FOR - PRODUCT COAL.

THIS FRACTION CONSTITUTES 32.0 PERCENT OF THE FEED.

SIZE FRACTION		-----DIRECT VALUES-----				-----CUMULATIVE RETAINED-----				-----CUMULATIVE PASSED-----			
PASSED	RETAINED	WEIGHT PERCENT	ASH PERCENT	SULFUR PERCENT	MOISTURE PERCENT	WEIGHT PERCENT	ASH PERCENT	SULFUR PERCENT	MOISTURE PERCENT	WEIGHT PERCENT	ASH PERCENT	SULFUR PERCENT	MOISTURE PERCENT
	30M	0.80	2.78	1.11	0.90	0.80	2.78	1.11	0.90	100.00	3.30	1.26	1.16
30M	60M	31.50	2.81	1.03	1.00	32.30	2.81	1.03	1.00	99.20	3.30	1.26	1.17
60M	100M	30.40	2.86	1.15	1.24	62.70	2.83	1.09	1.12	67.70	3.53	1.37	1.24
100M	150M	15.30	3.30	1.29	1.22	78.00	2.93	1.13	1.14	37.30	4.08	1.55	1.24
150M		22.00	4.62	1.73	1.26	100.00	3.30	1.26	1.16	22.00	4.62	1.73	1.26

DATA FOR - MIDDLING COAL.

THIS FRACTION CONSTITUTES 45.8 PERCENT OF THE FEED.

SIZE FRACTION		-----DIRECT VALUES-----				-----CUMULATIVE RETAINED-----				-----CUMULATIVE PASSED-----			
PASSED	RETAINED	WEIGHT PERCENT	ASH PERCENT	SULFUR PERCENT	MOISTURE PERCENT	WEIGHT PERCENT	ASH PERCENT	SULFUR PERCENT	MOISTURE PERCENT	WEIGHT PERCENT	ASH PERCENT	SULFUR PERCENT	MOISTURE PERCENT
	30M	11.90	3.09	1.03	0.98	11.90	3.09	1.03	0.98	100.00	3.52	1.23	1.02
30M	60M	70.60	3.37	1.09	0.96	82.50	3.33	1.08	0.96	88.10	3.58	1.26	1.03
60M	100M	14.50	3.85	1.69	1.32	97.00	3.41	1.17	1.02	17.50	4.41	1.93	1.32
100M	150M	1.90	6.68	3.01	1.50	98.90	3.47	1.21	1.03	3.00	7.11	3.09	1.30
150M		1.10	7.84	3.23	0.95	100.00	3.52	1.23	1.02	1.10	7.84	3.23	0.95

DATA FOR - REFUSE COAL.

THIS FRACTION CONSTITUTES 22.2 PERCENT OF THE FEED.

SIZE FRACTION		-----DIRECT VALUES-----				-----CUMULATIVE RETAINED-----				-----CUMULATIVE PASSED-----			
PASSED	RETAINED	WEIGHT PERCENT	ASH PERCENT	SULFUR PERCENT	MOISTURE PERCENT	WEIGHT PERCENT	ASH PERCENT	SULFUR PERCENT	MOISTURE PERCENT	WEIGHT PERCENT	ASH PERCENT	SULFUR PERCENT	MOISTURE PERCENT
	30M	20.60	4.76	1.54	1.24	20.60	4.76	1.54	1.24	100.00	5.69	2.31	1.34
30M	60M	71.00	5.64	2.17	1.36	91.60	5.44	2.03	1.33	79.40	5.93	2.51	1.37
60M	100M	7.50	9.35	5.99	1.64	99.10	5.74	2.33	1.36	8.40	8.35	5.35	1.46
100M	150M	0.30	0.00	0.00	0.00	99.40	5.72	2.32	1.35	0.90	0.00	0.00	0.00
150M		0.60	0.00	0.00	0.00	100.00	5.69	2.31	1.34	0.60	0.00	0.00	0.00

ANALYTICAL DATA

DATA FOR DRYFLO SEPARATION TEST # 24

FIGURES FROM PSOC 5 ROLL MILL FEED.

DATA FOR -

* * COMPOSITE * *

THIS FRACTION CONSTITUTES 100.0 PERCENT OF THE FEED.

SIZE FRACTION		-----DIRECT VALUES-----				-----CUMULATIVE RETAINED-----				-----CUMULATIVE PASSED-----			
PASSED	RETAINED	WEIGHT PERCENT	ASH PERCENT	SULFUR PERCENT	MOISTURE PERCENT	WEIGHT PERCENT	ASH PERCENT	SULFUR PERCENT	MOISTURE PERCENT	WEIGHT PERCENT	ASH PERCENT	SULFUR PERCENT	MOISTURE PERCENT
	30M	10.28	3.83	1.26	1.09	10.28	3.83	1.26	1.09	100.00	3.93	1.48	1.14
30M	60M	58.18	3.89	1.37	1.08	68.46	3.88	1.36	1.08	89.72	3.94	1.50	1.15
60M	100M	18.03	3.82	1.80	1.31	86.49	3.87	1.45	1.13	31.54	4.04	1.75	1.27
100M	150M	5.83	3.77	1.53	1.25	92.32	3.86	1.45	1.13	13.51	4.33	1.68	1.23
150M		7.68	4.75	1.80	1.22	100.00	3.93	1.48	1.14	7.68	4.75	1.80	1.22

ANALYTICAL DATA

DATA FOR DRYFLO SEPARATION TEST # 25

FIGURES FROM PSOC 5 ROLL MILL FEED.

DATA FOR - PRODUCT COAL.

THIS FRACTION CONSTITUTES 67.4 PERCENT OF THE FEED.

SIZE FRACTION		DIRECT VALUES				CUMULATIVE RETAINED				CUMULATIVE PASSED			
PASSED	RETAINED	WEIGHT PERCENT	ASH PERCENT	SULFUR PERCENT	MOISTURE PERCENT	WEIGHT PERCENT	ASH PERCENT	SULFUR PERCENT	MOISTURE PERCENT	WEIGHT PERCENT	ASH PERCENT	SULFUR PERCENT	MOISTURE PERCENT
	30M	5.30	3.30	1.03	1.20	5.30	3.30	1.03	1.20	100.00	3.37	1.29	1.41
30M	60M	43.50	3.11	1.13	1.24	48.80	3.13	1.12	1.24	94.70	3.38	1.31	1.42
60M	100M	24.80	3.02	1.31	1.56	73.60	3.09	1.18	1.34	51.20	3.61	1.46	1.58
100M	150M	11.40	3.33	1.37	1.58	85.00	3.13	1.21	1.38	26.40	4.16	1.59	1.59
150M		15.00	4.79	1.76	1.60	100.00	3.37	1.29	1.41	15.00	4.79	1.76	1.60

DATA FOR - MIDDLING COAL.

THIS FRACTION CONSTITUTES 4.7 PERCENT OF THE FEED.

SIZE FRACTION		DIRECT VALUES				CUMULATIVE RETAINED				CUMULATIVE PASSED			
PASSED	RETAINED	WEIGHT PERCENT	ASH PERCENT	SULFUR PERCENT	MOISTURE PERCENT	WEIGHT PERCENT	ASH PERCENT	SULFUR PERCENT	MOISTURE PERCENT	WEIGHT PERCENT	ASH PERCENT	SULFUR PERCENT	MOISTURE PERCENT
	30M	12.50	3.84	1.31	0.56	12.50	3.84	1.31	0.56	100.00	3.77	1.36	1.06
30M	60M	62.50	4.20	1.53	1.40	75.00	4.14	1.49	1.26	87.50	3.76	1.37	1.13
60M	100M	15.00	4.46	1.62	0.77	90.00	4.19	1.51	1.18	25.00	2.68	0.97	0.46
100M	150M	5.00	0.00	0.00	0.00	95.00	3.97	1.43	1.12	10.00	0.00	0.00	0.00
150M		5.00	0.00	0.00	0.00	100.00	3.77	1.36	1.06	5.00	0.00	0.00	0.00

DATA FOR - REFUSE COAL.

THIS FRACTION CONSTITUTES 27.9 PERCENT OF THE FEED.

SIZE FRACTION		DIRECT VALUES				CUMULATIVE RETAINED				CUMULATIVE PASSED			
PASSED	RETAINED	WEIGHT PERCENT	ASH PERCENT	SULFUR PERCENT	MOISTURE PERCENT	WEIGHT PERCENT	ASH PERCENT	SULFUR PERCENT	MOISTURE PERCENT	WEIGHT PERCENT	ASH PERCENT	SULFUR PERCENT	MOISTURE PERCENT
	30M	15.20	5.24	1.76	1.42	15.20	5.24	1.76	1.42	100.00	5.80	2.13	1.41
30M	60M	69.20	5.95	2.24	1.44	84.40	5.82	2.15	1.44	84.80	5.90	2.19	1.41
60M	100M	11.80	6.16	2.06	1.52	96.20	5.86	2.14	1.45	15.60	5.66	1.99	1.26
100M	150M	2.10	7.44	3.22	0.82	98.30	5.90	2.17	1.43	3.80	4.11	1.78	0.45
150M		1.70	0.00	0.00	0.00	100.00	5.80	2.13	1.41	1.70	0.00	0.00	0.00

ANALYTICAL DATA

DATA FOR DRYFLO SEPARATION TEST # 25

FIGURES FROM PSOC 5 ROLL MILL FEED.

DATA FOR -

* * COMPOSITE * *

THIS FRACTION CONSTITUTES 100.0 PERCENT OF THE FEED.

SIZE FRACTION		DIRECT VALUES				CUMULATIVE RETAINED				CUMULATIVE PASSED			
PASSED	RETAINED	WEIGHT PERCENT	ASH PERCENT	SULFUR PERCENT	MOISTURE PERCENT	WEIGHT PERCENT	ASH PERCENT	SULFUR PERCENT	MOISTURE PERCENT	WEIGHT PERCENT	ASH PERCENT	SULFUR PERCENT	MOISTURE PERCENT
	30M	8.40	4.32	1.42	1.27	8.40	4.32	1.42	1.27	100.00	4.07	1.53	1.39
30M	60M	51.56	4.24	1.57	1.32	59.96	4.25	1.55	1.32	91.60	4.05	1.54	1.40
60M	100M	20.71	3.57	1.44	1.53	80.68	4.07	1.52	1.37	40.04	3.80	1.50	1.51
100M	150M	8.50	3.52	1.46	1.48	89.18	4.02	1.51	1.38	19.32	4.06	1.56	1.49
150M		10.82	4.48	1.64	1.50	100.00	4.07	1.53	1.39	10.82	4.48	1.64	1.50

ANALYTICAL DATA

DATA FOR DRYFLO SEPARATION TEST # 26

FIGURES FROM PSOC 5 ROLL MILL FEED.

DATA FOR - PRODUCT COAL.

THIS FRACTION CONSTITUTES 47.5 PERCENT OF THE FEED.

SIZE FRACTION		-----DIRECT VALUES-----				-----CUMULATIVE RETAINED-----				-----CUMULATIVE PASSED-----			
PASSED	RETAINED	WEIGHT PERCENT	ASH PERCENT	SULFUR PERCENT	MOISTURE PERCENT	WEIGHT PERCENT	ASH PERCENT	SULFUR PERCENT	MOISTURE PERCENT	WEIGHT PERCENT	ASH PERCENT	SULFUR PERCENT	MOISTURE PERCENT
	30M	3.50	2.91	1.09	1.36	3.50	2.91	1.09	1.36	100.00	3.50	1.28	1.48
30M	60M	44.70	3.06	1.09	1.40	48.20	3.05	1.09	1.40	96.50	3.52	1.28	1.48
60M	100M	26.70	3.44	1.20	1.60	74.90	3.19	1.13	1.47	51.80	3.91	1.45	1.56
100M	150M	10.80	3.69	1.50	1.40	85.70	3.25	1.18	1.46	25.10	4.42	1.71	1.51
150M		14.30	4.97	1.87	1.60	100.00	3.50	1.28	1.48	14.30	4.97	1.87	1.60

DATA FOR - MIDDLING COAL.

THIS FRACTION CONSTITUTES 28.0 PERCENT OF THE FEED.

SIZE FRACTION		-----DIRECT VALUES-----				-----CUMULATIVE RETAINED-----				-----CUMULATIVE PASSED-----			
PASSED	RETAINED	WEIGHT PERCENT	ASH PERCENT	SULFUR PERCENT	MOISTURE PERCENT	WEIGHT PERCENT	ASH PERCENT	SULFUR PERCENT	MOISTURE PERCENT	WEIGHT PERCENT	ASH PERCENT	SULFUR PERCENT	MOISTURE PERCENT
	30M	14.70	3.57	1.09	1.28	14.70	3.57	1.09	1.28	100.00	3.89	1.39	1.35
30M	60M	65.70	3.61	1.37	1.36	80.40	3.60	1.32	1.35	85.30	3.95	1.44	1.36
60M	100M	15.30	4.75	1.42	1.58	95.70	3.79	1.33	1.36	19.60	5.09	1.66	1.37
100M	150M	2.30	5.77	2.82	0.49	98.00	3.83	1.37	1.36	4.30	6.30	2.52	0.61
150M		2.00	6.92	2.18	0.74	100.00	3.89	1.39	1.35	2.00	6.92	2.18	0.74

DATA FOR - REFUSE COAL.

THIS FRACTION CONSTITUTES 24.5 PERCENT OF THE FEED.

SIZE FRACTION		-----DIRECT VALUES-----				-----CUMULATIVE RETAINED-----				-----CUMULATIVE PASSED-----			
PASSED	RETAINED	WEIGHT PERCENT	ASH PERCENT	SULFUR PERCENT	MOISTURE PERCENT	WEIGHT PERCENT	ASH PERCENT	SULFUR PERCENT	MOISTURE PERCENT	WEIGHT PERCENT	ASH PERCENT	SULFUR PERCENT	MOISTURE PERCENT
	30M	15.20	5.05	1.65	1.32	15.20	5.05	1.65	1.32	100.00	5.16	2.08	1.36
30M	60M	71.50	4.86	2.14	1.38	86.70	4.89	2.05	1.37	84.80	5.18	2.16	1.37
60M	100M	11.40	8.04	2.65	1.50	98.10	5.26	2.12	1.38	13.30	6.89	2.27	1.29
100M	150M	1.10	0.00	0.00	0.00	99.20	5.20	2.10	1.37	1.90	0.00	0.00	0.00
150M		0.80	0.00	0.00	0.00	100.00	5.16	2.08	1.36	0.80	0.00	0.00	0.00

ANALYTICAL DATA

DATA FOR DRYFLO SEPARATION TEST # 26

FIGURES FROM PSOC 5 ROLL MILL FEED.

DATA FOR -

* * COMPOSITE * *

THIS FRACTION CONSTITUTES 100.0 PERCENT OF THE FEED.

SIZE FRACTION		-----DIRECT VALUES-----				-----CUMULATIVE RETAINED-----				-----CUMULATIVE PASSED-----			
PASSED	RETAINED	WEIGHT PERCENT	ASH PERCENT	SULFUR PERCENT	MOISTURE PERCENT	WEIGHT PERCENT	ASH PERCENT	SULFUR PERCENT	MOISTURE PERCENT	WEIGHT PERCENT	ASH PERCENT	SULFUR PERCENT	MOISTURE PERCENT
	30M	9.50	4.03	1.31	1.31	9.50	4.03	1.31	1.31	100.00	4.02	1.50	1.41
30M	60M	57.15	3.79	1.50	1.38	66.65	3.82	1.47	1.37	90.50	4.01	1.52	1.42
60M	100M	19.76	4.37	1.45	1.58	86.41	3.95	1.47	1.42	33.35	4.40	1.56	1.50
100M	150M	6.04	3.75	1.57	1.24	92.45	3.94	1.48	1.41	13.59	4.43	1.72	1.38
150M		7.55	4.99	1.84	1.49	100.00	4.02	1.50	1.41	7.55	4.99	1.84	1.49

ANALYTICAL DATA

DATA FOR DRYFLO SEPARATION TEST # 27

FIGURES FROM PSOC 5 ROLL MILL FEED.

DATA FOR - PRODUCT COAL.

THIS FRACTION CONSTITUTES 53.9 PERCENT OF THE FEED.

SIZE		-----DIRECT VALUES-----				-----CUMULATIVE RETAINED-----				-----CUMULATIVE PASSED-----			
FRACTION		WEIGHT	ASH	SULFUR	MOISTURE	WEIGHT	ASH	SULFUR	MOISTURE	WEIGHT	ASH	SULFUR	MOISTURE
PASSED	RETAINED	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT
	30M	4.00	2.86	1.03	1.24	4.00	2.86	1.03	1.24	100.00	3.26	1.18	1.56
30M	60M	46.80	2.92	1.04	1.38	50.80	2.92	1.04	1.37	96.00	3.28	1.18	1.57
60M	100M	26.40	3.13	1.02	1.78	77.20	2.99	1.03	1.51	49.20	3.62	1.32	1.75
100M	150M	10.80	3.44	1.33	1.64	88.00	3.04	1.07	1.53	22.80	4.19	1.66	1.72
150M		12.00	4.87	1.96	1.80	100.00	3.26	1.18	1.56	12.00	4.87	1.96	1.80

DATA FOR - MIDDLING COAL.

THIS FRACTION CONSTITUTES 18.4 PERCENT OF THE FEED.

SIZE		-----DIRECT VALUES-----				-----CUMULATIVE RETAINED-----				-----CUMULATIVE PASSED-----			
FRACTION		WEIGHT	ASH	SULFUR	MOISTURE	WEIGHT	ASH	SULFUR	MOISTURE	WEIGHT	ASH	SULFUR	MOISTURE
PASSED	RETAINED	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT
	30M	15.80	3.44	1.10	1.40	15.80	3.44	1.10	1.40	100.00	3.54	1.23	1.35
30M	60M	67.90	3.58	1.24	1.42	83.70	3.55	1.21	1.42	84.20	3.56	1.25	1.34
60M	100M	11.70	4.85	1.83	1.40	95.40	3.71	1.29	1.41	16.30	3.48	1.31	1.00
100M	150M	2.30	0.00	0.00	0.00	97.70	3.63	1.26	1.38	4.60	0.00	0.00	0.00
150M		2.30	0.00	0.00	0.00	100.00	3.54	1.23	1.35	2.30	0.00	0.00	0.00

DATA FOR - REFUSE COAL.

THIS FRACTION CONSTITUTES 27.7 PERCENT OF THE FEED.

SIZE		-----DIRECT VALUES-----				-----CUMULATIVE RETAINED-----				-----CUMULATIVE PASSED-----			
FRACTION		WEIGHT	ASH	SULFUR	MOISTURE	WEIGHT	ASH	SULFUR	MOISTURE	WEIGHT	ASH	SULFUR	MOISTURE
PASSED	RETAINED	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT
	30M	19.50	4.38	1.29	1.52	19.50	4.38	1.29	1.52	100.00	5.35	2.03	1.54
30M	60M	71.60	5.70	2.10	1.56	91.10	5.42	1.93	1.55	80.50	5.59	2.21	1.54
60M	100M	7.00	5.95	3.97	1.80	98.10	5.46	2.07	1.57	8.90	4.68	3.12	1.42
100M	150M	1.20	0.00	0.00	0.00	99.30	5.39	2.05	1.55	1.90	0.00	0.00	0.00
150M		0.70	0.00	0.00	0.00	100.00	5.35	2.03	1.54	0.70	0.00	0.00	0.00

ANALYTICAL DATA

DATA FOR DRYFLO SEPARATION TEST # 27

FIGURES FROM PSOC 5 ROLL MILL FEED.

DATA FOR -- * * COMPOSITE * *

THIS FRACTION CONSTITUTES 100.0 PERCENT OF THE FEED.

SIZE		-----DIRECT VALUES-----				-----CUMULATIVE RETAINED-----				-----CUMULATIVE PASSED-----			
FRACTION		WEIGHT	ASH	SULFUR	MOISTURE	WEIGHT	ASH	SULFUR	MOISTURE	WEIGHT	ASH	SULFUR	MOISTURE
PASSED	RETAINED	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT
	30M	10.46	3.81	1.18	1.43	10.46	3.81	1.18	1.43	100.00	3.89	1.42	1.51
30M	60M	57.55	4.02	1.45	1.45	68.02	3.99	1.41	1.45	89.54	3.90	1.45	1.52
60M	100M	18.32	3.63	1.43	1.74	86.34	3.91	1.41	1.51	31.98	3.69	1.46	1.66
100M	150M	6.58	3.04	1.18	1.45	92.91	3.85	1.40	1.50	13.66	3.77	1.49	1.55
150M		7.09	4.45	1.79	1.64	100.00	3.89	1.42	1.51	7.09	4.45	1.79	1.64

ANALYTICAL DATA

DATA FOR DRYFLO SEPARATION TEST # 28.

FIGURES FROM PSOC # 105 FEED SAMPLE.

DATA FOR - PRODUCT COAL.

THIS FRACTION CONSTITUTES 56.4 PERCENT OF THE FEED.

SIZE FRACTION		DIRECT VALUES				CUMULATIVE RETAINED				CUMULATIVE PASSED			
PASSED	RETAINED	WEIGHT PERCENT	ASH PERCENT	SULFUR PERCENT	MOISTURE PERCENT	WEIGHT PERCENT	ASH PERCENT	SULFUR PERCENT	MOISTURE PERCENT	WEIGHT PERCENT	ASH PERCENT	SULFUR PERCENT	MOISTURE PERCENT
	30M	21.90	7.77	1.66	6.00	21.90	7.77	1.66	6.00	100.00	8.34	1.97	5.62
30M	60M	34.40	8.03	1.77	6.00	56.30	7.93	1.73	6.00	78.10	8.50	2.06	5.51
60M	100M	17.70	8.19	1.91	6.00	74.00	7.99	1.77	6.00	43.70	8.88	2.29	5.13
100M	150M	9.00	8.80	2.05	5.65	83.00	8.08	1.80	5.96	26.00	9.34	2.55	4.54
150M		17.00	9.63	2.82	3.95	100.00	8.34	1.97	5.62	17.00	9.63	2.82	3.95

DATA FOR - RECYCLE TO TEST # 54.

THIS FRACTION CONSTITUTES 43.6 PERCENT OF THE FEED.

SIZE FRACTION		DIRECT VALUES				CUMULATIVE RETAINED				CUMULATIVE PASSED			
PASSED	RETAINED	WEIGHT PERCENT	ASH PERCENT	SULFUR PERCENT	MOISTURE PERCENT	WEIGHT PERCENT	ASH PERCENT	SULFUR PERCENT	MOISTURE PERCENT	WEIGHT PERCENT	ASH PERCENT	SULFUR PERCENT	MOISTURE PERCENT
	30M	57.40	9.74	2.00	5.50	57.40	9.74	2.00	5.50	100.00	9.71	2.10	5.65
30M	60M	38.40	9.20	2.08	5.95	95.80	9.52	2.03	5.68	42.60	9.67	2.23	5.86
60M	100M	3.60	12.49	3.33	5.50	99.40	9.63	2.08	5.67	4.20	13.96	3.56	5.02
100M	150M	0.30	24.15	4.53	2.55	99.70	9.67	2.09	5.66	0.60	22.77	4.94	2.12
150M		0.30	21.40	5.36	1.70	100.00	9.71	2.10	5.65	0.30	21.40	5.36	1.70

DATA FOR -

* * COMPOSITE * *

THIS FRACTION CONSTITUTES 100.0 PERCENT OF THE FEED.

SIZE FRACTION		DIRECT VALUES				CUMULATIVE RETAINED				CUMULATIVE PASSED			
PASSED	RETAINED	WEIGHT PERCENT	ASH PERCENT	SULFUR PERCENT	MOISTURE PERCENT	WEIGHT PERCENT	ASH PERCENT	SULFUR PERCENT	MOISTURE PERCENT	WEIGHT PERCENT	ASH PERCENT	SULFUR PERCENT	MOISTURE PERCENT
	30M	37.38	9.09	1.89	5.67	37.38	9.09	1.89	5.67	100.00	8.94	2.03	5.63
30M	60M	36.14	8.57	1.91	5.98	73.52	8.83	1.90	5.82	62.62	8.85	2.11	5.62
60M	100M	11.55	8.77	2.10	5.93	85.07	8.83	1.93	5.83	26.48	9.23	2.38	5.12
100M	150M	5.21	9.19	2.11	5.57	90.28	8.85	1.94	5.82	14.93	9.58	2.60	4.50
150M		9.72	9.79	2.65	3.92	100.00	8.94	2.03	5.63	9.72	9.79	2.85	3.92

ANALYTICAL DATA

DATA FOR DRYFLO SEPARATION TEST # 29.

FIGURES FROM PSOC # 105 FEED SAMPLE.

DATA FOR - PRODUCT COAL.

THIS FRACTION CONSTITUTES 85.8 PERCENT OF THE FEED.

SIZE FRACTION		DIRECT VALUES				CUMULATIVE RETAINED				CUMULATIVE PASSED			
PASSED	RETAINED	WEIGHT PERCENT	ASH PERCENT	SULFUR PERCENT	MOISTURE PERCENT	WEIGHT PERCENT	ASH PERCENT	SULFUR PERCENT	MOISTURE PERCENT	WEIGHT PERCENT	ASH PERCENT	SULFUR PERCENT	MOISTURE PERCENT
	1/4"	0.20	7.55	0.87	2.60	0.20	7.55	0.87	2.60	100.00	9.70	1.62	3.10
1/4"	8M	31.50	8.51	1.70	3.05	31.70	8.50	1.69	3.05	99.80	9.70	1.62	3.10
8M	16M	46.20	10.25	1.60	3.40	77.90	9.54	1.64	3.26	68.30	10.25	1.59	3.12
16M		22.10	10.26	1.56	2.55	100.00	9.70	1.62	3.10	22.10	10.26	1.56	2.55

DATA FOR - MIDDLING COAL.

THIS FRACTION CONSTITUTES 5.6 PERCENT OF THE FEED.

SIZE FRACTION		DIRECT VALUES				CUMULATIVE RETAINED				CUMULATIVE PASSED			
PASSED	RETAINED	WEIGHT PERCENT	ASH PERCENT	SULFUR PERCENT	MOISTURE PERCENT	WEIGHT PERCENT	ASH PERCENT	SULFUR PERCENT	MOISTURE PERCENT	WEIGHT PERCENT	ASH PERCENT	SULFUR PERCENT	MOISTURE PERCENT
	1/4"	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	100.00	13.33	2.58	1.88
1/4"	8M	22.70	16.41	4.39	1.25	22.70	16.41	4.39	1.25	100.00	13.33	2.58	1.88
8M	16M	51.50	12.64	2.12	2.10	74.20	13.79	2.81	1.84	77.30	12.42	2.05	2.07
16M		25.80	11.99	1.90	2.00	100.00	13.33	2.58	1.88	25.80	11.99	1.90	2.00

DATA FOR - REFUSE COAL.

THIS FRACTION CONSTITUTES 8.6 PERCENT OF THE FEED.

SIZE FRACTION		DIRECT VALUES				CUMULATIVE RETAINED				CUMULATIVE PASSED			
PASSED	RETAINED	WEIGHT PERCENT	ASH PERCENT	SULFUR PERCENT	MOISTURE PERCENT	WEIGHT PERCENT	ASH PERCENT	SULFUR PERCENT	MOISTURE PERCENT	WEIGHT PERCENT	ASH PERCENT	SULFUR PERCENT	MOISTURE PERCENT
	1/4"	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	100.00	13.50	2.10	2.19
1/4"	8M	20.80	11.62	1.90	2.35	20.80	11.62	1.90	2.35	100.00	13.50	2.10	2.19
8M	16M	54.40	14.20	2.08	2.10	75.20	13.49	2.03	2.17	79.20	14.00	2.15	2.15
16M		24.80	13.55	2.31	2.25	100.00	13.50	2.10	2.19	24.80	13.55	2.31	2.25

ANALYTICAL DATA

DATA FOR DRYFLO SEPARATION TEST # 29.

FIGURES FROM PSOC # 105 FEED SAMPLE.

DATA FOR -

* * COMPOSITE * *

THIS FRACTION CONSTITUTES 100.0 PERCENT OF THE FEED.

SIZE FRACTION		DIRECT VALUES				CUMULATIVE RETAINED				CUMULATIVE PASSED			
PASSED	RETAINED	WEIGHT PERCENT	ASH PERCENT	SULFUR PERCENT	MOISTURE PERCENT	WEIGHT PERCENT	ASH PERCENT	SULFUR PERCENT	MOISTURE PERCENT	WEIGHT PERCENT	ASH PERCENT	SULFUR PERCENT	MOISTURE PERCENT
	1/4"	0.17	7.55	0.87	2.60	0.17	7.55	0.87	2.60	100.00	10.23	1.72	2.95
1/4"	8M	30.09	9.03	1.83	2.93	30.26	9.02	1.82	2.93	99.83	10.23	1.72	2.95
8M	16M	47.20	10.79	1.68	3.19	77.46	10.10	1.73	3.09	69.74	10.75	1.67	2.96
16M		22.54	10.68	1.65	2.49	100.00	10.23	1.72	2.95	22.54	10.68	1.65	2.49

ANALYTICAL DATA

DATA FOR DRYFLO SEPARATION TEST # 30.

FIGURES FROM PSOC # 105 FEED SAMPLE.

DATA FOR - PRODUCT COAL.

THIS FRACTION CONSTITUTES 66.9 PERCENT OF THE FEED.

SIZE FRACTION		-----DIRECT VALUES-----				-----CUMULATIVE RETAINED-----				-----CUMULATIVE PASSED-----			
PASSED	RETAINED	WEIGHT PERCENT	ASH PERCENT	SULFUR PERCENT	MOISTURE PERCENT	WEIGHT PERCENT	ASH PERCENT	SULFUR PERCENT	MOISTURE PERCENT	WEIGHT PERCENT	ASH PERCENT	SULFUR PERCENT	MOISTURE PERCENT
	8M	26.40	8.48	1.55	2.98	26.40	8.48	1.55	2.98	100.00	9.53	1.58	2.71
8M	16M	48.60	9.77	1.59	2.96	75.00	9.32	1.58	2.97	73.60	9.90	1.59	2.61
16M		25.00	10.16	1.59	1.92	100.00	9.53	1.58	2.71	25.00	10.16	1.59	1.92

DATA FOR - MIDDLING COAL.

THIS FRACTION CONSTITUTES 22.0 PERCENT OF THE FEED.

SIZE FRACTION		-----DIRECT VALUES-----				-----CUMULATIVE RETAINED-----				-----CUMULATIVE PASSED-----			
PASSED	RETAINED	WEIGHT PERCENT	ASH PERCENT	SULFUR PERCENT	MOISTURE PERCENT	WEIGHT PERCENT	ASH PERCENT	SULFUR PERCENT	MOISTURE PERCENT	WEIGHT PERCENT	ASH PERCENT	SULFUR PERCENT	MOISTURE PERCENT
	8M	33.00	13.17	3.22	3.00	33.00	13.17	3.22	3.00	100.00	12.28	2.21	2.82
8M	16M	46.60	11.96	1.68	2.80	79.60	12.46	2.32	2.88	67.00	11.84	1.72	2.73
16M		20.40	11.56	1.81	2.58	100.00	12.28	2.21	2.82	20.40	11.56	1.81	2.58

DATA FOR - REFUSE COAL.

THIS FRACTION CONSTITUTES 11.1 PERCENT OF THE FEED.

SIZE FRACTION		-----DIRECT VALUES-----				-----CUMULATIVE RETAINED-----				-----CUMULATIVE PASSED-----			
PASSED	RETAINED	WEIGHT PERCENT	ASH PERCENT	SULFUR PERCENT	MOISTURE PERCENT	WEIGHT PERCENT	ASH PERCENT	SULFUR PERCENT	MOISTURE PERCENT	WEIGHT PERCENT	ASH PERCENT	SULFUR PERCENT	MOISTURE PERCENT
	8M	23.80	14.72	2.89	3.00	23.80	14.72	2.89	3.00	100.00	14.43	2.86	2.79
8M	16M	53.60	14.08	2.76	2.78	77.40	14.28	2.80	2.85	76.20	14.34	2.85	2.73
16M		22.60	14.96	3.08	2.60	100.00	14.43	2.86	2.79	22.60	14.96	3.08	2.60

ANALYTICAL DATA

DATA FOR DRYFLO SEPARATION TEST # 30.

FIGURES FROM PSOC # 105 FEED SAMPLE.

DATA FOR -

* * COMPOSITE * *

THIS FRACTION CONSTITUTES 100.0 PERCENT OF THE FEED.

SIZE FRACTION		-----DIRECT VALUES-----				-----CUMULATIVE RETAINED-----				-----CUMULATIVE PASSED-----			
PASSED	RETAINED	WEIGHT PERCENT	ASH PERCENT	SULFUR PERCENT	MOISTURE PERCENT	WEIGHT PERCENT	ASH PERCENT	SULFUR PERCENT	MOISTURE PERCENT	WEIGHT PERCENT	ASH PERCENT	SULFUR PERCENT	MOISTURE PERCENT
	8M	27.56	10.31	2.12	2.99	27.56	10.31	2.12	2.99	100.00	10.68	1.86	2.74
8M	16M	48.71	10.76	1.75	2.90	76.28	10.60	1.88	2.93	72.44	10.81	1.76	2.65
16M		23.72	10.93	1.79	2.12	100.00	10.68	1.86	2.74	23.72	10.93	1.79	2.12

ANALYTICAL DATA

DATA FOR DRYFLO SEPARATION TEST # 31.

FIGURES FROM PSOC # 105 FEED SAMPLE.

DATA FOR - PRODUCT COAL.

THIS FRACTION CONSTITUTES 71.3 PERCENT OF THE FEED.

SIZE		DIRECT VALUES				CUMULATIVE RETAINED				CUMULATIVE PASSED			
FRACTION		WEIGHT	ASH	SULFUR	MOISTURE	WEIGHT	ASH	SULFUR	MOISTURE	WEIGHT	ASH	SULFUR	MOISTURE
PASSED	RETAINED	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT
	8M	28.10	8.83	1.51	3.10	28.10	8.83	1.51	3.10	100.00	9.30	1.57	2.97
8M	16M	48.00	9.32	1.61	2.96	76.10	9.14	1.57	3.01	71.90	9.49	1.60	2.92
16M		23.90	9.82	1.58	2.84	100.00	9.30	1.57	2.97	23.90	9.82	1.58	2.84

DATA FOR - MIDDLING COAL.

THIS FRACTION CONSTITUTES 18.7 PERCENT OF THE FEED.

SIZE		DIRECT VALUES				CUMULATIVE RETAINED				CUMULATIVE PASSED			
FRACTION		WEIGHT	ASH	SULFUR	MOISTURE	WEIGHT	ASH	SULFUR	MOISTURE	WEIGHT	ASH	SULFUR	MOISTURE
PASSED	RETAINED	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT
	8M	36.70	10.30	1.66	3.00	36.70	10.30	1.66	3.00	100.00	11.13	1.72	2.86
8M	16M	44.60	11.74	1.73	2.78	81.30	11.09	1.70	2.88	63.30	11.62	1.75	2.79
16M		18.70	11.32	1.79	2.80	100.00	11.13	1.72	2.86	18.70	11.32	1.79	2.80

DATA FOR - REPUSE COAL.

THIS FRACTION CONSTITUTES 10.0 PERCENT OF THE FEED.

SIZE		DIRECT VALUES				CUMULATIVE RETAINED				CUMULATIVE PASSED			
FRACTION		WEIGHT	ASH	SULFUR	MOISTURE	WEIGHT	ASH	SULFUR	MOISTURE	WEIGHT	ASH	SULFUR	MOISTURE
PASSED	RETAINED	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT
	8M	25.40	17.56	2.43	2.80	25.40	17.56	2.43	2.80	100.00	16.98	3.50	2.69
8M	16M	52.60	17.80	4.23	2.60	78.00	17.72	3.64	2.67	74.60	16.79	3.86	2.65
16M		22.00	14.37	2.98	2.76	100.00	16.98	3.50	2.69	22.00	14.37	2.98	2.76

ANALYTICAL DATA

DATA FOR DRYFLO SEPARATION TEST # 31.

FIGURES FROM PSOC # 105 FEED SAMPLE.

DATA FOR -

* * COMPOSITE * *

THIS FRACTION CONSTITUTES 100.0 PERCENT OF THE FEED.

SIZE		DIRECT VALUES				CUMULATIVE RETAINED				CUMULATIVE PASSED			
FRACTION		WEIGHT	ASH	SULFUR	MOISTURE	WEIGHT	ASH	SULFUR	MOISTURE	WEIGHT	ASH	SULFUR	MOISTURE
PASSED	RETAINED	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT
	8M	29.44	9.93	1.62	3.05	29.44	9.93	1.62	3.05	100.00	10.41	1.79	2.92
8M	16M	47.82	10.67	1.92	2.89	77.26	10.39	1.81	2.95	70.56	10.62	1.86	2.87
16M		22.74	10.49	1.75	2.83	100.00	10.41	1.79	2.92	22.74	10.49	1.75	2.83

ANALYTICAL DATA

DATA FOR DRYPLC SEPARATION TEST # 32.

FIGURES FROM PSOC # 105 FEED SAMPLE.

DATA FOR - PRODUCT COAL.

THIS FRACTION CONSTITUTES 87.5 PERCENT OF THE FEED.

SIZE		-----DIRECT VALUES-----				-----CUMULATIVE RETAINED-----				-----CUMULATIVE PASSED-----			
FRACTION		WEIGHT	ASH	SULFUR	MOISTURE	WEIGHT	ASH	SULFUR	MOISTURE	WEIGHT	ASH	SULFUR	MOISTURE
PASSED	RETAINED	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT
8M	8M	30.10	9.82	1.55	3.04	30.10	9.82	1.55	3.04	100.00	9.88	1.62	2.87
16M	16M	48.70	9.66	1.65	2.80	78.80	9.72	1.61	2.89	69.90	9.91	1.65	2.79
	16M	21.20	10.48	1.64	2.78	100.00	9.88	1.62	2.87	21.20	10.48	1.64	2.78

DATA FOR - MIDDLING COAL.

THIS FRACTION CONSTITUTES 6.0 PERCENT OF THE FEED.

SIZE		-----DIRECT VALUES-----				-----CUMULATIVE RETAINED-----				-----CUMULATIVE PASSED-----			
FRACTION		WEIGHT	ASH	SULFUR	MOISTURE	WEIGHT	ASH	SULFUR	MOISTURE	WEIGHT	ASH	SULFUR	MOISTURE
PASSED	RETAINED	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT
8M	8M	26.10	14.16	2.64	2.76	26.10	14.16	2.64	2.76	100.00	12.70	2.12	2.65
16M	16M	50.40	12.69	1.98	2.60	76.50	13.19	2.21	2.65	73.90	12.18	1.94	2.61
	16M	23.50	11.10	1.84	2.64	100.00	12.70	2.12	2.65	23.50	11.10	1.84	2.64

DATA FOR - REFUSE COAL.

THIS FRACTION CONSTITUTES 6.5 PERCENT OF THE FEED.

SIZE		-----DIRECT VALUES-----				-----CUMULATIVE RETAINED-----				-----CUMULATIVE PASSED-----			
FRACTION		WEIGHT	ASH	SULFUR	MOISTURE	WEIGHT	ASH	SULFUR	MOISTURE	WEIGHT	ASH	SULFUR	MOISTURE
PASSED	RETAINED	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT
8M	8M	19.50	14.38	2.93	2.76	19.50	14.38	2.93	2.76	100.00	14.83	3.08	2.78
16M	16M	54.70	15.03	3.05	2.78	74.20	14.86	3.02	2.77	80.50	14.94	3.12	2.79
	16M	25.80	14.75	3.26	2.80	100.00	14.83	3.08	2.78	25.80	14.75	3.26	2.80

ANALYTICAL DATA

DATA FOR DRYPLC SEPARATION TEST # 32.

FIGURES FROM PSOC # 105 FEED SAMPLE.

DATA FOR -

* * COMPOSITE * *

THIS FRACTION CONSTITUTES 100.0 PERCENT OF THE FEED.

SIZE		-----DIRECT VALUES-----				-----CUMULATIVE RETAINED-----				-----CUMULATIVE PASSED-----			
FRACTION		WEIGHT	ASH	SULFUR	MOISTURE	WEIGHT	ASH	SULFUR	MOISTURE	WEIGHT	ASH	SULFUR	MOISTURE
PASSED	RETAINED	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT
8M	8M	29.17	10.25	1.67	3.01	29.17	10.25	1.67	3.01	100.00	10.37	1.74	2.85
16M	16M	49.19	10.23	1.77	2.79	78.36	10.24	1.73	2.87	70.83	10.42	1.77	2.78
	16M	21.64	10.85	1.78	2.77	100.00	10.37	1.74	2.85	21.64	10.85	1.78	2.77

ANALYTICAL DATA

DATA FOR DRYPLO SEPARATION TEST # 33.

FIGURES FROM PSOC # 208 FEED SAMPLE.

DATA FOR - PRODUCT COAL.

THIS FRACTION CONSTITUTES 63.9 PERCENT OF THE FEED.

SIZE FRACTION		DIRECT VALUES				CUMULATIVE RETAINED				CUMULATIVE PASSED			
PASSED	RETAINED	WEIGHT PERCENT	ASH PERCENT	SULFUR PERCENT	MOISTURE PERCENT	WEIGHT PERCENT	ASH PERCENT	SULFUR PERCENT	MOISTURE PERCENT	WEIGHT PERCENT	ASH PERCENT	SULFUR PERCENT	MOISTURE PERCENT
	8M	6.50	6.80	2.03	3.20	6.50	6.80	2.03	3.20	100.00	6.00	2.07	3.44
8M	16M	64.30	5.94	2.02	3.40	70.80	6.02	2.02	3.38	93.50	5.95	2.07	3.46
16M		29.20	5.57	2.18	3.58	100.00	6.00	2.07	3.44	29.20	5.97	2.18	3.58

DATA FOR - MIDDLING COAL.

THIS FRACTION CONSTITUTES 26.7 PERCENT OF THE FEED.

SIZE FRACTION		DIRECT VALUES				CUMULATIVE RETAINED				CUMULATIVE PASSED			
PASSED	RETAINED	WEIGHT PERCENT	ASH PERCENT	SULFUR PERCENT	MOISTURE PERCENT	WEIGHT PERCENT	ASH PERCENT	SULFUR PERCENT	MOISTURE PERCENT	WEIGHT PERCENT	ASH PERCENT	SULFUR PERCENT	MOISTURE PERCENT
	8M	14.10	12.30	3.75	3.00	14.10	12.30	3.75	3.00	100.00	8.81	3.21	3.32
8M	16M	78.10	8.26	3.15	3.38	92.20	8.88	3.24	3.32	85.90	8.24	3.12	3.38
16M		7.80	8.05	2.78	3.36	100.00	8.81	3.21	3.32	7.80	8.05	2.78	3.36

DATA FOR - REFUSE COAL.

THIS FRACTION CONSTITUTES 9.4 PERCENT OF THE FEED.

SIZE FRACTION		DIRECT VALUES				CUMULATIVE RETAINED				CUMULATIVE PASSED			
PASSED	RETAINED	WEIGHT PERCENT	ASH PERCENT	SULFUR PERCENT	MOISTURE PERCENT	WEIGHT PERCENT	ASH PERCENT	SULFUR PERCENT	MOISTURE PERCENT	WEIGHT PERCENT	ASH PERCENT	SULFUR PERCENT	MOISTURE PERCENT
	8M	7.70	31.74	10.28	2.60	7.70	31.74	10.28	2.60	100.00	21.51	7.61	2.90
8M	16M	69.10	22.00	7.91	3.04	76.80	22.98	8.15	3.00	92.30	20.65	7.39	2.93
16M		23.20	16.64	5.84	2.60	100.00	21.51	7.61	2.90	23.20	16.64	5.84	2.60

ANALYTICAL DATA

DATA FOR DRYPLO SEPARATION TEST # 33.

FIGURES FROM PSOC # 208 FEED SAMPLE.

DATA FOR -

* * COMPOSITE * *

THIS FRACTION CONSTITUTES 100.0 PERCENT OF THE FEED.

SIZE FRACTION		DIRECT VALUES				CUMULATIVE RETAINED				CUMULATIVE PASSED			
PASSED	RETAINED	WEIGHT PERCENT	ASH PERCENT	SULFUR PERCENT	MOISTURE PERCENT	WEIGHT PERCENT	ASH PERCENT	SULFUR PERCENT	MOISTURE PERCENT	WEIGHT PERCENT	ASH PERCENT	SULFUR PERCENT	MOISTURE PERCENT
	8M	8.64	11.28	3.47	3.06	8.64	11.28	3.47	3.06	100.00	8.21	2.89	3.36
8M	16M	68.44	8.17	2.92	3.36	77.08	8.52	2.98	3.33	91.36	7.92	2.84	3.39
16M		22.92	7.17	2.58	3.47	100.00	8.21	2.89	3.36	22.92	7.17	2.58	3.47

ANALYTICAL DATA

DATA FOR DRYFLO SEPARATION TEST # 34.

FIGURES FROM PSOC # 208 FEED SAMPLE.

DATA FOR - PRODUCT COAL.

THIS FRACTION CONSTITUTES 61.8 PERCENT OF THE FEED.

SIZE		-----DIRECT VALUES-----				-----CUMULATIVE RETAINED-----				-----CUMULATIVE PASSED-----			
FRACTION	RETAINED	WEIGHT	ASH	SULFUR	MOISTURE	WEIGHT	ASH	SULFUR	MOISTURE	WEIGHT	ASH	SULFUR	MOISTURE
PASSED	RETAINED	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT
	8M	7.90	8.36	2.42	2.18	7.90	8.36	2.42	2.18	100.00	6.47	2.28	2.21
8M	16M	64.80	6.32	2.32	2.24	72.70	6.54	2.33	2.23	92.10	6.31	2.27	2.22
16M		27.30	6.29	2.14	2.16	100.00	6.47	2.28	2.21	27.30	6.29	2.14	2.16

DATA FOR - MIDDLING COAL.

THIS FRACTION CONSTITUTES 26.5 PERCENT OF THE FEED.

SIZE		-----DIRECT VALUES-----				-----CUMULATIVE RETAINED-----				-----CUMULATIVE PASSED-----			
FRACTION	RETAINED	WEIGHT	ASH	SULFUR	MOISTURE	WEIGHT	ASH	SULFUR	MOISTURE	WEIGHT	ASH	SULFUR	MOISTURE
PASSED	RETAINED	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT
	8M	12.80	11.43	3.16	2.04	12.80	11.43	3.16	2.04	100.00	9.44	3.46	2.18
8M	16M	65.40	9.74	3.78	2.20	78.20	10.02	3.68	2.17	87.20	9.14	3.50	2.19
16M		21.80	7.36	2.67	2.18	100.00	9.44	3.46	2.16	21.80	7.36	2.67	2.18

DATA FOR - REFUSE COAL.

THIS FRACTION CONSTITUTES 11.7 PERCENT OF THE FEED.

SIZE		-----DIRECT VALUES-----				-----CUMULATIVE RETAINED-----				-----CUMULATIVE PASSED-----			
FRACTION	RETAINED	WEIGHT	ASH	SULFUR	MOISTURE	WEIGHT	ASH	SULFUR	MOISTURE	WEIGHT	ASH	SULFUR	MOISTURE
PASSED	RETAINED	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT
	8M	7.80	26.91	9.01	1.76	7.80	26.91	9.01	1.76	100.00	24.06	9.48	1.87
8M	16M	68.90	26.80	10.57	1.84	76.70	26.81	10.41	1.83	92.20	23.82	9.52	1.88
16M		23.30	15.00	6.40	2.00	100.00	24.06	9.48	1.87	23.30	15.00	6.40	2.00

ANALYTICAL DATA

DATA FOR DRYFLO SEPARATION TEST # 34.

FIGURES FROM PSOC # 208 FEED SAMPLE.

DATA FOR -

* * COMPOSITE * *

THIS FRACTION CONSTITUTES 100.0 PERCENT OF THE FEED.

SIZE		-----DIRECT VALUES-----				-----CUMULATIVE RETAINED-----				-----CUMULATIVE PASSED-----			
FRACTION	RETAINED	WEIGHT	ASH	SULFUR	MOISTURE	WEIGHT	ASH	SULFUR	MOISTURE	WEIGHT	ASH	SULFUR	MOISTURE
PASSED	RETAINED	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT
	8M	9.19	11.34	3.35	2.09	9.19	11.34	3.35	2.09	100.00	9.32	3.43	2.16
8M	16M	65.44	9.75	3.72	2.18	74.63	9.94	3.68	2.17	90.81	9.11	3.44	2.17
16M		25.37	7.47	2.72	2.15	100.00	9.32	3.43	2.15	25.37	7.47	2.72	2.15

ANALYTICAL DATA

DATA FOR DRYFLO SEPARATION TEST # 35

PSOC # 208 PLUS MAGNETITE FEED.

DATA FOR - PRODUCT COAL.

THIS FRACTION CONSTITUTES 80.9 PERCENT OF THE FEED.

SIZE		-----DIRECT VALUES-----				-----CUMULATIVE RETAINED-----				-----CUMULATIVE PASSED-----			
FRACTION		WEIGHT	ASH	SULFUR	MOISTURE	WEIGHT	ASH	SULFUR	MOISTURE	WEIGHT	ASH	SULFUR	MOISTURE
PASSED	RETAINED	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT
1/4"	8M	9.30	9.73	2.99	3.60	9.30	9.73	2.99	3.60	100.00	8.04	2.54	3.78
8M	16M	65.40	8.04	2.48	3.76	74.70	8.25	2.54	3.74	90.70	7.87	2.49	3.79
16M		25.30	7.43	2.51	3.88	100.00	8.04	2.54	3.78	25.30	7.43	2.51	3.88

DATA FOR - MIDDLING COAL.

THIS FRACTION CONSTITUTES 10.3 PERCENT OF THE FEED.

SIZE		-----DIRECT VALUES-----				-----CUMULATIVE RETAINED-----				-----CUMULATIVE PASSED-----			
FRACTION		WEIGHT	ASH	SULFUR	MOISTURE	WEIGHT	ASH	SULFUR	MOISTURE	WEIGHT	ASH	SULFUR	MOISTURE
PASSED	RETAINED	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT
1/4"	8M	9.90	17.76	5.14	3.48	9.90	17.76	5.14	3.48	100.00	14.27	4.70	3.56
8M	16M	67.00	15.28	5.02	3.49	76.90	15.60	5.04	3.49	90.10	13.88	4.65	3.57
16M		23.10	9.83	3.59	3.79	100.00	14.27	4.70	3.56	23.10	9.83	3.59	3.79

DATA FOR - REFUSE COAL.

THIS FRACTION CONSTITUTES 8.8 PERCENT OF THE FEED.

SIZE		-----DIRECT VALUES-----				-----CUMULATIVE RETAINED-----				-----CUMULATIVE PASSED-----			
FRACTION		WEIGHT	ASH	SULFUR	MOISTURE	WEIGHT	ASH	SULFUR	MOISTURE	WEIGHT	ASH	SULFUR	MOISTURE
PASSED	RETAINED	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT
1/4"	8M	6.60	30.56	10.58	3.60	6.60	30.56	10.58	3.60	100.00	19.79	8.66	3.41
8M	16M	66.50	20.84	9.12	3.32	73.10	21.72	9.25	3.35	93.40	19.03	8.52	3.39
16M		26.90	14.55	7.05	3.58	100.00	19.79	8.66	3.41	26.90	14.55	7.05	3.58

ANALYTICAL DATA

DATA FOR DRYFLO SEPARATION TEST # 35

PSOC # 208 PLUS MAGNETITE FEED.

DATA FOR -

* * COMPOSITE * *

THIS FRACTION CONSTITUTES 100.0 PERCENT OF THE FEED.

SIZE		-----DIRECT VALUES-----				-----CUMULATIVE RETAINED-----				-----CUMULATIVE PASSED-----			
FRACTION		WEIGHT	ASH	SULFUR	MOISTURE	WEIGHT	ASH	SULFUR	MOISTURE	WEIGHT	ASH	SULFUR	MOISTURE
PASSED	RETAINED	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT
1/4"	8M	9.12	11.95	3.71	3.59	9.12	11.95	3.71	3.59	100.00	9.72	3.30	3.72
8M	16M	65.66	9.94	3.34	3.69	74.79	10.19	3.38	3.68	90.88	9.49	3.26	3.73
16M		25.21	8.32	3.04	3.84	100.00	9.72	3.30	3.72	25.21	8.32	3.04	3.84

ANALYTICAL DATA

DATA FOR DRYFLO SEPARATION TEST # 36

PSOC # 208 PLUS MAGNETITE FEED.

DATA FOR - PRODUCT COAL.

THIS FRACTION CONSTITUTES 82.8 PERCENT OF THE FEED.

SIZE		-----DIRECT VALUES-----				-----CUMULATIVE RETAINED-----				-----CUMULATIVE PASSED-----			
FRACTION		WEIGHT	ASH	SULFUR	MOISTURE	WEIGHT	ASH	SULFUR	MOISTURE	WEIGHT	ASH	SULFUR	MOISTURE
PASSED	RETAINED	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT
1/4"	8M	10.00	10.49	2.62	3.02	10.00	10.49	2.62	3.02	100.00	7.66	2.54	3.48
8M	16M	65.70	7.58	2.64	3.50	75.70	7.96	2.64	3.44	90.00	7.35	2.53	3.53
16M		24.30	6.71	2.22	3.60	100.00	7.66	2.54	3.48	24.30	6.71	2.22	3.60

DATA FOR - MIDDLING COAL.

THIS FRACTION CONSTITUTES 9.1 PERCENT OF THE FEED.

SIZE		-----DIRECT VALUES-----				-----CUMULATIVE RETAINED-----				-----CUMULATIVE PASSED-----			
FRACTION		WEIGHT	ASH	SULFUR	MOISTURE	WEIGHT	ASH	SULFUR	MOISTURE	WEIGHT	ASH	SULFUR	MOISTURE
PASSED	RETAINED	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT
1/4"	8M	9.60	16.80	5.41	3.12	9.60	16.80	5.41	3.12	100.00	12.98	4.39	3.30
8M	16M	66.70	13.77	4.67	3.30	76.30	14.15	4.76	3.28	90.40	12.58	4.28	3.32
16M		23.70	9.23	3.18	3.38	100.00	12.98	4.39	3.30	23.70	9.23	3.18	3.38

DATA FOR - REFUSE COAL.

THIS FRACTION CONSTITUTES 8.1 PERCENT OF THE FEED.

SIZE		-----DIRECT VALUES-----				-----CUMULATIVE RETAINED-----				-----CUMULATIVE PASSED-----			
FRACTION		WEIGHT	ASH	SULFUR	MOISTURE	WEIGHT	ASH	SULFUR	MOISTURE	WEIGHT	ASH	SULFUR	MOISTURE
PASSED	RETAINED	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT
1/4"	8M	5.80	33.04	9.59	2.69	5.80	33.04	9.59	2.69	100.00	22.18	7.56	3.06
8M	16M	67.70	23.84	8.14	2.98	73.50	24.57	8.25	2.96	94.20	21.51	7.43	3.08
16M		26.50	15.56	5.63	3.35	100.00	22.18	7.56	3.06	26.50	15.56	5.63	3.35

ANALYTICAL DATA

DATA FOR DRYFLO SEPARATION TEST # 36

PSOC # 208 PLUS MAGNETITE FEED.

DATA FOR -

* * COMPOSITE * *

THIS FRACTION CONSTITUTES 100.0 PERCENT OF THE FEED.

SIZE		-----DIRECT VALUES-----				-----CUMULATIVE RETAINED-----				-----CUMULATIVE PASSED-----			
FRACTION		WEIGHT	ASH	SULFUR	MOISTURE	WEIGHT	ASH	SULFUR	MOISTURE	WEIGHT	ASH	SULFUR	MOISTURE
PASSED	RETAINED	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT
1/4"	8M	9.62	12.16	3.21	3.01	9.62	12.16	3.21	3.01	100.00	9.32	3.11	3.43
8M	16M	65.95	9.50	3.28	3.44	75.58	9.84	3.28	3.38	90.38	9.02	3.10	3.47
16M		24.42	7.71	2.60	3.56	100.00	9.32	3.11	3.43	24.42	7.71	2.60	3.56

ANALYTICAL DATA

DATA FOR DRYFLO SEPARATION TEST # 37

PSOC # 86 PLUS MAGNETITE FEED.

DATA FOR - PRODUCT COAL.

THIS FRACTION CONSTITUTES 79.6 PERCENT OF THE FEED.

SIZE		-----DIRECT VALUES-----				-----CUMULATIVE RETAINED-----				-----CUMULATIVE PASSED-----			
FRACTION		WEIGHT	ASH	SULFUR	MOISTURE	WEIGHT	ASH	SULFUR	MOISTURE	WEIGHT	ASH	SULFUR	MOISTURE
PASSED	RETAINED	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT
1/4"	8M	11.80	7.87	0.50	10.50	11.80	7.87	0.50	10.50	100.00	8.36	0.56	10.77
8M	16M	64.90	8.37	0.57	10.82	76.70	8.29	0.56	10.77	88.20	8.42	0.57	10.81
16M		23.30	8.57	0.58	10.78	100.00	8.36	0.56	10.77	23.30	8.57	0.58	10.78

DATA FOR - MIDDLING COAL.

THIS FRACTION CONSTITUTES 12.2 PERCENT OF THE FEED.

SIZE		-----DIRECT VALUES-----				-----CUMULATIVE RETAINED-----				-----CUMULATIVE PASSED-----			
FRACTION		WEIGHT	ASH	SULFUR	MOISTURE	WEIGHT	ASH	SULFUR	MOISTURE	WEIGHT	ASH	SULFUR	MOISTURE
PASSED	RETAINED	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT
1/4"	8M	11.00	10.72	1.16	10.28	11.00	10.72	1.16	10.28	100.00	9.18	0.73	10.42
8M	16M	66.70	8.95	0.67	10.42	77.70	9.20	0.74	10.40	89.00	8.99	0.67	10.44
16M		22.30	9.12	0.68	10.50	100.00	9.18	0.73	10.42	22.30	9.12	0.68	10.50

DATA FOR - REFUSE COAL.

THIS FRACTION CONSTITUTES 8.2 PERCENT OF THE FEED.

SIZE		-----DIRECT VALUES-----				-----CUMULATIVE RETAINED-----				-----CUMULATIVE PASSED-----			
FRACTION		WEIGHT	ASH	SULFUR	MOISTURE	WEIGHT	ASH	SULFUR	MOISTURE	WEIGHT	ASH	SULFUR	MOISTURE
PASSED	RETAINED	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT
1/4"	8M	5.60	16.67	2.91	9.29	5.60	16.67	2.91	9.29	100.00	12.27	1.72	10.05
8M	16M	66.20	12.53	1.87	10.09	71.80	12.85	1.95	10.03	94.40	12.01	1.65	10.10
16M		28.20	10.79	1.12	10.12	100.00	12.27	1.72	10.05	28.20	10.79	1.12	10.12

ANALYTICAL DATA

DATA FOR DRYFLO SEPARATION TEST # 37

PSOC # 86 PLUS MAGNETITE FEED.

DATA FOR -

* * COMPOSITE * *

THIS FRACTION CONSTITUTES 100.0 PERCENT OF THE FEED.

SIZE		-----DIRECT VALUES-----				-----CUMULATIVE RETAINED-----				-----CUMULATIVE PASSED-----			
FRACTION		WEIGHT	ASH	SULFUR	MOISTURE	WEIGHT	ASH	SULFUR	MOISTURE	WEIGHT	ASH	SULFUR	MOISTURE
PASSED	RETAINED	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT
1/4"	8M	11.19	8.57	0.68	10.42	11.19	8.57	0.68	10.42	100.00	8.78	0.68	10.67
8M	16M	65.23	8.79	0.69	10.71	76.42	8.76	0.69	10.67	88.81	8.81	0.68	10.70
16M		23.58	8.85	0.64	10.68	100.00	8.78	0.68	10.67	23.58	8.85	0.64	10.68

ANALYTICAL DATA

DATA FOR DRYFLO SEPARATION TEST # 38

PSOC # 86 PLUS MAGNETITE FEED.

DATA FOR - PRODUCT COAL.

THIS FRACTION CONSTITUTES 60.5 PERCENT OF THE FEED.

SIZE		DIRECT VALUES				CUMULATIVE RETAINED				CUMULATIVE PASSED			
FRACTION		WEIGHT	ASH	SULFUR	MOISTURE	WEIGHT	ASH	SULFUR	MOISTURE	WEIGHT	ASH	SULFUR	MOISTURE
PASSED	RETAINED	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT
1/4"	8M	9.30	7.31	0.47	10.58	9.30	7.31	0.47	10.58	100.00	8.02	0.52	10.91
8M	16M	63.80	7.91	0.52	10.96	73.10	7.83	0.51	10.91	90.70	8.09	0.52	10.94
16M		26.90	8.53	0.53	10.90	100.00	8.02	0.52	10.91	26.90	8.53	0.53	10.90

DATA FOR - MIDDLING COAL.

THIS FRACTION CONSTITUTES 28.9 PERCENT OF THE FEED.

SIZE		DIRECT VALUES				CUMULATIVE RETAINED				CUMULATIVE PASSED			
FRACTION		WEIGHT	ASH	SULFUR	MOISTURE	WEIGHT	ASH	SULFUR	MOISTURE	WEIGHT	ASH	SULFUR	MOISTURE
PASSED	RETAINED	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT
1/4"	8M	13.10	8.85	0.58	8.92	13.10	8.85	0.58	8.92	100.00	8.93	0.62	9.71
8M	16M	65.80	8.95	0.65	9.90	78.90	8.93	0.64	9.74	86.90	8.94	0.63	9.83
16M		21.10	8.92	0.56	9.63	100.00	8.93	0.62	9.71	21.10	8.92	0.56	9.63

DATA FOR - REFUSE COAL.

THIS FRACTION CONSTITUTES 10.6 PERCENT OF THE FEED.

SIZE		DIRECT VALUES				CUMULATIVE RETAINED				CUMULATIVE PASSED			
FRACTION		WEIGHT	ASH	SULFUR	MOISTURE	WEIGHT	ASH	SULFUR	MOISTURE	WEIGHT	ASH	SULFUR	MOISTURE
PASSED	RETAINED	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT
1/4"	8M	7.00	14.50	2.30	8.60	7.00	14.50	2.30	8.60	100.00	12.38	1.65	10.02
8M	16M	66.70	12.88	1.81	10.10	73.70	13.03	1.86	9.96	93.00	12.22	1.61	10.13
16M		26.30	10.55	1.09	10.20	100.00	12.38	1.65	10.02	26.30	10.55	1.09	10.20

ANALYTICAL DATA

DATA FOR DRYFLO SEPARATION TEST # 38

PSOC # 86 PLUS MAGNETITE FEED.

DATA FOR -

* * COMPOSITE * *

THIS FRACTION CONSTITUTES 100.0 PERCENT OF THE FEED.

SIZE		DIRECT VALUES				CUMULATIVE RETAINED				CUMULATIVE PASSED			
FRACTION		WEIGHT	ASH	SULFUR	MOISTURE	WEIGHT	ASH	SULFUR	MOISTURE	WEIGHT	ASH	SULFUR	MOISTURE
PASSED	RETAINED	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT
1/4"	8M	10.15	8.41	0.64	9.82	10.15	8.41	0.64	9.82	100.00	8.75	0.67	10.47
8M	16M	64.69	8.76	0.70	10.55	74.84	8.71	0.69	10.45	89.85	8.78	0.67	10.54
16M		25.16	8.85	0.60	10.51	100.00	8.75	0.67	10.47	25.16	8.85	0.60	10.51

ANALYTICAL DATA

DATA FOR DRYFLO SEPARATION TEST # 39

ELLIOT PLUS MAGNETITE FEED.

DATA FOR - PRODUCT COAL.

THIS FRACTION CONSTITUTES 62.8 PERCENT OF THE FEED.

SIZE		DIRECT VALUES				CUMULATIVE RETAINED				CUMULATIVE PASSED			
FRACTION		WEIGHT	ASH	SULFUR	MOISTURE	WEIGHT	ASH	SULFUR	MOISTURE	WEIGHT	ASH	SULFUR	MOISTURE
PASSED	RETAINED	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT
1/4"	8M	2.40	16.06	2.16	0.89	2.40	16.06	2.16	0.89	100.00	14.20	2.56	0.88
8M	16M	75.10	14.69	2.60	0.88	77.50	14.73	2.59	0.88	97.60	14.16	2.57	0.88
16M		22.50	12.38	2.49	0.90	100.00	14.20	2.56	0.88	22.50	12.38	2.49	0.90

DATA FOR - MIDDLING COAL.

THIS FRACTION CONSTITUTES 22.6 PERCENT OF THE FEED.

SIZE		DIRECT VALUES				CUMULATIVE RETAINED				CUMULATIVE PASSED			
FRACTION		WEIGHT	ASH	SULFUR	MOISTURE	WEIGHT	ASH	SULFUR	MOISTURE	WEIGHT	ASH	SULFUR	MOISTURE
PASSED	RETAINED	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT
1/4"	8M	5.30	31.37	6.77	0.69	5.30	31.37	6.77	0.69	100.00	21.31	3.91	0.80
8M	16M	79.10	21.15	3.71	0.80	84.40	21.79	3.90	0.79	94.70	20.75	3.75	0.81
16M		15.60	18.70	3.98	0.84	100.00	21.31	3.91	0.80	15.60	18.70	3.98	0.84

DATA FOR - REFUSE COAL.

THIS FRACTION CONSTITUTES 14.6 PERCENT OF THE FEED.

SIZE		DIRECT VALUES				CUMULATIVE RETAINED				CUMULATIVE PASSED			
FRACTION		WEIGHT	ASH	SULFUR	MOISTURE	WEIGHT	ASH	SULFUR	MOISTURE	WEIGHT	ASH	SULFUR	MOISTURE
PASSED	RETAINED	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT
1/4"	8M	5.40	59.50	29.19	0.40	5.40	59.50	29.19	0.40	100.00	46.22	16.64	0.61
8M	16M	78.80	47.43	16.73	0.59	84.20	48.20	17.53	0.58	94.60	45.46	15.93	0.62
16M		15.80	35.62	11.92	0.78	100.00	46.22	16.64	0.61	15.80	35.62	11.92	0.78

ANALYTICAL DATA

DATA FOR DRYFLO SEPARATION TEST # 39

ELLIOT PLUS MAGNETITE FEED.

DATA FOR -

* * COMPOSITE * *

THIS FRACTION CONSTITUTES 100.0 PERCENT OF THE FEED.

SIZE		DIRECT VALUES				CUMULATIVE RETAINED				CUMULATIVE PASSED			
FRACTION		WEIGHT	ASH	SULFUR	MOISTURE	WEIGHT	ASH	SULFUR	MOISTURE	WEIGHT	ASH	SULFUR	MOISTURE
PASSED	RETAINED	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT
1/4"	8M	3.49	31.11	9.84	0.71	3.49	31.11	9.84	0.71	100.00	20.48	4.93	0.83
8M	16M	76.54	21.12	4.98	0.82	80.04	21.56	5.20	0.81	96.51	20.10	4.75	0.83
16M		19.96	16.18	3.84	0.88	100.00	20.48	4.93	0.83	19.96	16.18	3.84	0.88

ANALYTICAL DATA

DATA FOR DRYFLO SEPARATION TEST # 40

ELLIOT PLUS MAGNETITE FEED.

DATA FOR - PRODUCT COAL.

THIS FRACTION CONSTITUTES 68.2 PERCENT OF THE FEED.

SIZE		-----DIRECT VALUES-----				-----CUMULATIVE RETAINED-----				-----CUMULATIVE PASSED-----			
FRACTION		WEIGHT	ASH	SULFUR	MOISTURE	WEIGHT	ASH	SULFUR	MOISTURE	WEIGHT	ASH	SULFUR	MOISTURE
PASSED	RETAINED	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT
1/4"	8M	3.20	26.54	5.09	0.80	3.20	26.54	5.09	0.80	100.00	16.71	3.08	0.83
8M	16M	75.80	17.26	3.09	0.80	79.00	17.64	3.17	0.80	96.80	16.39	3.01	0.83
16M		21.00	13.23	2.72	0.96	100.00	16.71	3.08	0.83	21.00	13.23	2.72	0.96

DATA FOR - MIDDLING COAL.

THIS FRACTION CONSTITUTES 14.6 PERCENT OF THE FEED.

SIZE		-----DIRECT VALUES-----				-----CUMULATIVE RETAINED-----				-----CUMULATIVE PASSED-----			
FRACTION		WEIGHT	ASH	SULFUR	MOISTURE	WEIGHT	ASH	SULFUR	MOISTURE	WEIGHT	ASH	SULFUR	MOISTURE
PASSED	RETAINED	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT
1/4"	8M	6.10	51.81	20.01	0.50	6.10	51.81	20.01	0.50	100.00	33.91	10.27	0.72
8M	16M	77.20	34.89	10.43	0.72	83.30	36.13	11.13	0.70	93.90	32.75	9.64	0.73
16M		16.70	22.85	5.99	0.79	100.00	33.91	10.27	0.72	16.70	22.85	5.99	0.79

DATA FOR - REFUSE COAL.

THIS FRACTION CONSTITUTES 17.2 PERCENT OF THE FEED.

SIZE		-----DIRECT VALUES-----				-----CUMULATIVE RETAINED-----				-----CUMULATIVE PASSED-----			
FRACTION		WEIGHT	ASH	SULFUR	MOISTURE	WEIGHT	ASH	SULFUR	MOISTURE	WEIGHT	ASH	SULFUR	MOISTURE
PASSED	RETAINED	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT
1/4"	8M	4.40	55.77	23.18	0.40	4.40	55.77	23.18	0.40	100.00	45.99	17.58	0.60
8M	16M	78.00	47.90	18.58	0.59	82.40	48.32	18.83	0.58	95.60	45.54	17.33	0.61
16M		17.60	35.09	11.77	0.68	100.00	45.99	17.58	0.60	17.60	35.09	11.77	0.68

ANALYTICAL DATA

DATA FOR DRYFLO SEPARATION TEST # 40

ELLIOT PLUS MAGNETITE FEED.

DATA FOR -

* * COMPOSITE * *

THIS FRACTION CONSTITUTES 100.0 PERCENT OF THE FEED.

SIZE		-----DIRECT VALUES-----				-----CUMULATIVE RETAINED-----				-----CUMULATIVE PASSED-----			
FRACTION		WEIGHT	ASH	SULFUR	MOISTURE	WEIGHT	ASH	SULFUR	MOISTURE	WEIGHT	ASH	SULFUR	MOISTURE
PASSED	RETAINED	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT
1/4"	8M	3.83	38.19	12.13	0.65	3.83	38.19	12.13	0.65	100.00	24.26	6.62	0.78
8M	16M	76.38	25.24	6.89	0.75	80.21	25.86	7.14	0.75	96.17	23.70	6.40	0.78
16M		19.79	17.76	4.51	0.90	100.00	24.26	6.62	0.78	19.79	17.76	4.51	0.90

ANALYTICAL DATA

DATA FOR DRYFLO SEPARATION TEST # 41

FIGURES FROM PSOC # 86 FEED SAMPLE.

DATA FOR - PRODUCT COAL.

THIS FRACTION CONSTITUTES 47.4 PERCENT OF THE FEED.

SIZE FRACTION		-----DIRECT VALUES-----				-----CUMULATIVE RETAINED-----				-----CUMULATIVE PASSED-----			
PASSED	RETAINED	WEIGHT PERCENT	ASH PERCENT	SULFUR PERCENT	MOISTURE PERCENT	WEIGHT PERCENT	ASH PERCENT	SULFUR PERCENT	MOISTURE PERCENT	WEIGHT PERCENT	ASH PERCENT	SULFUR PERCENT	MOISTURE PERCENT
	30M	15.00	8.04	0.55	10.45	15.00	8.04	0.55	10.45	100.00	10.08	0.82	10.86
30M	60M	34.40	8.39	0.62	10.60	49.40	8.28	0.60	10.55	85.00	10.44	0.87	10.93
60M	100M	24.60	9.82	0.76	10.90	74.00	8.79	0.65	10.67	50.60	11.83	1.04	11.16
100M	150M	13.70	11.48	0.96	11.55	87.70	9.21	0.70	10.81	26.00	13.73	1.31	11.41
150M		12.30	16.23	1.69	11.25	100.00	10.08	0.82	10.86	12.30	16.23	1.69	11.25

DATA FOR - MIDDLING COAL.

THIS FRACTION CONSTITUTES 35.9 PERCENT OF THE FEED.

SIZE FRACTION		-----DIRECT VALUES-----				-----CUMULATIVE RETAINED-----				-----CUMULATIVE PASSED-----			
PASSED	RETAINED	WEIGHT PERCENT	ASH PERCENT	SULFUR PERCENT	MOISTURE PERCENT	WEIGHT PERCENT	ASH PERCENT	SULFUR PERCENT	MOISTURE PERCENT	WEIGHT PERCENT	ASH PERCENT	SULFUR PERCENT	MOISTURE PERCENT
	30M	49.80	8.43	0.60	10.45	49.80	8.43	0.60	10.45	100.00	9.32	0.75	10.52
30M	60M	41.50	9.32	0.77	10.45	91.30	8.83	0.68	10.45	50.20	10.19	0.90	10.59
60M	100M	7.10	12.65	1.13	11.45	98.40	9.11	0.71	10.52	8.70	14.37	1.51	11.27
100M	150M	0.80	21.41	3.25	10.80	99.20	9.21	0.73	10.52	1.60	21.99	3.22	10.45
150M		0.80	22.58	3.18	10.10	100.00	9.32	0.75	10.52	0.80	22.58	3.18	10.10

DATA FOR - REFUSE COAL.

THIS FRACTION CONSTITUTES 16.7 PERCENT OF THE FEED.

SIZE FRACTION		-----DIRECT VALUES-----				-----CUMULATIVE RETAINED-----				-----CUMULATIVE PASSED-----			
PASSED	RETAINED	WEIGHT PERCENT	ASH PERCENT	SULFUR PERCENT	MOISTURE PERCENT	WEIGHT PERCENT	ASH PERCENT	SULFUR PERCENT	MOISTURE PERCENT	WEIGHT PERCENT	ASH PERCENT	SULFUR PERCENT	MOISTURE PERCENT
	30M	55.30	10.08	0.94	9.20	55.30	10.08	0.94	9.20	100.00	10.69	1.00	9.29
30M	60M	40.60	10.47	0.93	9.30	95.90	10.25	0.94	9.24	44.70	11.43	1.08	9.40
60M	100M	3.30	18.75	2.37	10.40	99.20	10.53	0.98	9.28	4.10	20.97	2.53	10.34
100M	150M	0.30	32.17	0.00	10.25	99.50	10.59	0.98	9.28	0.80	30.15	3.17	10.09
150M		0.50	28.94	5.07	10.00	100.00	10.69	1.00	9.29	0.50	28.94	5.07	10.00

ANALYTICAL DATA

DATA FOR DRYFLO SEPARATION TEST # 41

FIGURES FROM PSOC # 86 FEED SAMPLE.

DATA FOR -

* * COMPOSITE * *

THIS FRACTION CONSTITUTES 100.0 PERCENT OF THE FEED.

SIZE FRACTION		-----DIRECT VALUES-----				-----CUMULATIVE RETAINED-----				-----CUMULATIVE PASSED-----			
PASSED	RETAINED	WEIGHT PERCENT	ASH PERCENT	SULFUR PERCENT	MOISTURE PERCENT	WEIGHT PERCENT	ASH PERCENT	SULFUR PERCENT	MOISTURE PERCENT	WEIGHT PERCENT	ASH PERCENT	SULFUR PERCENT	MOISTURE PERCENT
	30M	34.22	8.79	0.68	10.11	34.22	8.79	0.68	10.11	100.00	9.91	0.83	10.48
30M	60M	37.98	9.13	0.73	10.31	72.21	8.97	0.71	10.22	65.78	10.48	0.90	10.67
60M	100M	14.76	10.64	0.88	10.98	86.97	9.25	0.74	10.35	27.79	12.34	1.13	11.15
100M	150M	6.83	12.05	1.05	11.51	93.80	9.46	0.76	10.43	13.03	14.26	1.41	11.35
150M		6.20	16.70	1.80	11.18	100.00	9.91	0.83	10.48	6.20	16.70	1.80	11.18

ANALYTICAL DATA

DATA FOR DRYFLO SEPARATION TEST # 42

FIGURES FROM PSOC # 86 FEED SAMPLE.

DATA FOR - PRODUCT COAL.

THIS FRACTION CONSTITUTES 46.1 PERCENT OF THE FEED.

SIZE FRACTION		-----DIRECT VALUES-----				-----CUMULATIVE RETAINED-----				-----CUMULATIVE PASSED-----			
PASSED	RETAINED	WEIGHT PERCENT	ASH PERCENT	SULFUR PERCENT	MOISTURE PERCENT	WEIGHT PERCENT	ASH PERCENT	SULFUR PERCENT	MOISTURE PERCENT	WEIGHT PERCENT	ASH PERCENT	SULFUR PERCENT	MOISTURE PERCENT
	30M	8.70	7.87	0.51	10.45	8.70	7.87	0.51	10.45	100.00	10.03	0.86	10.94
30M	60M	32.70	7.32	0.59	10.50	41.40	7.44	0.57	10.49	91.30	10.23	0.90	10.98
60M	100M	28.70	9.72	0.76	11.50	70.10	8.37	0.65	10.90	58.60	11.86	1.07	11.25
100M	150M	16.00	11.49	0.99	11.20	86.10	8.95	0.71	10.96	29.90	13.91	1.37	11.01
150M		13.90	16.70	1.80	10.80	100.00	10.03	0.86	10.94	13.90	16.70	1.80	10.80

DATA FOR - MIDDLING COAL.

THIS FRACTION CONSTITUTES 38.6 PERCENT OF THE FEED.

SIZE FRACTION		-----DIRECT VALUES-----				-----CUMULATIVE RETAINED-----				-----CUMULATIVE PASSED-----			
PASSED	RETAINED	WEIGHT PERCENT	ASH PERCENT	SULFUR PERCENT	MOISTURE PERCENT	WEIGHT PERCENT	ASH PERCENT	SULFUR PERCENT	MOISTURE PERCENT	WEIGHT PERCENT	ASH PERCENT	SULFUR PERCENT	MOISTURE PERCENT
	30M	44.00	8.68	0.62	10.70	44.00	8.68	0.62	10.70	100.00	9.67	0.79	10.75
30M	60M	45.50	9.35	0.76	10.65	89.50	9.02	0.69	10.67	56.00	10.44	0.92	10.78
60M	100M	9.00	13.45	1.30	11.55	98.50	9.43	0.75	10.75	10.50	15.17	1.62	11.35
100M	150M	0.90	24.47	3.15	10.50	99.40	9.56	0.77	10.75	1.50	25.52	3.55	10.14
150M		0.60	27.10	4.14	9.60	100.00	9.67	0.79	10.75	0.60	27.10	4.14	9.60

DATA FOR - REFUSE COAL.

THIS FRACTION CONSTITUTES 15.3 PERCENT OF THE FEED.

SIZE FRACTION		-----DIRECT VALUES-----				-----CUMULATIVE RETAINED-----				-----CUMULATIVE PASSED-----			
PASSED	RETAINED	WEIGHT PERCENT	ASH PERCENT	SULFUR PERCENT	MOISTURE PERCENT	WEIGHT PERCENT	ASH PERCENT	SULFUR PERCENT	MOISTURE PERCENT	WEIGHT PERCENT	ASH PERCENT	SULFUR PERCENT	MOISTURE PERCENT
	30M	35.00	9.29	0.72	9.55	35.00	9.29	0.72	9.55	100.00	10.57	0.96	9.67
30M	60M	58.10	9.57	0.89	9.70	93.10	9.71	0.83	9.64	65.00	11.26	1.09	9.73
60M	100M	5.30	19.64	1.94	10.15	98.40	10.25	0.89	9.67	6.90	22.17	2.75	10.00
100M	150M	0.60	32.82	6.54	9.20	99.00	10.39	0.92	9.67	1.60	30.54	5.45	9.51
150M		1.00	29.18	4.80	9.70	100.00	10.57	0.96	9.67	1.00	29.18	4.80	9.70

ANALYTICAL DATA

DATA FOR DRYFLO SEPARATION TEST # 42

FIGURES FROM PSOC # 86 FEED SAMPLE.

DATA FOR -

* * COMPOSITE * *

THIS FRACTION CONSTITUTES 100.0 PERCENT OF THE FEED.

SIZE FRACTION		-----DIRECT VALUES-----				-----CUMULATIVE RETAINED-----				-----CUMULATIVE PASSED-----			
PASSED	RETAINED	WEIGHT PERCENT	ASH PERCENT	SULFUR PERCENT	MOISTURE PERCENT	WEIGHT PERCENT	ASH PERCENT	SULFUR PERCENT	MOISTURE PERCENT	WEIGHT PERCENT	ASH PERCENT	SULFUR PERCENT	MOISTURE PERCENT
	30M	26.35	8.68	0.62	10.43	26.35	8.68	0.62	10.43	100.00	9.97	0.85	10.67
30M	60M	41.53	8.75	0.73	10.39	67.88	8.72	0.69	10.41	73.65	10.43	0.93	10.75
60M	100M	17.52	10.92	0.92	11.45	85.39	9.17	0.73	10.62	32.12	12.62	1.19	11.22
100M	150M	7.82	12.32	1.15	11.15	93.21	9.44	0.77	10.66	14.61	14.65	1.52	10.95
150M		6.79	17.34	1.95	10.73	100.00	9.97	0.85	10.67	6.79	17.34	1.95	10.73

ANALYTICAL DATA

DATA FOR DRYFLO SEPARATION TEST # 43

FIGURES FROM PSOC # 86 FEED SAMPLE.

DATA FOR - PRODUCT COAL.

THIS FRACTION CONSTITUTES 52.1 PERCENT OF THE FEED.

SIZE FRACTION		DIRECT VALUES				CUMULATIVE RETAINED				CUMULATIVE PASSED			
PASSED	RETAINED	WEIGHT PERCENT	ASH PERCENT	SULFUR PERCENT	MOISTURE PERCENT	WEIGHT PERCENT	ASH PERCENT	SULFUR PERCENT	MOISTURE PERCENT	WEIGHT PERCENT	ASH PERCENT	SULFUR PERCENT	MOISTURE PERCENT
	30M	8.50	7.78	0.49	10.05	8.50	7.78	0.49	10.05	100.00	9.95	0.81	10.40
30M	60M	31.80	8.10	0.56	10.45	40.30	8.03	0.55	10.37	91.50	10.16	0.84	10.43
60M	100M	28.20	9.55	0.73	10.50	68.50	8.66	0.62	10.42	59.70	11.25	0.99	10.42
100M	150M	15.30	10.67	0.89	10.50	83.80	9.02	0.67	10.44	31.50	12.77	1.23	10.35
150M		16.20	14.76	1.55	10.20	100.00	9.95	0.81	10.40	16.20	14.76	1.55	10.20

DATA FOR - MIDDLING COAL.

THIS FRACTION CONSTITUTES 24.5 PERCENT OF THE FEED.

SIZE FRACTION		DIRECT VALUES				CUMULATIVE RETAINED				CUMULATIVE PASSED			
PASSED	RETAINED	WEIGHT PERCENT	ASH PERCENT	SULFUR PERCENT	MOISTURE PERCENT	WEIGHT PERCENT	ASH PERCENT	SULFUR PERCENT	MOISTURE PERCENT	WEIGHT PERCENT	ASH PERCENT	SULFUR PERCENT	MOISTURE PERCENT
	30M	41.60	8.24	0.55	10.20	41.60	8.24	0.55	10.20	100.00	9.32	0.74	10.32
30M	60M	47.80	9.04	0.69	10.40	89.40	8.67	0.62	10.31	58.40	10.09	0.88	10.41
60M	100M	9.00	12.91	1.25	10.55	98.40	9.06	0.68	10.33	10.60	14.82	1.72	10.46
100M	150M	0.80	26.18	4.88	10.05	99.20	9.19	0.72	10.33	1.60	25.54	4.39	9.95
150M		0.80	24.90	3.90	9.85	100.00	9.32	0.74	10.32	0.80	24.90	3.90	9.85

DATA FOR - REFUSE COAL.

THIS FRACTION CONSTITUTES 23.4 PERCENT OF THE FEED.

SIZE FRACTION		DIRECT VALUES				CUMULATIVE RETAINED				CUMULATIVE PASSED			
PASSED	RETAINED	WEIGHT PERCENT	ASH PERCENT	SULFUR PERCENT	MOISTURE PERCENT	WEIGHT PERCENT	ASH PERCENT	SULFUR PERCENT	MOISTURE PERCENT	WEIGHT PERCENT	ASH PERCENT	SULFUR PERCENT	MOISTURE PERCENT
	30M	50.40	8.91	0.68	9.65	50.40	8.91	0.68	9.65	100.00	9.75	0.84	9.72
30M	60M	44.10	9.70	0.79	9.75	94.50	9.28	0.73	9.70	49.60	10.60	1.00	9.80
60M	100M	4.40	14.99	1.86	10.25	98.90	9.53	0.78	9.72	5.50	17.81	2.67	10.21
100M	150M	0.40	35.03	8.68	9.80	99.30	9.64	0.81	9.72	1.10	29.11	5.89	10.05
150M		0.70	25.72	4.29	10.20	100.00	9.75	0.84	9.72	0.70	25.72	4.29	10.20

ANALYTICAL DATA

DATA FOR DRYFLO SEPARATION TEST # 43

FIGURES FROM PSOC # 86 FEED SAMPLE.

DATA FOR -

* * COMPOSITE * *

THIS FRACTION CONSTITUTES 100.0 PERCENT OF THE FEED.

SIZE FRACTION		DIRECT VALUES				CUMULATIVE RETAINED				CUMULATIVE PASSED			
PASSED	RETAINED	WEIGHT PERCENT	ASH PERCENT	SULFUR PERCENT	MOISTURE PERCENT	WEIGHT PERCENT	ASH PERCENT	SULFUR PERCENT	MOISTURE PERCENT	WEIGHT PERCENT	ASH PERCENT	SULFUR PERCENT	MOISTURE PERCENT
	30M	26.41	8.46	0.60	9.93	26.41	8.46	0.60	9.93	100.00	9.75	0.80	10.22
30M	60M	38.60	8.81	0.66	10.25	65.01	8.67	0.64	10.12	73.59	10.21	0.87	10.33
60M	100M	17.93	10.28	0.86	10.49	82.94	9.02	0.68	10.20	34.99	11.76	1.11	10.41
100M	150M	8.26	11.31	1.07	10.48	91.20	9.23	0.72	10.22	17.06	13.31	1.37	10.33
150M		8.80	15.19	1.65	10.19	100.00	9.75	0.80	10.22	8.80	15.19	1.65	10.19

ANALYTICAL DATA

DATA FOR DRYFLO SEPARATION TEST # 44

FIGURES FROM PSOC # 66 FEED SAMPLE.

DATA FOR - PRODUCT COAL.

THIS FRACTION CONSTITUTES 64.1 PERCENT OF THE FEED.

SIZE FRACTION		-----DIRECT VALUES-----				-----CUMULATIVE RETAINED-----				-----CUMULATIVE PASSED-----			
PASSED	RETAINED	WEIGHT PERCENT	ASH PERCENT	SULFUR PERCENT	MOISTURE PERCENT	WEIGHT PERCENT	ASH PERCENT	SULFUR PERCENT	MOISTURE PERCENT	WEIGHT PERCENT	ASH PERCENT	SULFUR PERCENT	MOISTURE PERCENT
	30M	23.80	8.45	0.65	11.20	23.80	8.45	0.65	11.20	100.00	9.70	0.82	11.25
30M	60M	40.70	8.72	0.67	11.10	64.50	8.62	0.66	11.14	76.20	10.10	0.87	11.26
60M	100M	18.60	10.25	0.87	11.70	83.10	8.99	0.71	11.26	35.50	11.67	1.10	11.45
100M	150M	9.50	11.34	1.05	11.35	92.60	9.23	0.74	11.27	16.90	13.24	1.34	11.17
150M		7.40	15.67	1.72	10.95	100.00	9.70	0.82	11.25	7.40	15.67	1.72	10.95

DATA FOR - MIDDLING COAL.

THIS FRACTION CONSTITUTES 20.7 PERCENT OF THE FEED.

SIZE FRACTION		-----DIRECT VALUES-----				-----CUMULATIVE RETAINED-----				-----CUMULATIVE PASSED-----			
PASSED	RETAINED	WEIGHT PERCENT	ASH PERCENT	SULFUR PERCENT	MOISTURE PERCENT	WEIGHT PERCENT	ASH PERCENT	SULFUR PERCENT	MOISTURE PERCENT	WEIGHT PERCENT	ASH PERCENT	SULFUR PERCENT	MOISTURE PERCENT
	30M	61.20	9.14	0.69	10.30	61.20	9.14	0.69	10.30	100.00	9.95	0.78	10.25
30M	60M	35.80	10.35	0.80	10.15	97.00	9.59	0.73	10.24	38.80	11.24	0.93	10.17
60M	100M	2.20	19.14	2.70	10.65	99.20	9.80	0.77	10.25	3.00	21.81	2.48	10.42
100M	150M	0.30	38.05	0.00	9.25	99.50	9.88	0.77	10.25	0.80	29.14	1.86	9.78
150M		0.50	23.80	2.98	10.10	100.00	9.95	0.78	10.25	0.50	23.80	2.98	10.10

DATA FOR - REFUSE COAL.

THIS FRACTION CONSTITUTES 15.2 PERCENT OF THE FEED.

SIZE FRACTION		-----DIRECT VALUES-----				-----CUMULATIVE RETAINED-----				-----CUMULATIVE PASSED-----			
PASSED	RETAINED	WEIGHT PERCENT	ASH PERCENT	SULFUR PERCENT	MOISTURE PERCENT	WEIGHT PERCENT	ASH PERCENT	SULFUR PERCENT	MOISTURE PERCENT	WEIGHT PERCENT	ASH PERCENT	SULFUR PERCENT	MOISTURE PERCENT
	30M	65.50	11.71	1.24	10.30	65.50	11.71	1.24	10.30	100.00	12.03	1.29	10.32
30M	60M	32.70	11.83	1.23	10.40	98.20	11.75	1.24	10.33	34.50	12.65	1.39	10.36
60M	100M	0.90	27.47	5.85	9.35	99.10	11.89	1.28	10.32	1.80	27.45	4.35	9.68
100M	150M	0.20	45.77	0.00	10.40	99.30	11.96	1.28	10.32	0.90	27.44	2.85	10.01
150M		0.70	22.20	3.66	9.90	100.00	12.03	1.29	10.32	0.70	22.20	3.66	9.90

ANALYTICAL DATA

DATA FOR DRYFLO SEPARATION TEST # 44

FIGURES FROM PSOC # 86 FEED SAMPLE.

DATA FOR -

* * COMPOSITE * *

THIS FRACTION CONSTITUTES 100.0 PERCENT OF THE FEED.

SIZE FRACTION		-----DIRECT VALUES-----				-----CUMULATIVE RETAINED-----				-----CUMULATIVE PASSED-----			
PASSED	RETAINED	WEIGHT PERCENT	ASH PERCENT	SULFUR PERCENT	MOISTURE PERCENT	WEIGHT PERCENT	ASH PERCENT	SULFUR PERCENT	MOISTURE PERCENT	WEIGHT PERCENT	ASH PERCENT	SULFUR PERCENT	MOISTURE PERCENT
	30M	37.88	9.54	0.82	10.66	37.88	9.54	0.82	10.66	100.00	10.11	0.88	10.90
30M	60M	38.47	9.84	0.77	10.83	76.35	9.49	0.79	10.75	62.12	10.46	0.92	11.05
60M	100M	12.51	10.76	0.99	11.64	88.86	9.67	0.82	10.87	23.65	12.12	1.17	11.40
100M	150M	6.18	11.78	1.03	11.32	95.05	9.80	0.83	10.90	11.14	13.65	1.37	11.14
150M		4.95	15.98	1.79	10.91	100.00	10.11	0.88	10.90	4.95	15.98	1.79	10.91

ANALYTICAL DATA

DATA FOR DRYFLO SEPARATION TEST # 45

FIGURES FROM PSOC # 86 FEED SAMPLE.

DATA FOR - PRODUCT COAL.

THIS FRACTION CONSTITUTES 66.1 PERCENT OF THE FEED.

SIZE FRACTION		-----DIRECT VALUES-----				-----CUMULATIVE RETAINED-----				-----CUMULATIVE PASSED-----			
PASSED	RETAINED	WEIGHT PERCENT	ASH PERCENT	SULFUR PERCENT	MOISTURE PERCENT	WEIGHT PERCENT	ASH PERCENT	SULFUR PERCENT	MOISTURE PERCENT	WEIGHT PERCENT	ASH PERCENT	SULFUR PERCENT	MOISTURE PERCENT
	30M	25.40	8.72	0.66	11.10	25.40	8.72	0.66	11.10	100.00	9.82	0.78	11.27
30M	60M	40.10	8.89	0.64	11.15	65.50	8.82	0.65	11.13	74.60	10.19	0.82	11.32
60M	100M	18.40	10.42	0.82	11.75	83.90	9.17	0.69	11.27	34.50	11.70	1.02	11.52
100M	150M	9.40	11.25	0.97	11.55	93.30	9.38	0.71	11.30	16.10	13.17	1.25	11.26
150M		6.70	15.87	1.64	10.85	100.00	9.82	0.78	11.27	6.70	15.87	1.64	10.85

DATA FOR - MIDDLING COAL.

THIS FRACTION CONSTITUTES 24.3 PERCENT OF THE FEED.

SIZE FRACTION		-----DIRECT VALUES-----				-----CUMULATIVE RETAINED-----				-----CUMULATIVE PASSED-----			
PASSED	RETAINED	WEIGHT PERCENT	ASH PERCENT	SULFUR PERCENT	MOISTURE PERCENT	WEIGHT PERCENT	ASH PERCENT	SULFUR PERCENT	MOISTURE PERCENT	WEIGHT PERCENT	ASH PERCENT	SULFUR PERCENT	MOISTURE PERCENT
	30M	61.40	9.99	0.73	11.45	61.40	9.99	0.73	11.45	100.00	10.53	0.89	11.20
30M	60M	35.80	10.76	0.99	10.80	97.20	10.27	0.83	11.21	38.60	11.40	1.14	10.80
60M	100M	2.10	17.21	2.42	11.10	99.30	10.42	0.86	11.21	2.80	19.52	3.13	10.82
100M	150M	0.30	33.41	6.67	9.30	99.60	10.49	0.88	11.20	0.70	26.45	5.25	9.99
150M		0.40	21.23	4.18	10.50	100.00	10.53	0.89	11.20	0.40	21.23	4.18	10.50

DATA FOR - REFUSE COAL.

THIS FRACTION CONSTITUTES 9.6 PERCENT OF THE FEED.

SIZE FRACTION		-----DIRECT VALUES-----				-----CUMULATIVE RETAINED-----				-----CUMULATIVE PASSED-----			
PASSED	RETAINED	WEIGHT PERCENT	ASH PERCENT	SULFUR PERCENT	MOISTURE PERCENT	WEIGHT PERCENT	ASH PERCENT	SULFUR PERCENT	MOISTURE PERCENT	WEIGHT PERCENT	ASH PERCENT	SULFUR PERCENT	MOISTURE PERCENT
	30M	63.00	12.41	1.47	9.75	63.00	12.41	1.47	9.75	100.00	12.76	1.61	9.82
30M	60M	35.00	12.44	1.57	9.95	98.00	12.42	1.51	9.82	37.00	13.36	1.85	9.95
60M	100M	1.00	33.94	8.48	9.40	99.00	12.64	1.58	9.82	2.00	29.50	6.74	9.90
100M	150M	1.00	25.06	5.00	10.40	100.00	12.76	1.61	9.82	1.00	25.06	5.00	10.40
150M		0.00	0.00	0.00	0.00	100.00	12.76	1.61	9.82	0.00	0.00	0.00	0.00

ANALYTICAL DATA

DATA FOR DRYFLO SEPARATION TEST # 45

FIGURES FROM PSOC # 86 FEED SAMPLE.

DATA FOR -

* * COMPOSITE * *

THIS FRACTION CONSTITUTES 100.0 PERCENT OF THE FEED.

SIZE FRACTION		-----DIRECT VALUES-----				-----CUMULATIVE RETAINED-----				-----CUMULATIVE PASSED-----			
PASSED	RETAINED	WEIGHT PERCENT	ASH PERCENT	SULFUR PERCENT	MOISTURE PERCENT	WEIGHT PERCENT	ASH PERCENT	SULFUR PERCENT	MOISTURE PERCENT	WEIGHT PERCENT	ASH PERCENT	SULFUR PERCENT	MOISTURE PERCENT
	30M	37.76	9.81	0.82	11.02	37.76	9.81	0.82	11.02	100.00	10.27	0.88	11.11
30M	60M	38.57	9.62	0.80	10.97	76.32	9.72	0.81	10.99	62.24	10.55	0.92	11.16
60M	100M	12.77	10.87	0.94	11.71	89.09	9.88	0.83	11.10	23.68	12.07	1.13	11.49
100M	150M	6.38	11.71	1.10	11.51	95.47	10.00	0.85	11.12	10.91	13.48	1.34	11.23
150M		4.53	15.99	1.69	10.84	100.00	10.27	0.88	11.11	4.53	15.99	1.69	10.84

ANALYTICAL DATA

DATA FOR DRYFLO SEPARATION TEST # 46

FIGURES FROM PSOC # 208 FEED SAMPLE.

DATA FOR - PRODUCT COAL.

THIS FRACTION CONSTITUTES 54.4 PERCENT OF THE FEED.

SIZE FRACTION		-----DIRECT VALUES-----				-----CUMULATIVE RETAINED-----				-----CUMULATIVE PASSED-----			
PASSED	RETAINED	WEIGHT PERCENT	ASH PERCENT	SULFUR PERCENT	MOISTURE PERCENT	WEIGHT PERCENT	ASH PERCENT	SULFUR PERCENT	MOISTURE PERCENT	WEIGHT PERCENT	ASH PERCENT	SULFUR PERCENT	MOISTURE PERCENT
	30M	16.30	5.16	1.73	2.20	16.30	5.16	1.73	2.20	100.00	8.25	2.66	3.31
30M	60M	32.60	5.58	1.91	3.15	48.90	5.44	1.85	2.83	83.70	8.85	2.84	3.53
60M	100M	22.70	7.38	2.34	3.80	71.60	6.06	2.01	3.14	51.10	10.93	3.44	3.77
100M	150M	11.40	9.65	3.15	3.60	83.00	6.55	2.16	3.20	28.40	13.77	4.32	3.75
150M		17.00	16.54	5.10	3.85	100.00	8.25	2.66	3.31	17.00	16.54	5.10	3.85

DATA FOR - MIDDLING COAL.

THIS FRACTION CONSTITUTES 33.7 PERCENT OF THE FEED.

SIZE FRACTION		-----DIRECT VALUES-----				-----CUMULATIVE RETAINED-----				-----CUMULATIVE PASSED-----			
PASSED	RETAINED	WEIGHT PERCENT	ASH PERCENT	SULFUR PERCENT	MOISTURE PERCENT	WEIGHT PERCENT	ASH PERCENT	SULFUR PERCENT	MOISTURE PERCENT	WEIGHT PERCENT	ASH PERCENT	SULFUR PERCENT	MOISTURE PERCENT
	30M	51.40	6.85	2.53	2.85	51.40	6.85	2.53	2.85	100.00	7.67	2.91	2.94
30M	60M	39.10	7.05	2.77	2.90	90.50	6.94	2.63	2.87	48.60	8.54	3.32	3.04
60M	100M	7.40	11.53	3.88	3.70	97.90	7.28	2.73	2.93	9.50	14.68	5.59	3.60
100M	150M	1.30	22.29	9.97	3.10	99.20	7.48	2.82	2.94	2.10	25.78	11.61	3.25
150M		0.80	31.45	14.28	3.50	100.00	7.67	2.91	2.94	0.80	31.45	14.28	3.50

DATA FOR - REFUSE COAL.

THIS FRACTION CONSTITUTES 11.9 PERCENT OF THE FEED.

SIZE FRACTION		-----DIRECT VALUES-----				-----CUMULATIVE RETAINED-----				-----CUMULATIVE PASSED-----			
PASSED	RETAINED	WEIGHT PERCENT	ASH PERCENT	SULFUR PERCENT	MOISTURE PERCENT	WEIGHT PERCENT	ASH PERCENT	SULFUR PERCENT	MOISTURE PERCENT	WEIGHT PERCENT	ASH PERCENT	SULFUR PERCENT	MOISTURE PERCENT
	30M	55.60	9.72	3.75	2.75	55.60	9.72	3.75	2.75	100.00	10.47	4.01	2.85
30M	60M	39.30	9.84	3.71	2.95	94.90	9.77	3.73	2.83	44.40	11.40	4.33	2.98
60M	100M	4.10	19.73	6.90	3.20	99.00	10.18	3.86	2.85	5.10	23.41	9.10	3.21
100M	150M	0.50	42.13	20.01	2.20	99.50	10.34	3.95	2.84	1.00	38.51	18.13	3.25
150M		0.50	34.90	16.25	4.30	100.00	10.47	4.01	2.85	0.50	34.90	16.25	4.30

ANALYTICAL DATA

DATA FOR DRYFLO SEPARATION TEST # 46

FIGURES FROM PSOC # 208 FEED SAMPLE.

DATA FOR -

* * COMPOSITE * *

THIS FRACTION CONSTITUTES 100.0 PERCENT OF THE FEED.

SIZE FRACTION		-----DIRECT VALUES-----				-----CUMULATIVE RETAINED-----				-----CUMULATIVE PASSED-----			
PASSED	RETAINED	WEIGHT PERCENT	ASH PERCENT	SULFUR PERCENT	MOISTURE PERCENT	WEIGHT PERCENT	ASH PERCENT	SULFUR PERCENT	MOISTURE PERCENT	WEIGHT PERCENT	ASH PERCENT	SULFUR PERCENT	MOISTURE PERCENT
	30M	32.81	6.57	2.56	2.65	32.81	6.97	2.56	2.65	100.00	8.32	2.91	3.13
30M	60M	35.59	6.68	2.46	3.03	68.39	6.82	2.51	2.85	67.19	8.97	3.08	3.37
60M	100M	15.33	8.45	2.74	3.76	83.72	7.12	2.55	3.02	31.61	11.55	3.77	3.74
100M	150M	6.70	10.77	3.75	3.55	90.42	7.39	2.64	3.06	16.28	14.48	4.74	3.72
150M		9.58	17.07	5.43	3.84	100.00	8.32	2.91	3.13	9.58	17.07	5.43	3.84

ANALYTICAL DATA

DATA FOR DRYFLO SEPARATION TEST # 47

FIGURES FROM PSOC # 208 FEED SAMPLE.

DATA FOR - PRODUCT COAL.

THIS FRACTION CONSTITUTES 59.9 PERCENT OF THE FEED.

SIZE FRACTION		DIRECT VALUES				CUMULATIVE RETAINED				CUMULATIVE PASSED			
PASSED	RETAINED	WEIGHT PERCENT	ASH PERCENT	SULFUR PERCENT	MOISTURE PERCENT	WEIGHT PERCENT	ASH PERCENT	SULFUR PERCENT	MOISTURE PERCENT	WEIGHT PERCENT	ASH PERCENT	SULFUR PERCENT	MOISTURE PERCENT
	30M	18.90	5.84	1.88	3.20	18.90	5.84	1.88	3.20	100.00	8.05	2.67	3.28
30M	60M	32.90	5.31	2.07	3.05	51.80	5.50	2.00	3.10	81.10	8.57	2.86	3.29
60M	100M	21.70	7.31	2.35	3.60	73.50	6.04	2.10	3.25	48.20	10.79	3.40	3.46
100M	150M	11.10	10.37	3.36	3.55	84.60	6.61	2.27	3.29	26.50	13.65	4.25	3.35
150M		15.40	16.01	4.90	3.20	100.00	8.05	2.67	3.28	15.40	16.01	4.90	3.20

DATA FOR - MIDDLING COAL.

THIS FRACTION CONSTITUTES 14.0 PERCENT OF THE FEED.

SIZE FRACTION		DIRECT VALUES				CUMULATIVE RETAINED				CUMULATIVE PASSED			
PASSED	RETAINED	WEIGHT PERCENT	ASH PERCENT	SULFUR PERCENT	MOISTURE PERCENT	WEIGHT PERCENT	ASH PERCENT	SULFUR PERCENT	MOISTURE PERCENT	WEIGHT PERCENT	ASH PERCENT	SULFUR PERCENT	MOISTURE PERCENT
	30M	47.60	5.99	2.17	3.15	47.60	5.99	2.17	3.15	100.00	7.23	2.69	3.17
30M	60M	40.30	6.92	2.65	3.20	87.90	6.42	2.39	3.17	52.40	8.35	3.17	3.19
60M	100M	9.40	10.08	3.51	3.30	97.30	6.77	2.50	3.19	12.10	13.11	4.89	3.17
100M	150M	1.60	19.77	7.79	2.65	98.90	6.98	2.58	3.18	2.70	23.68	9.68	2.71
150M		1.10	29.37	12.43	2.80	100.00	7.23	2.69	3.17	1.10	29.37	12.43	2.80

DATA FOR - REFUSE COAL.

THIS FRACTION CONSTITUTES 26.1 PERCENT OF THE FEED.

SIZE FRACTION		DIRECT VALUES				CUMULATIVE RETAINED				CUMULATIVE PASSED			
PASSED	RETAINED	WEIGHT PERCENT	ASH PERCENT	SULFUR PERCENT	MOISTURE PERCENT	WEIGHT PERCENT	ASH PERCENT	SULFUR PERCENT	MOISTURE PERCENT	WEIGHT PERCENT	ASH PERCENT	SULFUR PERCENT	MOISTURE PERCENT
	30M	55.20	8.41	3.02	1.95	55.20	8.41	3.02	1.95	100.00	9.20	3.41	2.18
30M	60M	38.50	8.76	3.39	2.35	93.70	8.55	3.17	2.11	44.80	10.17	3.89	2.47
60M	100M	5.30	16.03	5.48	3.30	99.00	8.95	3.30	2.18	6.30	18.77	6.93	3.20
100M	150M	0.60	33.50	14.33	2.10	99.60	9.10	3.36	2.18	1.00	33.30	14.61	2.70
150M		0.40	32.99	15.04	3.60	100.00	9.20	3.41	2.18	0.40	32.99	15.04	3.60

ANALYTICAL DATA

DATA FOR DRYFLO SEPARATION TEST # 47

FIGURES FROM PSOC # 208 FEED SAMPLE.

DATA FOR -

* * COMPOSITE * *

THIS FRACTION CONSTITUTES 100.0 PERCENT OF THE FEED.

SIZE FRACTION		DIRECT VALUES				CUMULATIVE RETAINED				CUMULATIVE PASSED			
PASSED	RETAINED	WEIGHT PERCENT	ASH PERCENT	SULFUR PERCENT	MOISTURE PERCENT	WEIGHT PERCENT	ASH PERCENT	SULFUR PERCENT	MOISTURE PERCENT	WEIGHT PERCENT	ASH PERCENT	SULFUR PERCENT	MOISTURE PERCENT
	30M	32.39	7.01	2.45	2.63	32.39	7.01	2.45	2.63	100.00	8.24	2.87	2.98
30M	60M	35.40	6.55	2.54	2.88	67.79	6.77	2.49	2.76	67.61	8.82	3.07	3.14
60M	100M	15.70	8.31	2.72	3.55	83.49	7.06	2.54	2.91	32.21	11.32	3.66	3.43
100M	150M	7.03	11.18	3.75	3.49	90.52	7.38	2.63	2.95	16.51	14.19	4.54	3.32
150M		9.48	16.41	5.13	3.20	100.00	8.24	2.87	2.98	9.48	16.41	5.13	3.20

ANALYTICAL DATA

DATA FOR DRYFLO SEPARATION TEST # 48

FIGURES FROM PSOC # 208 FEED SAMPLE.

DATA FOR - PRODUCT COAL.

THIS FRACTION CONSTITUTES 60.2 PERCENT OF THE FEED.

SIZE FRACTION		-----DIRECT VALUES-----				-----CUMULATIVE RETAINED-----				-----CUMULATIVE PASSED-----			
PASSED	RETAINED	WEIGHT PERCENT	ASH PERCENT	SULFUR PERCENT	MOISTURE PERCENT	WEIGHT PERCENT	ASH PERCENT	SULFUR PERCENT	MOISTURE PERCENT	WEIGHT PERCENT	ASH PERCENT	SULFUR PERCENT	MOISTURE PERCENT
	30M	20.60	5.15	1.91	3.00	20.60	5.15	1.91	3.00	100.00	7.93	2.66	3.25
30M	60M	32.80	5.78	2.07	3.05	53.40	5.54	2.01	3.03	79.40	8.66	2.86	3.31
60M	100M	19.20	7.52	2.38	3.55	72.60	6.06	2.11	3.17	46.60	10.68	3.41	3.50
100M	150M	15.10	10.21	3.36	3.55	87.70	6.78	2.32	3.23	27.40	12.89	4.13	3.46
150M		12.30	16.19	5.08	3.35	100.00	7.93	2.66	3.25	12.30	16.19	5.08	3.35

DATA FOR - MIDDLING COAL.

THIS FRACTION CONSTITUTES 19.6 PERCENT OF THE FEED.

SIZE FRACTION		-----DIRECT VALUES-----				-----CUMULATIVE RETAINED-----				-----CUMULATIVE PASSED-----			
PASSED	RETAINED	WEIGHT PERCENT	ASH PERCENT	SULFUR PERCENT	MOISTURE PERCENT	WEIGHT PERCENT	ASH PERCENT	SULFUR PERCENT	MOISTURE PERCENT	WEIGHT PERCENT	ASH PERCENT	SULFUR PERCENT	MOISTURE PERCENT
	30M	51.10	7.05	2.48	3.60	51.10	7.05	2.48	3.60	100.00	7.98	2.91	3.44
30M	60M	39.50	7.75	2.87	3.25	90.60	7.36	2.65	3.45	48.90	8.95	3.37	3.27
60M	100M	7.50	10.93	4.00	3.45	98.10	7.63	2.75	3.45	9.40	14.01	5.46	3.37
100M	150M	1.10	21.69	8.87	2.95	99.20	7.78	2.82	3.44	1.90	26.16	11.20	3.08
150M		0.80	32.30	14.41	3.25	100.00	7.98	2.91	3.44	0.80	32.30	14.41	3.25

DATA FOR - REFUSE COAL.

THIS FRACTION CONSTITUTES 20.2 PERCENT OF THE FEED.

SIZE FRACTION		-----DIRECT VALUES-----				-----CUMULATIVE RETAINED-----				-----CUMULATIVE PASSED-----			
PASSED	RETAINED	WEIGHT PERCENT	ASH PERCENT	SULFUR PERCENT	MOISTURE PERCENT	WEIGHT PERCENT	ASH PERCENT	SULFUR PERCENT	MOISTURE PERCENT	WEIGHT PERCENT	ASH PERCENT	SULFUR PERCENT	MOISTURE PERCENT
	30M	56.70	8.25	3.23	3.05	56.70	8.25	3.23	3.05	100.00	9.19	3.51	3.12
30M	60M	38.00	8.94	3.43	3.20	94.70	8.53	3.31	3.11	43.30	10.42	3.88	3.21
60M	100M	4.30	17.58	5.80	3.30	99.00	8.92	3.42	3.12	5.30	21.01	7.10	3.27
100M	150M	0.50	36.89	17.46	2.40	99.50	9.06	3.49	3.11	1.00	35.76	12.69	3.13
150M		0.50	34.63	7.91	3.85	100.00	9.19	3.51	3.12	0.50	34.63	7.91	3.85

ANALYTICAL DATA

DATA FOR DRYFLO SEPARATION TEST # 48

FIGURES FROM PSOC # 208 FEED SAMPLE.

DATA FOR -

* * COMPOSITE * *

THIS FRACTION CONSTITUTES 100.0 PERCENT OF THE FEED.

SIZE FRACTION		-----DIRECT VALUES-----				-----CUMULATIVE RETAINED-----				-----CUMULATIVE PASSED-----			
PASSED	RETAINED	WEIGHT PERCENT	ASH PERCENT	SULFUR PERCENT	MOISTURE PERCENT	WEIGHT PERCENT	ASH PERCENT	SULFUR PERCENT	MOISTURE PERCENT	WEIGHT PERCENT	ASH PERCENT	SULFUR PERCENT	MOISTURE PERCENT
	30M	33.87	6.76	2.52	3.19	33.87	6.76	2.52	3.19	100.00	8.20	2.88	3.26
30M	60M	35.16	6.90	2.54	3.13	69.03	6.83	2.53	3.16	66.13	8.93	3.07	3.29
60M	100M	13.90	8.51	2.77	3.52	82.93	7.11	2.57	3.22	30.97	11.24	3.66	3.48
100M	150M	9.41	10.76	3.64	3.52	92.34	7.49	2.68	3.25	17.07	13.45	4.39	3.45
150M		7.66	16.76	5.31	3.35	100.00	8.20	2.88	3.26	7.66	16.76	5.31	3.35

ANALYTICAL DATA

DATA FOR DRYFLO SEPARATION TEST # 49

FIGURES FROM PSOC # 208 FEED SAMPLE.

DATA FOR - PRODUCT COAL.

THIS FRACTION CONSTITUTES 56.2 PERCENT OF THE FEED.

SIZE FRACTION		DIRECT VALUES				CUMULATIVE RETAINED				CUMULATIVE PASSED			
PASSED	RETAINED	WEIGHT PERCENT	ASH PERCENT	SULFUR PERCENT	MOISTURE PERCENT	WEIGHT PERCENT	ASH PERCENT	SULFUR PERCENT	MOISTURE PERCENT	WEIGHT PERCENT	ASH PERCENT	SULFUR PERCENT	MOISTURE PERCENT
	30M	14.10	5.12	1.77	3.30	14.10	5.12	1.77	3.30	100.00	7.76	2.57	3.42
30M	60M	38.40	5.64	1.94	3.45	52.50	5.50	1.89	3.41	85.90	8.19	2.70	3.45
60M	100M	27.20	7.10	2.46	3.50	79.70	6.05	2.09	3.44	47.50	10.25	3.32	3.44
100M	150M	11.40	12.64	3.85	3.45	91.10	6.87	2.31	3.44	20.30	14.46	4.47	3.36
150M		8.90	16.80	5.26	3.25	100.00	7.76	2.57	3.42	8.90	16.80	5.26	3.25

DATA FOR - MIDDLING COAL.

THIS FRACTION CONSTITUTES 20.3 PERCENT OF THE FEED.

SIZE FRACTION		DIRECT VALUES				CUMULATIVE RETAINED				CUMULATIVE PASSED			
PASSED	RETAINED	WEIGHT PERCENT	ASH PERCENT	SULFUR PERCENT	MOISTURE PERCENT	WEIGHT PERCENT	ASH PERCENT	SULFUR PERCENT	MOISTURE PERCENT	WEIGHT PERCENT	ASH PERCENT	SULFUR PERCENT	MOISTURE PERCENT
	30M	49.50	5.95	2.07	3.35	49.50	5.95	2.07	3.35	100.00	7.32	2.68	3.36
30M	60M	43.10	7.35	2.68	3.35	92.60	6.60	2.35	3.35	50.50	8.67	3.27	3.36
60M	100M	6.40	12.95	4.86	3.50	99.00	7.01	2.52	3.36	7.40	16.33	6.73	3.42
100M	150M	0.50	35.45	16.98	2.50	99.50	7.15	2.59	3.36	1.00	37.97	18.68	2.90
150M		0.50	40.49	20.39	3.30	100.00	7.32	2.68	3.36	0.50	40.49	20.39	3.30

DATA FOR - REFUSE COAL.

THIS FRACTION CONSTITUTES 23.5 PERCENT OF THE FEED.

SIZE FRACTION		DIRECT VALUES				CUMULATIVE RETAINED				CUMULATIVE PASSED			
PASSED	RETAINED	WEIGHT PERCENT	ASH PERCENT	SULFUR PERCENT	MOISTURE PERCENT	WEIGHT PERCENT	ASH PERCENT	SULFUR PERCENT	MOISTURE PERCENT	WEIGHT PERCENT	ASH PERCENT	SULFUR PERCENT	MOISTURE PERCENT
	30M	58.50	8.15	3.03	3.10	58.50	8.15	3.03	3.10	100.00	9.03	3.55	3.08
30M	60M	37.90	8.72	3.58	3.05	96.40	8.37	3.25	3.08	41.50	10.27	4.28	3.06
60M	100M	3.00	23.83	9.55	3.05	99.40	8.84	3.44	3.08	3.60	26.61	11.60	3.16
100M	150M	0.60	40.50	21.87	3.70	100.00	9.03	3.55	3.08	0.60	40.50	21.87	3.70
150M		0.00	0.00	0.00	0.00	100.00	9.03	3.55	3.08	0.00	0.00	0.00	0.00

ANALYTICAL DATA

DATA FOR DRYFLO SEPARATION TEST # 49

FIGURES FROM PSOC # 208 FEED SAMPLE.

DATA FOR -

* * COMPOSITE * *

THIS FRACTION CONSTITUTES 100.0 PERCENT OF THE FEED.

SIZE FRACTION		DIRECT VALUES				CUMULATIVE RETAINED				CUMULATIVE PASSED			
PASSED	RETAINED	WEIGHT PERCENT	ASH PERCENT	SULFUR PERCENT	MOISTURE PERCENT	WEIGHT PERCENT	ASH PERCENT	SULFUR PERCENT	MOISTURE PERCENT	WEIGHT PERCENT	ASH PERCENT	SULFUR PERCENT	MOISTURE PERCENT
	30M	31.72	6.70	2.41	3.23	31.72	6.70	2.41	3.23	100.00	7.97	2.82	3.33
30M	60M	39.24	6.72	2.48	3.34	70.96	6.71	2.45	3.29	68.28	8.56	3.01	3.38
60M	100M	17.29	8.22	2.93	3.48	88.25	7.01	2.54	3.33	29.04	11.04	3.74	3.43
100M	150M	6.65	13.58	4.43	3.44	94.90	7.47	2.67	3.33	11.75	15.18	4.92	3.36
150M		5.10	17.27	5.56	3.25	100.00	7.97	2.82	3.33	5.10	17.27	5.56	3.25

ANALYTICAL DATA

DATA FOR DRYFLO SEPARATION TEST # 50

FIGURES FROM PSOC # 208 FEED SAMPLE.

DATA FOR - PRODUCT COAL.

THIS FRACTION CONSTITUTES 63.0 PERCENT OF THE FEED.

SIZE		-----DIRECT VALUES-----				-----CUMULATIVE RETAINED-----				-----CUMULATIVE PASSED-----			
FRACTION		WEIGHT	ASH	SULFUR	MOISTURE	WEIGHT	ASH	SULFUR	MOISTURE	WEIGHT	ASH	SULFUR	MOISTURE
PASSED	RETAINED	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT
	30M	17.80	5.11	1.74	3.20	17.80	5.11	1.74	3.20	100.00	8.00	2.72	3.32
30M	60M	43.20	5.95	2.12	3.40	61.00	5.70	2.01	3.34	82.20	8.62	2.93	3.34
60M	100M	23.90	8.79	2.88	3.35	84.90	6.57	2.25	3.34	39.00	11.59	3.82	3.28
100M	150M	9.60	14.77	4.93	3.15	94.50	7.41	2.53	3.32	15.10	16.01	5.31	3.17
150M		5.50	18.18	5.98	3.20	100.00	8.00	2.72	3.32	5.50	18.18	5.98	3.20

DATA FOR - MIDDLING COAL.

THIS FRACTION CONSTITUTES 17.7 PERCENT OF THE FEED.

SIZE		-----DIRECT VALUES-----				-----CUMULATIVE RETAINED-----				-----CUMULATIVE PASSED-----			
FRACTION		WEIGHT	ASH	SULFUR	MOISTURE	WEIGHT	ASH	SULFUR	MOISTURE	WEIGHT	ASH	SULFUR	MOISTURE
PASSED	RETAINED	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT
	30M	56.90	6.10	2.18	3.20	56.90	6.10	2.18	3.20	100.00	7.45	2.76	3.19
30M	60M	38.80	7.95	2.95	3.20	95.70	6.85	2.49	3.20	43.10	9.22	3.54	3.18
60M	100M	3.50	17.91	7.74	3.10	99.20	7.24	2.68	3.20	4.30	20.72	8.83	3.04
100M	150M	0.80	33.02	13.61	2.80	100.00	7.45	2.76	3.19	0.80	33.02	13.61	2.80
150M		0.00	0.00	0.00	0.00	100.00	7.45	2.76	3.19	0.00	0.00	0.00	0.00

DATA FOR - REFUSE COAL.

THIS FRACTION CONSTITUTES 19.3 PERCENT OF THE FEED.

SIZE		-----DIRECT VALUES-----				-----CUMULATIVE RETAINED-----				-----CUMULATIVE PASSED-----			
FRACTION		WEIGHT	ASH	SULFUR	MOISTURE	WEIGHT	ASH	SULFUR	MOISTURE	WEIGHT	ASH	SULFUR	MOISTURE
PASSED	RETAINED	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT
	30M	68.30	10.49	3.77	3.20	68.30	10.49	3.77	3.20	100.00	11.61	4.30	3.19
30M	60M	30.10	12.81	4.92	3.20	98.40	11.20	4.12	3.20	31.70	14.01	5.45	3.18
60M	100M	1.10	38.80	15.80	2.45	99.50	11.50	4.25	3.19	1.60	36.57	15.34	2.75
100M	150M	0.50	31.68	14.33	3.40	100.00	11.61	4.30	3.19	0.50	31.68	14.33	3.40
150M		0.00	0.00	0.00	0.00	100.00	11.61	4.30	3.19	0.00	0.00	0.00	0.00

ANALYTICAL DATA

DATA FOR DRYFLO SEPARATION TEST # 50

FIGURES FROM PSOC # 208 FEED SAMPLE.

DATA FOR -

* * COMPOSITE * *

THIS FRACTION CONSTITUTES 100.0 PERCENT OF THE FEED.

SIZE		-----DIRECT VALUES-----				-----CUMULATIVE RETAINED-----				-----CUMULATIVE PASSED-----			
FRACTION		WEIGHT	ASH	SULFUR	MOISTURE	WEIGHT	ASH	SULFUR	MOISTURE	WEIGHT	ASH	SULFUR	MOISTURE
PASSED	RETAINED	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT
	30M	34.47	7.46	2.64	3.20	34.47	7.46	2.64	3.20	100.00	8.60	3.03	3.27
30M	60M	39.89	7.29	2.67	3.34	74.36	7.37	2.66	3.27	65.53	9.20	3.23	3.31
60M	100M	15.89	9.55	3.24	3.33	90.25	7.75	2.76	3.28	25.64	12.16	4.11	3.27
100M	150M	6.29	15.44	5.27	3.15	96.53	8.25	2.92	3.27	9.75	16.41	5.52	3.17
150M		3.46	18.18	5.98	3.20	100.00	8.60	3.03	3.27	3.46	18.18	5.98	3.20

ANALYTICAL DATA

DATA FOR DRYFLO SEPARATION TEST # 51

FIGURES FROM ELLIOT FEED SAMPLE.

DATA FOR - PRODUCT COAL.

THIS FRACTION CONSTITUTES 39.0 PERCENT OF THE FEED.

SIZE		DIRECT VALUES				CUMULATIVE RETAINED				CUMULATIVE PASSED			
FRACTION		WEIGHT	ASH	SULFUR	MOISTURE	WEIGHT	ASH	SULFUR	MOISTURE	WEIGHT	ASH	SULFUR	MOISTURE
PASSED	RETAINED	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT
	16M	7.00	7.00	1.36	0.70	7.00	7.00	1.36	0.70	100.00	9.24	2.63	0.52
16M	30M	14.40	6.95	1.41	0.70	21.40	6.97	1.39	0.70	93.00	9.41	2.72	0.51
30M	60M	27.30	7.43	1.68	0.40	48.70	7.23	1.55	0.53	78.60	9.86	2.96	0.47
60M	100M	24.90	8.34	2.28	0.45	73.60	7.60	1.80	0.50	51.30	11.15	3.64	0.51
100M	150M	10.10	10.75	3.66	0.50	83.70	7.98	2.02	0.50	26.40	13.80	4.93	0.56
150M		16.30	15.69	5.72	0.60	100.00	9.24	2.63	0.52	16.30	15.69	5.72	0.60

DATA FOR - MIDDLING COAL.

THIS FRACTION CONSTITUTES 28.3 PERCENT OF THE FEED.

SIZE		DIRECT VALUES				CUMULATIVE RETAINED				CUMULATIVE PASSED			
FRACTION		WEIGHT	ASH	SULFUR	MOISTURE	WEIGHT	ASH	SULFUR	MOISTURE	WEIGHT	ASH	SULFUR	MOISTURE
PASSED	RETAINED	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT
	16M	25.40	12.85	1.77	0.40	25.40	12.85	1.77	0.40	100.00	12.06	2.64	0.40
16M	30M	32.30	12.03	2.34	0.35	57.70	12.39	2.09	0.37	74.60	11.79	2.94	0.40
30M	60M	29.70	10.74	2.77	0.40	87.40	11.83	2.32	0.38	42.30	11.60	3.40	0.44
60M	100M	8.70	12.01	3.23	0.50	96.10	11.85	2.40	0.39	12.60	13.62	4.89	0.53
100M	150M	1.80	18.31	8.91	0.60	97.90	11.97	2.52	0.40	3.90	17.23	8.60	0.60
150M		2.10	16.30	8.33	0.60	100.00	12.06	2.64	0.40	2.10	16.30	8.33	0.60

DATA FOR - REFUSE COAL.

THIS FRACTION CONSTITUTES 32.7 PERCENT OF THE FEED.

SIZE		DIRECT VALUES				CUMULATIVE RETAINED				CUMULATIVE PASSED			
FRACTION		WEIGHT	ASH	SULFUR	MOISTURE	WEIGHT	ASH	SULFUR	MOISTURE	WEIGHT	ASH	SULFUR	MOISTURE
PASSED	RETAINED	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT
	16M	26.60	25.72	4.98	0.35	26.60	25.72	4.98	0.35	100.00	17.28	4.26	0.34
16M	30M	35.60	16.15	4.12	0.30	62.20	20.24	4.49	0.32	73.40	14.22	4.00	0.34
30M	60M	28.60	11.53	3.29	0.30	90.80	17.50	4.11	0.31	37.80	12.41	3.88	0.37
60M	100M	5.80	14.49	4.48	0.65	96.60	17.32	4.13	0.33	9.20	15.15	5.72	0.59
100M	150M	3.40	16.28	7.84	0.50	100.00	17.28	4.26	0.34	3.40	16.28	7.84	0.50
150M		0.00	0.00	0.00	0.00	100.00	17.28	4.26	0.34	0.00	0.00	0.00	0.00

ANALYTICAL DATA

DATA FOR DRYFLO SEPARATION TEST # 51

FIGURES FROM ELLIOT FEED SAMPLE.

DATA FOR -

* * COMPOSITE * *

THIS FRACTION CONSTITUTES 100.0 PERCENT OF THE FEED.

SIZE		DIRECT VALUES				CUMULATIVE RETAINED				CUMULATIVE PASSED			
FRACTION		WEIGHT	ASH	SULFUR	MOISTURE	WEIGHT	ASH	SULFUR	MOISTURE	WEIGHT	ASH	SULFUR	MOISTURE
PASSED	RETAINED	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT
	16M	18.62	18.01	3.21	0.42	18.62	18.01	3.21	0.42	100.00	12.67	3.17	0.43
16M	30M	26.40	12.77	2.93	0.40	45.01	14.93	3.04	0.41	81.38	11.45	3.16	0.43
30M	60M	28.40	9.76	2.53	0.37	73.42	12.93	2.85	0.39	54.99	10.81	3.26	0.44
60M	100M	14.07	9.81	2.74	0.49	87.49	12.43	2.83	0.41	26.58	11.93	4.05	0.52
100M	150M	5.56	12.55	4.98	0.51	93.05	12.44	2.96	0.41	12.51	14.32	5.51	0.56
M		6.95	15.74	5.94	0.60	100.00	12.67	3.17	0.43	6.95	15.74	5.94	0.60

ANALYTICAL DATA

DATA FOR DRYFLO SEPARATION TEST # 52

FIGURES BASED ON ELLIOT FEED SAMPLE.

DATA FOR - PRODUCT COAL.

THIS FRACTION CONSTITUTES 51.0 PERCENT OF THE FEED.

SIZE FRACTION		-----DIRECT VALUES-----				-----CUMULATIVE RETAINED-----				-----CUMULATIVE PASSED-----			
PASSED	RETAINED	WEIGHT PERCENT	ASH PERCENT	SULFUR PERCENT	MOISTURE PERCENT	WEIGHT PERCENT	ASH PERCENT	SULFUR PERCENT	MOISTURE PERCENT	WEIGHT PERCENT	ASH PERCENT	SULFUR PERCENT	MOISTURE PERCENT
	16M	8.90	8.84	1.38	0.50	8.90	8.84	1.38	0.50	100.00	10.02	2.76	0.51
16M	30M	19.50	9.19	1.78	0.40	28.40	9.08	1.65	0.43	91.10	10.14	2.90	0.51
30M	60M	32.60	8.94	2.18	0.40	61.00	9.01	1.94	0.41	71.60	10.39	3.20	0.54
60M	100M	20.30	9.97	2.84	0.70	81.30	9.25	2.16	0.49	39.00	11.61	4.06	0.66
100M	150M	9.00	12.37	4.66	0.60	90.30	9.56	2.41	0.50	18.70	13.39	5.39	0.63
150M		9.70	14.34	6.06	0.65	100.00	10.02	2.76	0.51	9.70	14.34	6.06	0.65

DATA FOR - MIDDLING COAL.

THIS FRACTION CONSTITUTES 22.6 PERCENT OF THE FEED.

SIZE FRACTION		-----DIRECT VALUES-----				-----CUMULATIVE RETAINED-----				-----CUMULATIVE PASSED-----			
PASSED	RETAINED	WEIGHT PERCENT	ASH PERCENT	SULFUR PERCENT	MOISTURE PERCENT	WEIGHT PERCENT	ASH PERCENT	SULFUR PERCENT	MOISTURE PERCENT	WEIGHT PERCENT	ASH PERCENT	SULFUR PERCENT	MOISTURE PERCENT
	16M	0.00	15.98	2.08	0.50	0.00	0.00	0.00	0.00	100.00	14.38	4.73	0.50
16M	30M	28.70	13.47	3.06	0.50	28.70	13.47	3.06	0.50	100.00	14.38	4.73	0.50
30M	60M	35.30	11.76	3.33	0.50	64.00	12.53	3.21	0.50	71.30	14.75	5.40	0.51
60M	100M	28.80	17.24	6.91	0.50	92.80	13.99	4.36	0.50	36.00	17.67	7.43	0.51
100M	150M	5.00	19.41	9.51	0.55	97.80	14.27	4.62	0.50	7.20	19.41	9.51	0.55
150M		2.20	19.41	9.51	0.55	100.00	14.38	4.73	0.50	2.20	19.41	9.51	0.55

DATA FOR - REFUSE COAL.

THIS FRACTION CONSTITUTES 26.4 PERCENT OF THE FEED.

SIZE FRACTION		-----DIRECT VALUES-----				-----CUMULATIVE RETAINED-----				-----CUMULATIVE PASSED-----			
PASSED	RETAINED	WEIGHT PERCENT	ASH PERCENT	SULFUR PERCENT	MOISTURE PERCENT	WEIGHT PERCENT	ASH PERCENT	SULFUR PERCENT	MOISTURE PERCENT	WEIGHT PERCENT	ASH PERCENT	SULFUR PERCENT	MOISTURE PERCENT
	16M	0.00	25.55	6.07	0.60	0.00	0.00	0.00	0.00	100.00	17.00	5.72	0.44
16M	30M	31.50	15.46	3.70	0.40	31.50	15.46	3.70	0.40	100.00	17.00	5.72	0.44
30M	60M	38.10	15.33	4.57	0.50	69.60	15.39	4.18	0.45	68.50	17.70	6.65	0.46
60M	100M	25.90	20.83	9.16	0.40	95.50	16.86	5.53	0.44	30.40	20.68	9.26	0.41
100M	150M	3.10	19.80	9.86	0.50	98.60	16.96	5.66	0.44	4.50	19.80	9.86	0.50
150M		1.40	19.80	9.86	0.50	100.00	17.00	5.72	0.44	1.40	19.80	9.86	0.50

ANALYTICAL DATA

DATA FOR DRYFLO SEPARATION TEST # 52

FIGURES BASED ON ELLIOT FEED SAMPLE.

DATA FOR -

* * COMPOSITE * *

THIS FRACTION CONSTITUTES 100.0 PERCENT OF THE FEED.

SIZE FRACTION		-----DIRECT VALUES-----				-----CUMULATIVE RETAINED-----				-----CUMULATIVE PASSED-----			
PASSED	RETAINED	WEIGHT PERCENT	ASH PERCENT	SULFUR PERCENT	MOISTURE PERCENT	WEIGHT PERCENT	ASH PERCENT	SULFUR PERCENT	MOISTURE PERCENT	WEIGHT PERCENT	ASH PERCENT	SULFUR PERCENT	MOISTURE PERCENT
	16M	4.54	8.84	1.38	0.50	4.54	8.84	1.38	0.50	100.00	12.85	3.99	0.49
16M	30M	24.75	12.42	2.76	0.43	29.29	11.86	2.55	0.44	95.46	13.04	4.11	0.49
30M	60M	34.66	11.44	3.14	0.45	63.95	11.64	2.87	0.45	70.71	13.26	4.59	0.51
60M	100M	23.70	15.10	5.78	0.56	87.65	12.57	3.66	0.48	36.05	15.00	5.98	0.57
100M	150M	6.54	14.52	6.15	0.58	94.19	12.71	3.83	0.48	12.35	14.80	6.36	0.60
150M		5.81	15.12	6.60	0.63	100.00	12.85	3.99	0.49	5.81	15.12	6.60	0.63

ANALYTICAL DATA

DATA FOR DRYFLO SEPARATION TEST # 53.

FIGURES FROM ELLIOT FEED SAMPLE.

DATA FOR - PRODUCT COAL.

THIS FRACTION CONSTITUTES 60.6 PERCENT OF THE FEED.

SIZE FRACTION		DIRECT VALUES				CUMULATIVE RETAINED				CUMULATIVE PASSED			
PASSED	RETAINED	WEIGHT PERCENT	ASH PERCENT	SULFUR PERCENT	MOISTURE PERCENT	WEIGHT PERCENT	ASH PERCENT	SULFUR PERCENT	MOISTURE PERCENT	WEIGHT PERCENT	ASH PERCENT	SULFUR PERCENT	MOISTURE PERCENT
	30M	36.20	8.02	1.78	0.90	36.20	8.02	1.78	0.90	100.00	9.07	2.59	0.82
30M	60M	32.40	8.26	1.77	0.75	68.60	8.13	1.78	0.83	63.80	9.66	3.05	0.77
60M	100M	16.50	9.39	3.11	0.80	85.10	8.38	2.03	0.82	31.40	11.11	4.37	0.80
100M	150M	7.40	11.39	4.81	0.80	92.50	8.62	2.26	0.82	14.90	13.02	5.76	0.80
150M		7.50	14.62	6.70	0.80	100.00	9.07	2.59	0.82	7.50	14.62	6.70	0.80

DATA FOR - MIDDLING COAL.

THIS FRACTION CONSTITUTES 23.6 PERCENT OF THE FEED.

SIZE FRACTION		DIRECT VALUES				CUMULATIVE RETAINED				CUMULATIVE PASSED			
PASSED	RETAINED	WEIGHT PERCENT	ASH PERCENT	SULFUR PERCENT	MOISTURE PERCENT	WEIGHT PERCENT	ASH PERCENT	SULFUR PERCENT	MOISTURE PERCENT	WEIGHT PERCENT	ASH PERCENT	SULFUR PERCENT	MOISTURE PERCENT
	30M	70.80	15.33	2.65	0.55	70.80	15.33	2.65	0.55	100.00	14.79	3.17	0.60
30M	60M	25.30	12.34	3.48	0.75	96.10	14.54	2.87	0.60	29.20	13.47	4.42	0.73
60M	100M	2.70	21.23	10.80	0.60	98.80	14.73	3.09	0.60	3.90	20.80	10.54	0.59
100M	150M	0.60	22.85	12.61	0.45	99.40	14.77	3.14	0.60	1.20	19.83	9.96	0.57
150M		0.60	16.82	7.30	0.70	100.00	14.79	3.17	0.60	0.60	16.82	7.30	0.70

DATA FOR - REFUSE COAL.

THIS FRACTION CONSTITUTES 15.8 PERCENT OF THE FEED.

SIZE FRACTION		DIRECT VALUES				CUMULATIVE RETAINED				CUMULATIVE PASSED			
PASSED	RETAINED	WEIGHT PERCENT	ASH PERCENT	SULFUR PERCENT	MOISTURE PERCENT	WEIGHT PERCENT	ASH PERCENT	SULFUR PERCENT	MOISTURE PERCENT	WEIGHT PERCENT	ASH PERCENT	SULFUR PERCENT	MOISTURE PERCENT
	30M	76.30	21.81	5.47	0.50	76.30	21.81	5.47	0.50	100.00	20.71	5.61	0.53
30M	60M	21.20	16.36	5.53	0.65	97.50	20.62	5.48	0.53	23.70	17.17	6.06	0.64
60M	100M	1.50	26.80	11.74	0.55	99.00	20.72	5.58	0.53	2.50	24.00	10.59	0.55
100M	150M	0.50	23.56	11.18	0.45	99.50	20.73	5.61	0.53	1.00	19.80	8.86	0.55
150M		0.50	16.05	6.55	0.65	100.00	20.71	5.61	0.53	0.50	16.05	6.55	0.65

ANALYTICAL DATA

DATA FOR DRYFLO SEPARATION TEST # 53.

FIGURES FROM ELLIOT FEED SAMPLE.

DATA FOR -

* * COMPOSITE * *

THIS FRACTION CONSTITUTES 100.0 PERCENT OF THE FEED.

SIZE FRACTION		DIRECT VALUES				CUMULATIVE RETAINED				CUMULATIVE PASSED			
PASSED	RETAINED	WEIGHT PERCENT	ASH PERCENT	SULFUR PERCENT	MOISTURE PERCENT	WEIGHT PERCENT	ASH PERCENT	SULFUR PERCENT	MOISTURE PERCENT	WEIGHT PERCENT	ASH PERCENT	SULFUR PERCENT	MOISTURE PERCENT
	30M	50.70	13.71	2.94	0.69	50.70	13.71	2.94	0.69	100.00	12.26	3.20	0.72
30M	60M	28.95	10.04	2.56	0.74	79.66	12.37	2.80	0.71	49.30	10.77	3.47	0.76
60M	100M	10.87	10.46	3.75	0.78	90.53	12.14	2.92	0.72	20.34	11.80	4.77	0.79
100M	150M	4.70	11.94	5.15	0.78	95.23	12.13	3.03	0.72	9.47	13.33	5.94	0.79
150M		4.77	14.71	6.72	0.79	100.00	12.26	3.20	0.72	4.77	14.71	6.72	0.79

ANALYTICAL DATA

DATA FOR DRYFLO SEPARATION TEST # 54.

FIGURES FROM TEST # 28 RECYCLE

DATA FOR - PRODUCT COAL.

THIS FRACTION CONSTITUTES 44.3 PERCENT OF THE FEED.

SIZE FRACTION		-----DIRECT VALUES-----				-----CUMULATIVE RETAINED-----				-----CUMULATIVE PASSED-----			
PASSED	RETAINED	WEIGHT PERCENT	ASH PERCENT	SULFUR PERCENT	MOISTURE PERCENT	WEIGHT PERCENT	ASH PERCENT	SULFUR PERCENT	MOISTURE PERCENT	WEIGHT PERCENT	ASH PERCENT	SULFUR PERCENT	MOISTURE PERCENT
	30M	37.30	8.05	1.60	5.60	37.30	8.05	1.60	5.60	100.00	8.33	1.81	5.70
30M	60M	52.90	7.92	1.73	5.90	90.20	7.97	1.68	5.78	62.70	8.50	1.94	5.76
60M	100M	8.60	10.03	2.25	5.30	98.80	8.15	1.73	5.73	9.80	11.65	3.09	4.99
100M	150M	0.70	21.13	7.50	3.70	99.50	8.24	1.77	5.72	1.20	23.30	9.08	2.76
150M		0.50	26.33	11.29	1.45	100.00	8.33	1.81	5.70	0.50	26.33	11.29	1.45

DATA FOR - MIDDLING COAL.

THIS FRACTION CONSTITUTES 39.4 PERCENT OF THE FEED.

SIZE FRACTION		-----DIRECT VALUES-----				-----CUMULATIVE RETAINED-----				-----CUMULATIVE PASSED-----			
PASSED	RETAINED	WEIGHT PERCENT	ASH PERCENT	SULFUR PERCENT	MOISTURE PERCENT	WEIGHT PERCENT	ASH PERCENT	SULFUR PERCENT	MOISTURE PERCENT	WEIGHT PERCENT	ASH PERCENT	SULFUR PERCENT	MOISTURE PERCENT
	30M	65.90	9.39	1.82	5.25	65.90	9.39	1.82	5.25	100.00	10.72	2.59	4.97
30M	60M	32.50	12.67	3.66	4.50	98.40	10.47	2.43	5.00	34.10	13.30	4.07	4.44
60M	100M	1.20	24.35	10.83	3.90	99.60	10.64	2.53	4.99	1.60	26.13	12.42	3.18
100M	150M	0.10	56.78	35.67	0.35	99.70	10.69	2.56	4.98	0.40	31.47	17.19	1.02
150M		0.30	23.04	11.03	1.25	100.00	10.72	2.59	4.97	0.30	23.04	11.03	1.25

DATA FOR - REFUSE COAL.

THIS FRACTION CONSTITUTES 16.3 PERCENT OF THE FEED.

SIZE FRACTION		-----DIRECT VALUES-----				-----CUMULATIVE RETAINED-----				-----CUMULATIVE PASSED-----			
PASSED	RETAINED	WEIGHT PERCENT	ASH PERCENT	SULFUR PERCENT	MOISTURE PERCENT	WEIGHT PERCENT	ASH PERCENT	SULFUR PERCENT	MOISTURE PERCENT	WEIGHT PERCENT	ASH PERCENT	SULFUR PERCENT	MOISTURE PERCENT
	30M	71.60	22.97	2.85	4.45	71.60	22.97	2.85	4.45	100.00	19.62	3.00	4.66
30M	60M	27.40	9.98	2.60	5.35	99.00	19.37	2.78	4.70	28.40	11.18	3.39	5.20
60M	100M	0.60	45.49	27.00	1.40	99.60	19.53	2.93	4.68	1.00	43.98	25.14	0.95
100M	150M	0.20	61.62	44.70	0.25	99.80	19.62	3.01	4.67	0.40	41.71	22.35	0.27
150M		0.20	21.80	0.00	0.30	100.00	19.62	3.00	4.66	0.20	21.80	0.00	0.30

ANALYTICAL DATA

DATA FOR DRYFLO SEPARATION TEST # 54.

FIGURES FROM TEST # 28 RECYCLE

DATA FOR -

* * COMPOSITE * *

THIS FRACTION CONSTITUTES 100.0 PERCENT OF THE FEED.

SIZE FRACTION		-----DIRECT VALUES-----				-----CUMULATIVE RETAINED-----				-----CUMULATIVE PASSED-----			
PASSED	RETAINED	WEIGHT PERCENT	ASH PERCENT	SULFUR PERCENT	MOISTURE PERCENT	WEIGHT PERCENT	ASH PERCENT	SULFUR PERCENT	MOISTURE PERCENT	WEIGHT PERCENT	ASH PERCENT	SULFUR PERCENT	MOISTURE PERCENT
	30M	54.16	11.91	1.97	5.18	54.16	11.91	1.97	5.18	100.00	11.12	2.31	5.24
30M	60M	40.71	9.64	2.43	5.40	94.87	10.93	2.17	5.28	45.84	10.18	2.71	5.31
60M	100M	4.38	12.37	3.73	5.06	99.25	11.00	2.24	5.27	5.13	14.46	4.93	4.64
100M	150M	0.38	28.26	13.58	3.06	99.63	11.06	2.28	5.26	0.75	26.60	11.92	2.18
150M		0.37	24.89	10.22	1.29	100.00	11.12	2.31	5.24	0.37	24.89	10.22	1.29

ANALYTICAL DATA

DATA FOR DRYFLO SEPARATION TEST # 55.

FIGURES FROM TEST # 28 RECYCLE.

DATA FOR - PRODUCT COAL.

THIS FRACTION CONSTITUTES 65.0 PERCENT OF THE FEED.

SIZE FRACTION		-----DIRECT VALUES-----				-----CUMULATIVE RETAINED-----				-----CUMULATIVE PASSED-----			
PASSED	RETAINED	WEIGHT PERCENT	ASH PERCENT	SULFUR PERCENT	MOISTURE PERCENT	WEIGHT PERCENT	ASH PERCENT	SULFUR PERCENT	MOISTURE PERCENT	WEIGHT PERCENT	ASH PERCENT	SULFUR PERCENT	MOISTURE PERCENT
	30M	46.50	8.25	1.72	5.50	46.50	8.25	1.72	5.50	100.00	8.56	1.89	5.50
30M	60M	47.00	8.21	1.83	5.60	93.50	8.23	1.78	5.55	53.50	8.82	2.04	5.49
60M	100M	5.70	11.59	2.64	5.05	99.20	8.42	1.82	5.52	6.50	13.27	3.59	4.74
100M	150M	0.50	22.15	8.92	3.15	99.70	8.49	1.86	5.51	0.80	25.24	10.33	2.49
150M		0.30	30.38	12.67	1.40	100.00	8.56	1.89	5.50	0.30	30.38	12.67	1.40

DATA FOR - MIDDLING COAL.

THIS FRACTION CONSTITUTES 24.8 PERCENT OF THE FEED.

SIZE FRACTION		-----DIRECT VALUES-----				-----CUMULATIVE RETAINED-----				-----CUMULATIVE PASSED-----			
PASSED	RETAINED	WEIGHT PERCENT	ASH PERCENT	SULFUR PERCENT	MOISTURE PERCENT	WEIGHT PERCENT	ASH PERCENT	SULFUR PERCENT	MOISTURE PERCENT	WEIGHT PERCENT	ASH PERCENT	SULFUR PERCENT	MOISTURE PERCENT
	30M	74.00	10.57	1.92	6.30	74.00	10.57	1.92	6.30	100.00	10.85	2.11	6.02
30M	60M	25.40	10.98	2.41	5.30	99.40	10.67	2.05	6.04	26.00	11.63	2.65	5.21
60M	100M	0.40	38.72	19.43	1.60	99.80	10.79	2.11	6.03	0.60	39.25	12.95	1.22
100M	150M	0.10	59.48	0.00	0.10	99.90	10.84	2.11	6.02	0.20	40.30	0.00	0.47
150M		0.10	21.13	0.00	0.85	100.00	10.85	2.11	6.02	0.10	21.13	0.00	0.85

DATA FOR - REFUSE COAL.

THIS FRACTION CONSTITUTES 10.2 PERCENT OF THE FEED.

SIZE FRACTION		-----DIRECT VALUES-----				-----CUMULATIVE RETAINED-----				-----CUMULATIVE PASSED-----			
PASSED	RETAINED	WEIGHT PERCENT	ASH PERCENT	SULFUR PERCENT	MOISTURE PERCENT	WEIGHT PERCENT	ASH PERCENT	SULFUR PERCENT	MOISTURE PERCENT	WEIGHT PERCENT	ASH PERCENT	SULFUR PERCENT	MOISTURE PERCENT
	30M	76.50	14.46	3.69	2.50	76.50	14.46	3.69	2.50	100.00	14.91	3.99	2.71
30M	60M	23.30	16.05	5.02	3.40	99.80	14.83	4.00	2.71	23.50	16.38	4.98	3.38
60M	100M	0.20	55.32	0.00	0.55	100.00	14.91	3.99	2.71	0.20	55.32	0.00	0.55
100M	150M	0.00	61.81	0.00	0.20	100.00	14.91	3.99	2.71	0.00	0.00	0.00	0.00
150M		0.00	23.20	0.00	0.40	100.00	14.91	3.99	2.71	0.00	0.00	0.00	0.00

ANALYTICAL DATA

DATA FOR DRYFLO SEPARATION TEST # 55.

FIGURES FROM TEST # 28 RECYCLE.

DATA FOR -

* * COMPOSITE * *

THIS FRACTION CONSTITUTES 100.0 PERCENT OF THE FEED.

SIZE FRACTION		-----DIRECT VALUES-----				-----CUMULATIVE RETAINED-----				-----CUMULATIVE PASSED-----			
PASSED	RETAINED	WEIGHT PERCENT	ASH PERCENT	SULFUR PERCENT	MOISTURE PERCENT	WEIGHT PERCENT	ASH PERCENT	SULFUR PERCENT	MOISTURE PERCENT	WEIGHT PERCENT	ASH PERCENT	SULFUR PERCENT	MOISTURE PERCENT
	30M	56.38	9.86	2.06	5.35	56.38	9.86	2.06	5.35	100.00	9.77	2.16	5.34
30M	60M	39.23	9.13	2.12	5.42	95.61	9.56	2.08	5.38	43.62	9.66	2.29	5.34
60M	100M	3.82	12.53	3.06	4.94	99.43	9.68	2.12	5.36	4.39	14.34	3.89	4.60
100M	150M	0.35	24.80	8.29	2.93	99.78	9.73	2.14	5.35	0.57	26.55	9.43	2.32
150M		0.22	29.34	11.24	1.34	100.00	9.77	2.16	5.34	0.22	29.34	11.24	1.34

ANALYTICAL DATA

DATA FOR DRYFLO SEPARATION TEST # 56

FIGURES FROM PSOC # 105 FEED SAMPLE

DATA FOR - PRODUCT COAL.

THIS FRACTION CONSTITUTES 71.9 PERCENT OF THE FEED.

SIZE		-----DIRECT VALUES-----				-----CUMULATIVE RETAINED-----				-----CUMULATIVE PASSED-----			
FRACTION		WEIGHT	ASH	SULFUR	MOISTURE	WEIGHT	ASH	SULFUR	MOISTURE	WEIGHT	ASH	SULFUR	MOISTURE
PASSED	RETAINED	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT
	30M	45.60	8.34	1.52	5.30	45.60	8.34	1.52	5.30	100.00	8.37	1.79	5.37
30M	60M	48.50	7.80	1.88	5.50	94.10	8.06	1.71	5.40	54.40	8.39	2.02	5.43
60M	100M	5.30	11.49	2.03	5.15	99.40	8.24	1.72	5.39	5.90	13.21	3.16	4.81
100M	150M	0.40	28.29	12.51	2.10	99.80	8.32	1.77	5.38	0.60	28.40	13.16	1.83
150M		0.20	28.62	14.46	1.30	100.00	8.37	1.79	5.37	0.20	28.62	14.46	1.30

DATA FOR - MIDDLING COAL.

THIS FRACTION CONSTITUTES 19.2 PERCENT OF THE FEED.

SIZE		-----DIRECT VALUES-----				-----CUMULATIVE RETAINED-----				-----CUMULATIVE PASSED-----			
FRACTION		WEIGHT	ASH	SULFUR	MOISTURE	WEIGHT	ASH	SULFUR	MOISTURE	WEIGHT	ASH	SULFUR	MOISTURE
PASSED	RETAINED	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT
	30M	78.90	10.18	1.82	2.25	78.90	10.18	1.82	2.25	100.00	10.57	2.09	2.27
30M	60M	20.60	11.32	2.68	2.40	99.50	10.42	2.00	2.28	21.10	12.01	3.11	2.37
60M	100M	0.30	46.51	20.30	1.10	99.80	10.52	2.05	2.28	0.50	40.50	20.95	1.05
100M	150M	0.10	54.41	35.74	0.25	99.90	10.57	2.09	2.28	0.20	31.48	21.92	0.97
150M		0.10	8.55	9.10	1.70	100.00	10.57	2.09	2.27	0.10	8.55	8.10	1.70

DATA FOR - REFUSE COAL.

THIS FRACTION CONSTITUTES 8.9 PERCENT OF THE FEED.

SIZE		-----DIRECT VALUES-----				-----CUMULATIVE RETAINED-----				-----CUMULATIVE PASSED-----			
FRACTION		WEIGHT	ASH	SULFUR	MOISTURE	WEIGHT	ASH	SULFUR	MOISTURE	WEIGHT	ASH	SULFUR	MOISTURE
PASSED	RETAINED	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT
	30M	80.50	12.99	2.97	2.25	80.50	12.99	2.97	2.25	100.00	13.50	3.34	2.23
30M	60M	18.90	14.88	5.03	2.20	99.40	13.35	3.36	2.24	19.50	15.59	4.88	2.15
60M	100M	0.30	51.54	0.00	0.60	99.70	13.46	3.35	2.24	0.60	37.87	0.00	0.65
100M	150M	0.00	0.00	0.00	0.00	99.70	13.46	3.35	2.24	0.30	24.21	0.00	0.70
150M		0.30	24.21	0.00	0.70	100.00	13.50	3.34	2.23	0.30	24.21	0.00	0.70

ANALYTICAL DATA

DATA FOR DRYFLO SEPARATION TEST # 56

FIGURES FROM PSOC # 105 FEED SAMPLE

DATA FOR -

* * COMPOSITE * *

THIS FRACTION CONSTITUTES 100.0 PERCENT OF THE FEED.

SIZE		-----DIRECT VALUES-----				-----CUMULATIVE RETAINED-----				-----CUMULATIVE PASSED-----			
FRACTION		WEIGHT	ASH	SULFUR	MOISTURE	WEIGHT	ASH	SULFUR	MOISTURE	WEIGHT	ASH	SULFUR	MOISTURE
PASSED	RETAINED	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT
	30M	55.10	9.45	1.79	4.06	55.10	9.45	1.79	4.06	100.00	9.24	1.99	4.50
30M	60M	40.51	8.44	2.09	5.06	95.61	9.02	1.92	4.49	44.90	8.99	2.23	5.02
60M	100M	3.89	12.28	2.29	5.06	99.50	9.15	1.93	4.51	4.39	14.11	3.51	4.68
100M	150M	0.31	29.92	13.96	1.98	99.81	9.21	1.97	4.50	0.50	28.41	13.13	1.71
150M		0.19	25.97	11.78	1.26	100.00	9.24	1.99	4.50	0.19	25.97	11.78	1.26

ANALYTICAL DATA

DATA FOR DRYFLO SEPARATION TEST # 57.

FIGURES FROM BRADFORD FEED SAMPLE.

DATA FOR - PRODUCT COAL.

THIS FRACTION CONSTITUTES 87.4 PERCENT OF THE FEED.

SIZE		-----DIRECT VALUES-----				-----CUMULATIVE RETAINED-----				-----CUMULATIVE PASSED-----			
FRACTION		WEIGHT	ASH	SULFUR	MOISTURE	WEIGHT	ASH	SULFUR	MOISTURE	WEIGHT	ASH	SULFUR	MOISTURE
PASSED	RETAINED	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT
1/4"	8M	63.14	11.39	3.72	0.35	63.14	11.39	3.72	0.35	100.00	10.60	3.41	0.35
8M	16M	29.16	9.33	2.88	0.35	92.30	10.74	3.45	0.35	36.86	9.26	2.89	0.36
16M		7.70	8.99	2.92	0.40	100.00	10.60	3.41	0.35	7.70	8.99	2.92	0.40

DATA FOR - MIDDLING COAL.

THIS FRACTION CONSTITUTES 6.2 PERCENT OF THE FEED.

SIZE		-----DIRECT VALUES-----				-----CUMULATIVE RETAINED-----				-----CUMULATIVE PASSED-----			
FRACTION		WEIGHT	ASH	SULFUR	MOISTURE	WEIGHT	ASH	SULFUR	MOISTURE	WEIGHT	ASH	SULFUR	MOISTURE
PASSED	RETAINED	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT
1/4"	8M	57.90	26.03	9.94	0.30	57.90	26.03	9.94	0.30	100.00	22.97	8.47	0.31
8M	16M	34.90	19.46	6.71	0.30	92.80	23.56	8.73	0.30	42.10	18.76	6.44	0.32
16M		7.20	15.36	5.15	0.40	100.00	22.97	8.47	0.31	7.20	15.36	5.15	0.40

DATA FOR - REFUSE COAL.

THIS FRACTION CONSTITUTES 6.4 PERCENT OF THE FEED.

SIZE		-----DIRECT VALUES-----				-----CUMULATIVE RETAINED-----				-----CUMULATIVE PASSED-----			
FRACTION		WEIGHT	ASH	SULFUR	MOISTURE	WEIGHT	ASH	SULFUR	MOISTURE	WEIGHT	ASH	SULFUR	MOISTURE
PASSED	RETAINED	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT
1/4"	8M	45.50	36.01	10.01	0.30	45.50	36.01	10.01	0.30	100.00	30.55	9.90	0.32
8M	16M	45.10	26.74	9.97	0.35	90.60	31.40	9.99	0.32	54.50	25.99	9.81	0.34
16M		9.40	22.42	9.02	0.30	100.00	30.55	9.90	0.32	9.40	22.42	9.02	0.30

ANALYTICAL DATA

DATA FOR DRYFLC SEPARATION TEST # 57.

FIGURES FROM BRADFORD FEED SAMPLE.

DATA FOR -

* * COMPOSITE * *

THIS FRACTION CONSTITUTES 100.0 PERCENT OF THE FEED.

SIZE		-----DIRECT VALUES-----				-----CUMULATIVE RETAINED-----				-----CUMULATIVE PASSED-----			
FRACTION		WEIGHT	ASH	SULFUR	MOISTURE	WEIGHT	ASH	SULFUR	MOISTURE	WEIGHT	ASH	SULFUR	MOISTURE
PASSED	RETAINED	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT
1/4"	8M	61.69	13.40	4.38	0.34	61.69	13.40	4.38	0.34	100.00	12.65	4.14	0.35
8M	16M	30.54	11.69	3.82	0.35	92.22	12.84	4.19	0.35	38.31	11.43	3.76	0.36
16M		7.78	10.39	3.52	0.39	100.00	12.65	4.14	0.35	7.78	10.39	3.52	0.39

ANALYTICAL DATA

DATA FOR DRYFLO SEPARATION TEST # 58.

FIGURES FROM BRADFORD FEED SAMPLE.

DATA FOR - PRODUCT COAL.

THIS FRACTION CONSTITUTES 72.4 PERCENT OF THE FEED.

SIZE		-----DIRECT VALUES-----				-----CUMULATIVE RETAINED-----				-----CUMULATIVE PASSED-----			
FRACTION		WEIGHT	ASH	SULFUR	MOISTURE	WEIGHT	ASH	SULFUR	MOISTURE	WEIGHT	ASH	SULFUR	MOISTURE
PASSED	RETAINED	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT
1/4"	8M	63.24	8.78	2.63	0.30	63.24	8.78	2.63	0.30	100.00	8.51	2.63	0.32
8M	16M	28.54	8.03	2.67	0.40	91.78	8.55	2.64	0.33	36.76	8.05	2.64	0.36
16M		8.22	8.12	2.55	0.20	100.00	8.51	2.63	0.32	8.22	8.12	2.55	0.20

DATA FOR - MIDDLING COAL.

THIS FRACTION CONSTITUTES 16.1 PERCENT OF THE FEED.

SIZE		-----DIRECT VALUES-----				-----CUMULATIVE RETAINED-----				-----CUMULATIVE PASSED-----			
FRACTION		WEIGHT	ASH	SULFUR	MOISTURE	WEIGHT	ASH	SULFUR	MOISTURE	WEIGHT	ASH	SULFUR	MOISTURE
PASSED	RETAINED	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT
1/4"	8M	59.30	16.25	5.68	0.30	59.30	16.25	5.68	0.30	100.00	14.83	5.20	0.31
8M	16M	35.40	12.94	4.58	0.30	94.70	15.01	5.27	0.30	40.70	12.77	4.50	0.31
16M		5.30	11.65	3.94	0.40	100.00	14.83	5.20	0.31	5.30	11.65	3.94	0.40

DATA FOR - REFUSE COAL.

THIS FRACTION CONSTITUTES 11.5 PERCENT OF THE FEED.

SIZE		-----DIRECT VALUES-----				-----CUMULATIVE RETAINED-----				-----CUMULATIVE PASSED-----			
FRACTION		WEIGHT	ASH	SULFUR	MOISTURE	WEIGHT	ASH	SULFUR	MOISTURE	WEIGHT	ASH	SULFUR	MOISTURE
PASSED	RETAINED	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT
1/4"	8M	58.30	35.51	10.13	0.30	58.30	35.51	10.13	0.30	100.00	31.70	10.02	0.32
8M	16M	35.60	26.94	9.97	0.35	93.90	32.26	10.07	0.32	41.70	26.37	9.88	0.34
16M		6.10	23.02	9.33	0.30	100.00	31.70	10.02	0.32	6.10	23.02	9.33	0.30

ANALYTICAL DATA

DATA FOR DRYFLO SEPARATION TEST # 58.

FIGURES FROM BRADFORD FEED SAMPLE.

DATA FOR - * * COMPOSITE * *

THIS FRACTION CONSTITUTES 100.0 PERCENT OF THE FEED.

SIZE		-----DIRECT VALUES-----				-----CUMULATIVE RETAINED-----				-----CUMULATIVE PASSED-----			
FRACTION		WEIGHT	ASH	SULFUR	MOISTURE	WEIGHT	ASH	SULFUR	MOISTURE	WEIGHT	ASH	SULFUR	MOISTURE
PASSED	RETAINED	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT
1/4"	8M	62.04	12.82	3.91	0.30	62.04	12.82	3.91	0.30	100.00	12.20	3.90	0.32
8M	16M	30.46	11.49	4.01	0.37	92.49	12.38	3.94	0.32	37.96	11.18	3.88	0.35
16M		7.51	9.91	3.34	0.23	100.00	12.20	3.90	0.32	7.51	9.91	3.34	0.23

APPENDIX B

SMOKE POINT AND HEAT TRANSFER CHARACTERISTICS OF OIL/WATER/AIR
EMULSIONS WITHOUT AND WITH COAL ADDITION IN A HOT WALL FURNACE

SMOKE POINT AND HEAT TRANSFER CHARACTERISTICS OF OIL/WATER/AIR
EMULSIONS WITHOUT AND WITH COAL ADDITION IN A HOT WALL FURNACE

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SUMMARY

Emulsions of Number 2 oil, water and air, generated by a Sebba (6) emulsifier, fired in a hot wall furnace at 1.25 million Btu/hr, were found: to reduce the flame emissivity; and to remove carbon build-up on the burner. Excess air at the smoke point was unchanged; however, smoke level at a given excess air, and soot concentration at a given smoke level, were generally reduced by the water addition. On account to reduced emissivity, thermal efficiency also dropped, by about 5 percentage points at efficiencies in the region of 20 to 25%. Flame emissivity was restored to its original value or better by addition of coal at concentrations ranging from traces to 1%, or by addition of inert magnesia (or by permitting operation with medium to heavy smoke). The furnace was a refractory wall unit of internal dimensions 2'x2'x10' with 17 water-cooled tubes on its floor to simulate the load of a continuous industrial thermal processing furnace. The burner was a split jet-can (perforated wall) type of combustor with air so supplied that it produced a double vortex mixing pattern. An impact atomizer with large clearances to accomodate the coal was used in the burner. Flame stability and turn down were very good. In additional results, carbon monoxide levels were substantially independent of water content, with CO not appearing until smoke was at the 10 to 15% level, and therefore at a lower excess air level than required for onset of smoke. It is therefore suggested that the principal combustion reactions and the smoke formation reactions are effectively independent of each other, with smoke somewhat influenced by, and combustion largely uninfluenced by added water. The reduced radiation with added water suggests that emulsions would be appropriate for substitution of gas by oil where oil radiation can cause problems of overheating and burn-out, for example, in radiant tube furnaces. Field tests on such a furnace are now providing support for this conclusion.

1. INTRODUCTION

The addition of water to oil during combustion is a practice with a history of about 25 years in the case of mixtures or emulsions, and a history of 40 years or more for water added by separate injectors. The combustion systems involved have included reciprocating engines, gas turbines, and steam boilers (but not, it would appear, industrial furnaces of the hot wall type used for thermal processing). Advantages claimed have been equally varied depending on the system, the objectives current at the time (e.g. reducing NO_x), the types of emulsion, and so forth. Included as advantages (some inter-related) one can find: increased power from engines, decreased engine cooling requirements, elimination of hard knock, increased thermal efficiency, increased combustion efficiency, reduced excess-air requirements, reduced flame length, faster burning, improved atomization, reduced NO_x emissions, reduced SO_3 production from SO_2 , lower combustion noise, less carbon build up, and reduced smoke or combustible particulate emissions. Much of this is covered in three recent reviews (1-3). To the extent that the claims are substantiated, water addition is clearly advantageous, although supporting data are still not fully in evidence.

It is by no means clear what the most significant scientific issues and problems really are on which pertinent fundamental programs can properly be based.

Our own reasons for engaging in the experiments reported depended on the chance juxtaposition of two otherwise independent items of information. The first was that a number of companies faced with tight oil supplies two to three years ago had experienced burner problems, such as flame instability, flame-out, excessive smoke production, and so forth,

when they changed oil suppliers, even if the oil number was the same (with the exception of number 2). Inspection of the oil specifications shows that there is sufficient latitude in viscosity and similar requirements that variations in the oil characteristics allowed within the specifications were probably the source of the combustion problems. A closely related problem that was faced but not solved generally derived from the purchase of oils that were different from those already in use by the company, which purchases were made on the assumption that anything available was better than nothing.

It occurred to us in examining this problem of oil variability that emulsifying the oil might provide the answer if the emulsion properties over-rode the oil properties, and were reasonably consistent for a narrow or wide range of different oils. This would permit change of oil suppliers, and also oil type within limits, without need to change or re-set the burner. A disadvantage might be that many water-in-oil emulsions have higher viscosities than the original oils, and this in turn can lead to larger drop size on atomization (4), which is clearly potentially detrimental and undesirable in combustion. A possible solution to this problem, however, was provided by the second chance item of information, that a new method of manufacturing emulsions (5,6) was capable in some instances of generating emulsions in which the viscosity was no greater than and sometimes less than that of the original fluid (7). If this potential for reducing viscosity could be realized it would not only be advantageous in maintaining or reducing the atomized drop size from the burner, but it also opened up the possibility of emulsifying heavy fuel oils that might then continue to flow (due to the viscosity reduction) without steam tracing when this is normally necessary.

This could also be relevant in due course to use of fuel liquids from coal. Such liquids as are already available tend to be on the heavy side, with SRC coal in particular existing as a liquid when heated but as a pitch-like solid at normal temperatures. It can also be foreseen that the problem of maintaining fuel oil specifications will be a particularly difficult task for oils derived from coal in view of the wide variation in coal properties from a single mine or even from a single seam. If specification margins for the product oils could be relaxed by the use of emulsions, the advantages in reducing the plant complexity and costs of manufacture are obvious. Another area of application might be to coal/oil dispersions, which have a history of experiment dating back to at least 1913, and for which a very good case can currently be made (8). In the interests jointly of saving oil by coal replacement and of improving the handleability and usability in combustion of coal, the objective is to use mixtures as rich in coal as possible. Viscosity of the mixture, however, increases both with increased solids concentration (with a practical limit at present in the region of 50%) and with reduced particle size (with very significant increases as particle size drops below 2 to 3 microns, [9, 10]). If there is a drop in viscosity of the mixture on emulsification, the coal loading can be increased, as desired.

We have not yet addressed experimentally the viscosity problem: it was, however, central to the conclusions that there could be further scope for the use of emulsions, and to the choice of emulsifier. We considered it necessary first to investigate the behavior of the emulsions in combustion, before embarking on an investigation of the viscosity problem, partly on account of some apparent inconsistencies in previously

reported work, but principally because we had selected an emulsion with a new type of structure, and its combustion behavior could not be assumed necessarily to parallel that of other emulsions. Unlike most other emulsions, these contain finely divided air as well as water, and to which the name microgas dispersions has been applied. Generally a combination of emulsifying agents, in ppm concentrations, is required, but with some oils, no agent is needed at all.

The experiments described in this paper have been carried out in a hot-wall furnace with water cooled floor pipes that simulates certain types of small industrial furnaces. (There seems to be only one previously recorded instance of similar experiments, 11). We were also interested in the heat balance, and more particularly in the heat flux profile, which appears to have been measured previously only by Moses, in a jet engine combustor (12), though he only quotes conclusions without (so it seems) providing the supporting test data. In the experiments described here, the principal measurements were the smoke profile and smoke point, the heat delivered to the load, the thermal efficiency, and the heat-flux profile for the different emulsions or dispersion mixtures. Most of our experiments were done with No. 2 oil, some being with additions of coal or magnesia. An emulsion with No. 4 oil has also been satisfactorily fired.

2. EXPERIMENTAL

2.1 Furnace - The furnace, illustrated in Fig. 1, is a rectangular refractory box, of square cross-section, of internal dimensions 2'x2'x10' long (0.61m x 0.61m x 3.05m), giving a working volume of 40 cu.ft. (1.13 cu.m.) of combustion space. Walls, roof, and base are 9" (0.23m) thick, with outside metal cladding, of super duty firebrick for the floor and walls, and roof of high temperature castable. The total weight of material

is about 12 tons, which is a factor of importance in determining some aspects of experimental procedures. On the floor are 17 brass water-cooled tubes of 1-1/4" (0.032m) o.d., with facility for measurement of water flow rate and temperature rise. The spacing between tubes is mostly 6" (0.015m). The exact spacing is indicated in Fig. 1. The tubes are fed from a single manifold, but discharge individually into a water trough: this is so that the flows can be individually observed at any time for safety reasons. The roof is also fitted down the centerline with 24 thermocouples in wells with their tips set flush with the inside surface of the roof. Spacings vary: the first 14 are 3" apart (0.08m); the next 5 are 6" apart (0.15m); and the last 5 are 7.9" apart (0.2m). The positions are as illustrated in Fig. 1. In both sides of the side wall at the burner end (see Fig. 1) are two slots, 4'6" long (1.37m) and 12" high (0.3m). Each slot is closed by castable refractory covers 5" thick (0.15m) cast in metal cases and slung on rollers from a rail so that the cover can be slid open for inspection of the flame or other suitable purposes. Two ports with screw on covers pierce these refractory blocks. These can be used for insertion of probes; the design permits 3-dimensional probing of the flame. The ports have been used to a limited extent for this purpose in the present experiments, but the results are too limited as yet to be of value and they will not be reported in this paper. Two other observation/probe ports exist in the side walls on the center line, 75" (1.9m) and 45" (1.15m) from the exhaust end of the furnace, as indicated on Fig. 1. Two other ports are set through the corners of the furnace at the burner end, angling in for a line of sight intersection on the geometrical axis 30" (0.76m) from the burner end.

2.2 Burner and Atomizer - The burner is illustrated in Fig. 2. It consists essentially of two concentric tubes, each 11" long (0.28m), and of diameters respectively 7.5" (0.19m) and 15" (0.38m), thus forming a 3.5" (0.09m) annulus between the tubes. The inner tube is perforated with 3/4" dia. holes (0.02m). One end of the assembly is closed by a metal plate that also carries the atomizer. The other end of the annular space is also closed. There is also a divider half way down the annulus splitting it into two. Combustion air is supplied to the annulus through 2" dia tubes (0.05m) with elbows on the their ends so that the air is forced to rotate as it emerges from the annulus into the inner (combustion) tubes, thus generating a vortex. The air is arranged to rotate in opposite directions in the two halves (upstream and downstream) of the annulus so that the flow pattern in the combustion tube consists of two vortices rotating in opposite senses. As found in a number of previous cold model (13) and combustion experiments (14), mixing by such a double vortex is intense, and combustion tends to be very stable with high intensity at maximum firing rate, and with good turn down. As shown in Fig. 2, the burner penetrates 5.5" (0.14m) into the wall with the final aperture shaped with a flare out (of refractory) into the furnace. The flare out plays no part in the flame stabilization. The gases emerge in horizontal flow with no residual rotation for best performance.

The atomizer is illustrated in Fig. 3. This uses an impact plate for atomization, which is normally good. As illustrated, atomizing air, normally at 80 psig (56000N/m²) is supplied up the center tube in the atomizer block. This tube converges to a venturi throat about 0.5" (0.013m) from the end of the block. Oil or the emulsion is supplied from a small ring main through four tubes in the block to the throat of the venturi. The mixture is carried to the end of the block where it strikes an impact plate of

about the diameter of the exit port. An impact plate any larger than this tends to make the oil splash back onto the face of the block where it condenses and runs down. The dimensions of the various ports are as, given in the figure. The block also carries six gas ports that run to the end of the block, angling out as indicated at an angle of 30°. This is necessary to avoid destroying the backmix pattern that exists on the combustion tube axis some inches downstream from the atomizer (see Refs. 13).

The design directs the fuel (oil or gas) to the wall of the combustor tube; it is brought back from there by the mixing behavior of the air pattern. Air is generally used for atomizing; however, pressure gas is just as good, and provides easier light-off. This atomizer has also been successfully used in incineration tests of a chlorinated hydrocarbon in water (1%), with the liquid for incineration supplied in place of the oil, and with the gas ports used to supply the sustaining fuel for the incineration flare. The successful incineration of the chlorinated hydrocarbon testified to the excellent mixing pattern obtained without by-pass in the combustion tube. In less successful tests, the same waste liquid in ethanol (5%) was incinerated using the ethanol for the incineration flame. This mixture was too rich in chlorine and much carbon was produced though this was greatly reduced by diluting the mixture with additional water.

2.3 Emulsifier - The device used to make the emulsions was developed by SMS Associates from the Sebba design (6) and is illustrated in Fig. 4. The heart of the unit is a venturi section, as illustrated, in a closed loop, with air supplied in the form of a conical sheet to the throat of the venturi (and with supply lines for oil, surfactant, and water to the loop and a delivery line tapping off from the loop to the burner). The elements of the design have a strong similarity to the atomizer except that the roles

played by the liquids and the gas are reversed. A surfactant stabilizing agent is generally used. Classifying emulsifiers as: (1) mechanical; (2) chemical; and (3) other; this device is classified in category 3, but it has aspects of both mechanical and chemical emulsifiers. The design, however, permits use of lower pressures than are required for other mechanical atomizers -- typically in the range 10 to 50 psig (70,000 to 350,000 N/m²) -- and the use of much lower quantities of surfactant -- typically in the region of 500 ppm, compared with 1 to 10% for a purely chemically formed emulsion.

The structure and properties of the emulsion, to the extent that these have been identified, are also somewhat-to-substantially different from those of other emulsions (7). Photomicrographs show the emulsion to have something of a concentric bubble structure, with discrete colloidal sized gas bubbles (generally 1 to 10 microns) dispersed in a continuous water phase that in turn is permeated by a continuous oil phase. This is illustrated schematically in Fig. 5. One can imagine this as a porous mass of frog spawn, with the pores all connecting and permeated by oil as the first (and main) continuous phase: the eggs then represent the discrete gas bubbles surrounded by the containing gel, also as a continuous phase, representing the water. A mixture of both water soluble and oil soluble surfactants is used, when stabilizers are required (substances with partial solubility in both oil and water, such as organic acids, may also be used). Because of this structure, the tendency of the gas bubbles to coalesce is hindered by the surrounding water phase, and synergistically, the tendency of the connecting water layers on the bubbles to grow into one another and separate out from the oil is hindered by the gas bubbles. An additional consequence of this

structure is that the emulsion is compressible. Properties of the emulsions are still under investigation, but one additional characteristic of considerable relevance is that they evidently behave as Newtonian fluids (6), unlike most or all other emulsions which are non-Newtonian (4).

2.4 Sampling and Instrumentation - Measurements of interest include both overall heat and material balances, and also internal profiles. The only internal profiles so far measured are the heat flux profiles by the water pipes on the floor of the furnace, as described above, and the centerline roof temperature profiles, as also described above. As mentioned, provision exists for three-dimensional sampling from the burner exit to about half way down the furnace, and at two further stations downstream, but the few measurements of gas compositions and temperatures so far made will not be reported in this paper.

Principal other measurements so far have been gas exit temperatures, gas analyses, particulate loads, and smoke number. Probe stations for these measurements are located at the furnace exit or in the flue pass leading to the stack. The first section of flue pass from the furnace exit is a horizontal refractory lined tunnel of 1'x1' (internal) square cross-section (0.30m x 0.30m) as indicated in Fig. 1. At the end of this section, which is 4' (1.22m) long, the flue pass turns vertically upwards into a steel, unlined section. This section carries a light obscuration smoke meter (Bailey Type U5000 A) arbitrarily calibrated in percentage obscuration by Ringelmann grids. Downstream of that is an atmospheric damper to maintain draft at the required level. The furnace was mostly operated at balanced draft to eliminate air inleakage (and gas exleakage), the draft point being in the horizontal flue pass, on the level of the geometric axis of the furnace as indicated in Fig. 1. Read out was by a Bristol 24-hour draft meter

Model D 40 M with full scale readings of 0.05" (0.0013m) w.c. pressure to 0.15" (0.0038m) w.c. draft. Reading accuracy sensitivity was to 0.001" (0.0003m) w.c. The meter was installed with balanced lines. During operation, the furnace was also sealed to the extent possible with moistened asbestos tape squeezed into possible cracks.

Gases were sampled through a conventional water-cooled probe, passed through a wash bottle, dried, and collected in batch sampling bottles for batch analysis, by chromatography for O_2 , CO_2 , CO , N_2 , and CH_4 . Excess-air percent was calculated from the gas analyses, and compared with the values determined from air and fuel flow rates.

Exhaust-gas temperatures were measured just ahead of the gas sampling point using a laboratory-built suction pyrometer of conventional design.

The solid-sampling probe was another water-cooled tube leading to a small external cyclone for principal capture of the solids, followed by a 2" (0.05m) dia filter paper supported on a wire mesh to capture the fines leaving the cyclone. The transit distance from probe entry to cyclone is 42" (1.1m). The sampling rate is 2 cfm (cold) ($0.001m^3/sec$), so that the transit time between entry and capture is 0.07 sec.

Other instrumentation includes: 24-point read-out for the roof temperatures on an L & N potentiometric multipoint recorder; smoke level read-out on a circular scale (24 hr) calibrated in percentage obscuration of the light; direct reading flowmeters (rotameter type) for water to the emulsifier (range 0 - 2.0 gph; $0 - 0.0000021m^3/sec$); for oil (range 0 - 26gph; $0 - 0.000027m^3/sec$); and for the atomizing air (or gas) (range 0 - 10 cfm; $0 - 0.005m^3/sec$); combustion air flow by a directly calibrated inclined gage connected to an Annubar element in the air line (range 0 - 230cfm; $0 - 0.11m^3/sec$).

2.5 Ancillaries - Other equipment included the following. Combustion air is supplied from a Pyronics 24 oz. ($10,400 N/m^2$) blower with a free air capacity of 430cfm ($0.20m^3/sec$). Atomization air is supplied from the University compressed air line system, at 60 psig ($400,000 N/m^2$). Necessary water is available at 80 psig ($550,000 N/m^2$). Oil storage is in two 225 gal. ($0.85m^3$) capacity tanks (for No. 2), with feed to the furnace or emulsifier through a 15gph ($0.000016m^3/sec$) capacity pump, delivering at 100 psig ($700,000 N/m^2$). Where lower pressure is needed, it is reduced accordingly. Some few experiments were carried out with Number 4 oil, and for these an auxiliary drum of 30 gal. ($0.000115m^3$) capacity was used. Light-off was usually started with (natural) gas which is available at 15 psig ($100,000 N/m^2$) to a line capacity of 500 cfh ($0.004m^3/sec$). This fuel has also been used in comparative experiments. Suction for the probes is provided either by a suction pump or by a water or air ejector.

3. RESULTS

3.1 Scope of Experiments and Experimental Procedure - All except the comparative experiments with gas were carried out at 1.25 ± 0.05 million Btu per hour -- $300,000 \pm 10,000$ kcal/hr (1.30 ± 0.05 GJ/hr or 0.35 ± 0.01 MW). In the experiments with gas, they were carried out at the line capacity of 0.5 million Btu per hour ($125,000$ kcal/hr, 0.53 GJ/hr, or 0.15 MW). Experiments were carried out with gas, pure oil (No. 2), with emulsions containing 10%, 12½%, 20%, 25%, 30%, 37½%, 40%, and 50% water by weight (generally with 350ppm surfactant), and with emulsions at 12.5% by weight of water and containing 7 different levels of coal (from approximately 0.02% to 1.5% by weight).

The fuel oil analysis and calorific values are given in Table 1.

All experiments were carried out with the furnace preheated up to the operating temperature. This generally meant preheating on high fire (at about 2 to 2.5 million But/hr)(500000 to 625000k cal/hr, 2.12 to 2.65GJ/hr, 0.6 to 0.75MW) for 4 to 6 hours. An experiment would be started by setting the air, oil and water supplies to the emulsifier at the required rates, and feeding the mixture to the preheated furnace for a period for a final stabilization of conditions. At this starting point, the combustion air was set at a (measured) level high enough to prevent smoke. Stability of conditions could be checked by monitoring the gas analyses and rise of water temperature in the floor tubes. When conditions were steady, the measurements were re-checked, additional samples (e.g. particulates) were drawn, and additional measurements (e.g. smoke) were made and recorded. With all measurements completed and samples drawn, the air rate was dropped, in a step equal to something between 1% and 10% change in the excess air, the magnitude of the step depending on the mixture involved and the position on the smoke curve. After a period for re-stabilization, all new measurements were recorded and samples drawn, and the sequence was repeated again. The procedure was repeated until the light obscuration by smoke was at or near 100%; this generally occurred between stoichiometric and 10% air deficiency. In a period of three to six hours it was possible to obtain about half a dozen measurements at different levels of excess air. The set constituted one complete run. In all, the results reported here are based on about 75 runs representing different conditions of experiment with 1 to 5 repeats of each condition.

3.2 General Behavior - In a typical run with low to zero smoke, the furnace viewed through an observation port at the end of the flue pass on the center line would appear clear or slightly hazy, except for the flame in the combustion can and its projection into the furnace, which was yellow and opaque. As air level was reduced, the haziness increased until at about 50% obscuration (Ringelmann 2 to 3), visibility in the furnace was reduced to zero.

The flame itself was contained only partly in the combustion can: the flame projected from two to four feet into the furnace in a flame brush or plume that approximated to a tapered cylinder of diameter 12" to 15" (0.3 to 0.38m). About 60 to 85% of the flame volume was therefore inside the furnace; at the same time, it is estimated that 50% or more of the combustion occurred inside the can. The flame volume in the furnace was at all times less than 10% of the furnace volume, down to 1% when firing gas. These are typical numbers for many industrial furnaces.

The flame length tended to increase with progressive reduction of the air rate, but the extent of the extension was soon obscured as the smoke level in the furnace rose.

In all experiments, both the roof temperatures and the heat-flux profiles showed lowest values at the stations closest to the burner and the exit, with peaks roughly three feet (one meter) from the burner. These are illustrated and discussed more fully below.

3.3 Smoke Profiles - Figure 6 illustrates the smoke profiles, plotted as percentage obscuration against excess air percent. Included on this graph are the curves for pure oil, for a chemical emulsion containing 12½% water and 7% emulsifier but no air, and for three oil/water/air emulsions at 12.5%, 25% and 37½% water. As shown, all curves have the

same general shape, being sigmoids varying from zero smoke to high smoke as the excess air drops. As the curves show, the smoke point in all cases is at about 10% excess air, and is not evidently affected by the emulsification. This seems to be contrary to all previous results (see Reviews, 1-3). As the curves also show, however, emulsification does clearly reduce the smoke level, at the same excess air level, for excess air less than that at the smoke point. Evidently, there is some interference with the smoke forming reactions.

In assessing the results, it is possible to summarize as follows. The smoke point, or excess air percent at smoke onset, shows no detectable reduction by the use of emulsions. Being contrary to previous reports, this may represent inherently good smoke control by good burner design. This itself could be a conclusion of practical significance that could become important if more furnaces are run near the smoke point to save fuel. The use of the microgas emulsion seems to be a little better than the chemical emulsion, though whether the difference is really significant is open to argument. There is in general, a significant reduction in smoke level with the emulsions, with the effect increasing as the excess air drops. This is a result of no practical value for burners such as the one in use where high smoke levels can not be permitted and there is no provision for final burn up, but it might have some practical significance for staged burners. The theoretical significance of the result in relation to understanding the mechanism of smoke formation may be greater significance in due course.

Supplementary to the above results, Fig. 7 is a plot of particulate concentration, identified as soot, against the percent obscuration Ringelmann number. This brings out another point. It shows that at the same Ringelmann number, the weight of soot collected drops with increasing

water in the emulsion. A replot of Fig. 6 with weight of soot in place of Ringelmann number would show an even greater effect of the emulsions.

Figure 7 contains the additional implication of importance that lower soot concentration for the same Ringelmann number requires smaller particle size. Such a result is in line with previous findings (1-3); the particle size of our samples is under examination at the moment but the results are not yet available.

3.4 Carbon Monoxide Profiles - The carbon monoxide profiles are similar in shape to the smoke profiles, but with certain differences that may be of fundamental importance. The profiles are illustrated in Fig. 8. As this shows, the analyses for the emulsions fall on a common line, unlike the smoke profiles, with the pure oil data possibly represented by a separate line (although this could be statistical scatter on the margin of the common line). This was a most unexpected result: it was assumed a priori that the CO profiles, like the smoke profiles, would also be sensitive to water content on the argument that CO appearance could be expected to correlate closely with smoke onset or smoke density. These results suggest that this is not the case. A possible interpretation of the results is that smoke formation and combustion take place by two independent reaction paths, the first, of course, being indexed by smoke, and the second being indexed by CO. If this is a valid conclusion it also then follows that water interferes with the smoke forming reaction but not, or not significantly, with the principal combustion reactions. This is a point that is not known to have been made before.

A further conclusion is that smoke onset occurs before, or significantly before, CO onset. This is not too evident from Fig. 8; it is much clearer in Fig. 9 which shows the correlation of CO with smoke level. This makes it quite clear that the smoke reaches 10% or more before the CO concentration starts to rise. This displacement

appears to be substantially independent of water percentage.

3.5 Heat Flux and Roof Temperature Profiles - Figure 10 illustrates the typical scatter plot profile obtained for the quantity of heat absorbed in each tube on the floor of the furnace. Figure 11 is the roof temperature profile for the same set of conditions. The interesting point about the profiles is that the gases can be expected to be at their highest temperature emerging from the combustor can, as observed experimentally in a smaller hot wall furnace that is a reasonable simulation of this present furnace (15). Such a peak in heat flux is often referred to in industrial practices as a "hot spot", and it is a common assumption that the hot spot position is controlled by the flame temperature and emissivity. As these results show, however, the hot spot is about three feet (one meter) from the point of maximum temperature and (probably) emissivity.

The reason for the displacement is provided by theoretical calculations in the previous paper (15). Those calculations show that in hot wall furnaces of this type, particularly with relatively small flame volumes as percentages of the furnace volume, anything from half to three quarters of the heat to the load (the floor tubes) is provided by radiation from the walls and roof. A detailed integration of heat supplied from the walls and roof will then generate a flux profile that will reflect the wall and roof temperature profiles, not forgetting that the wall-to-wall re-radiation tends to eliminate major asymmetries of differences in temperature (15). The wall and roof temperature profiles are therefore determined as much by their local losses through the walls as by the pattern of radiant flux directly from the flame. Since the

wall loss is largest at the corners, a furnace with a completely symmetrical heat supply (for example, if it was perfectly stirred to produce completely uniform gas temperatures and emissivities) would still have peaking temperature profiles, but they would be completely symmetrical. Heat flux from the walls and roof to the cooled floor must then reflect to some degree the wall and roof temperature profiles. The product would be a symmetrically peaked profile of heat flux to the load, i.e. with a hot spot, in spite of the uniform gas temperatures and emissivities. In this present case, since the furnace length is about 10 ft (3m), a symmetrical profile would place the hot spot 5 ft (1.5m) from the burner. We therefore regard the hot spot, or peak flux position, as having been moved from the center to a point 1.5 ft^3 (0.5m) upstream from the center due to the asymmetry of the heat supply.

3.6 Influence of Water Percent on Heat Flux Profiles - To compare the effect of water on the heat flux profiles, the average heat absorbed at each station was calculated in order to construct the comparative plot of Fig. 12. This is at the minimum excess air for zero smoke in each case. The trend is unmistakable: with increasing water in the emulsion, the peak heat flux drops, although heat flux in the downstream section of the furnace may rise. According to the argument of Sec. 3.5, this must reflect changes in wall and roof temperatures. Figure 13 is a plot of the center line roof temperatures, and as expected, they drop steadily with rise in water percent. With less heat leaving the furnace through the walls and into the water tubes, there must be more in the stack exhaust, and a check of the gas exit temperatures showed that this was indeed the case (Fig. 14).

With reduction in both wall temperatures and in heat flux to the tubes, it is clear that the heat transfer from the flame gases must also be reduced. Since radiation is well recognized to be the main mode of heat transfer from flame gases, the choices to explain the reduced heat transfer are: reduced gas temperatures, or reduced gas emissivities, or both. However, if more heat is left in the flame gases, the temperatures must be higher all the way along the flame, just as they are at the furnace exit, as measured. Consequently, the effect of the water must be to reduce the gas emissivities. This opens up a fundamental question that is discussed to some greater extent below.

3.6 Effect of Particles on Heat Transfer - As a further check on the conclusion that the reduced heat transfer was due to reduced radiation, the effect of particles added in various ways was investigated. In all cases the heat flux was increased. The simplest way of adding additional radiative material was to operate the furnace fuel-rich. Following that test, small quantities of coal were added. In the final experiments, finely dispersed magnesia was used (Phillips Milk of Magnesia).

The effect of the smoke showed a most interesting pattern. As smoke increased for the 0%, 12.5%, and 25% water in the emulsion, the centerline roof temperatures rose steadily, up to the highest smoke level examined, of 94%, with the peaks remaining at the same point. It should be noted: that level of smoke would correspond to less than 1% heat loss by unburned solids, though heat loss by unburned gases might be higher. Likewise, the flux profile to the water tubes also increased with increasing smoke, but only for the pure oil case; and above 30% smoke, the further effect of smoke on the displacement of the curves was minor. With the emulsions, there was an initial rise, until the smoke reached 50 to 60%, after which the flux fell again (the peaking point was uncertain).

The explanation for this behavior appears to be as follows. Increased power of the radiative sources by way of increased roof and wall temperatures is available. For an unchanged optical thickness of the gases in the furnace, the increased roof and wall radiation would increase the heat transfer to the tubes. However, the increasing smoke would increase the optical thickness, and the extra attenuation would modify the simple picture. We may conclude that in the case of the pure oil, the increased radiant flux is almost exactly balanced by the increased optical thickness due to the smoke above 30% smoke. In the case of the emulsions, noting first that a given smoke level represents substantially different excess air levels (see Fig. 6), we may conclude that, initially, the increased radiant flux from the walls exceeds the effect of the increased optical thickness, but as the smoke level rises, the effects reverse. At high smoke levels, an increasing fraction of the radiation in transit from the walls to the tubes is absorbed by the smoke.

Addition of coal provides a means of increasing the flame emissivity (and the gases absorptivity) with small to negligible addition to the thermal input at low coal loadings. To investigate the effects, coal was added to 12.5% water emulsions. The coal loadings were taken from a trace (at ppm concentration) up to 1.5 weight percent (about 1% thermal addition). The mean flux curves (Fig. 15) show an unexpected variation. As would be expected, the initial curves show increased heat transfer to the tubes (at trace concentration, 0.02 ± 0.01 wt.%, 0.175 ± 0.75 wt.%). In the next concentration range (0.5 wt.%), the flux dropped, to rise somewhat at higher concentrations again (1.1 ± 0.4 wt.%). The pattern is obscurely regular. Nevertheless, it is clear from the

results that trace additions of coal can increase heat transfer by a measurable amount. The magnitude of the effect is most easily seen from the efficiency plots (below).

Finally, in these experiments on particle additions, a dispersion of fine magnesita particles was added to the 12.5% water emulsion. As these particles do not burn, they can be expected to maintain their radiant additive contribution to the end of the furnace, so their effect might be expected to be greater than that of the coal additions. The magnesita line is included on Fig. 15. As can be seen, it is essentially indistinguishable from the coal lines. The possible significance of this is discussed below.

3.7. Thermal Efficiency - The thermal efficiency of the furnace is defined as the ratio of the heat absorbed by the water tubes to the heat input in the fuel. As a check on the accuracy of the figures, a closed heat balance was made for all runs at zero smoke. To do this, the stack enthalpy loss rate was calculated from the exhaust temperatures and the stack gas analyses; and wall losses were estimated from the inside roof temperatures and from a number of outside wall temperatures taken during the experiments. Of 60 definitive runs made, without coal, about 15 were found to have such disagreement between the excess air calculated from the fuel/air rates and from the stack analyses that they were considered unreliable and discarded. (These were obtained using an early model of the emulsifier.) Of the remaining 45 runs, about 25 showed heat balance closures to better than 10%. For the balance (20 runs), the closures were good to 10 to 50%. As the closure balance deteriorated, less confidence was placed in the results. [About 15 runs were made with coal addition].

Figure 16 shows the variation of thermal efficiency with water percent in the emulsions. As can be seen, and in agreement with expectation from the reduced heat flux curves, there is a relatively small decline in efficiency with increase in water content of the emulsions. However, the effect is relatively small, and the drop in efficiency is readily restored by addition of a relatively small quantity of coal.

4. DISCUSSION AND CONCLUSIONS

In evaluating the above results we have addressed ourselves to two points: (1) the meaning and fundamental implications of the results; and (2) the relevance of the results to our objectives of using emulsions for the reasons given in the Introduction.

(1) Summarizing first the salient results of this study: the only clearly beneficial effect of the use of emulsions was the ability to reduce carbon build up: in fact, where carbon may have built up either from the smoke experiments (rapid) or from normal firing of unwatered oil (much slower), the switch to the emulsions resulted in gasification of any previously formed carbon deposits. Otherwise, the excess air at the smoke point was unaffected; flame emissivity and thermal efficiency were both reduced. Of the above four findings, the first has been generally reported (1-3; also see Introduction). The third (reduced heat transfer) has been reported only by Moses (12). The second and last (unchanged smoke point and reduced efficiency) are contrary to effectively all other findings (Moses actually reported minimal drop in efficiency and rise in combustion temperature -- the minimal trend is in line with our results). Of the other advantages of emulsions listed in the Introduction, engine operation was irrelevant here, and other factors such as flame length, burning time, atomization, and so forth have not yet been investigated by us.

The principal differences between our findings and other work are, therefore, the influence on smoke point and efficiency. This may be the difference between hot wall and cold (mostly water) wall operation, but it could be due to something more fundamental. It is now well known from studies by Cooper et al (16) and others (see Review, 17) that smoke can be controlled or eliminated by recirculation of flue gases, and it has also been found that the "active principle" appears to be nothing more than dilution. The effect can be obtained by the addition of cylinder nitrogen, or CO_2 , or water. It is also well known that further dilution will result in the flame turning blue (the basis of blue flame burner designs). Indeed, we have performed this experiment ourselves, in the present furnace, using cylinder nitrogen, producing smoke-free, blue (or rather purple) flames even when operating fuel-rich (with 8% CO in the stack gas). When the blue flames are formed, the switch from the usual yellow is quite sudden. This is not a dilution effect: the boundary in Cooper's results (16) between blue and yellow was found by us to be a line of approximately constant oxygen concentration (16 to 17%) in terms of original mixture dilution.

It is common to interpret these dilution results as being due to interference with the smoke forming reactions which are assumed to be an alternate, parallel reaction path to the normal combustion reactions. As outlined briefly in Sec. 3.4, and amplified here, two parallel reaction paths to the final combustion products are postulated. The first is a very rapid breakdown of the fuel molecule as proposed, for example, in the Edelman and Fortune (18) Quasi-Global reaction scheme in which CO and H_2 are very rapidly formed. If this is rapid enough, intermediate products in the breakdown will always be at too low concentrations to show their presence by significant radiation. Flame color in combustion

by this sequence would therefore be blue. In parallel, we may suppose, following Echigo et al (19), that reaction proceeds through a path that includes a "soot precursor". This soot precursor was found to be the source of the yellow radiation commonly (and wrongly, according to Echigo et al) attributed to solid particles of carbon. The well-known difficulty of burning up flame-formed carbon supports their view. In this soot precursor scheme, reaction of the precursor has two further parallel alternatives: either total reaction proceeding to the usual end products of CO_2 and water vapor; or it continues to soot, as the end product, by some such path as that discussed by Palmer (20). The circumstances that result in the choice of the path to soot, rather than to CO_2 and water vapor, are obscure. These alternate paths are illustrated in schematic summary in Fig. 17.

We can now see that interference with the path to soot (evidently by dilution to reduce the flame temperature) will reduce or eliminate this branch of the reaction sequence. Further dilution to reduce the oxygen concentration would then eliminate the other branch of the reaction sequence, presumably by eliminating production of the soot precursor. As the soot precursor is the yellow radiating component, and since the only path to complete combustion left is the first path discussed which is blue flame combustion (as the combustion of essentially CO and H_2), we should find that the flame should turn from yellow to blue. If we now suppose that before the soot-precursor reaction path is eliminated by the progressive dilution, its rate is so affected that the soot precursor concentration is progressively reduced (which seems reasonable), the outcome would be progressive reduction in flame emissivity, which, of course, is in line with our experimental findings, and those of Moses (12). We could also expect that this mechanism should hold universally.

If this is a valid argument it becomes somewhat difficult to understand the claims, as reported in the Reviews (1-3), for increased efficiency by the use of emulsions. Evaluation of the claims is difficult because the conditions of experiment were not always too fully specified; in particular, it is not clear that the role of excess air was fully accounted for. It has indeed been suggested, particularly by Iammartino (1), that the efficiency gains were due to reduction in excess air, not to better heat transfer. This is most likely, in our opinion, to be the case although it raises a further difficulty. Addition of water provides an increased thermal load in the flame that, other things being equal, would reduce thermal efficiency. Increased thermal efficiency therefore requires a better than one-to-one trade off by reduced excess air, or else it requires increased heat transfer by increased temperature and/or emissivity. The one-to-one trade-off between the two can be approximately calculated. The results, expressed as percentage point drop in excess air against the water/fuel weight ratio, is illustrated in Fig. 18. As shown, it also depends on the exhaust gas temperature. For a given temperature, the plot shows that for a selected water/fuel ratio, the excess air percentage points must drop by at least the amount on the relevant line to break even. Thus, at 10% water, the excess air must drop by 2 to 3.5 percentage points for exhaust temperatures in the range 800° to 2000°C, and it must exceed 5% drop if the temperature is down to 400°C. In our experiments, stack temperatures were in the region of 800°C, and we would therefore have required a drop in excess air of 5 to 15 percentage points to obtain an even trade off. In the case of cold wall boilers of high efficiency, exhaust temperatures would be 400°C or lower, and in the range 10% to 30% water in the oil, the excess air percentage point drop would have to be in the range 5 to 25%, to break even, and greater still to gain in efficiency.

Noting that Coopers experiments (16) showed a smoke point at 50% excess air, the existence of high excess air systems for zero smoke is demonstrated. Noting also the relatively low excess air at the smoke point in our own experiments (10 to 15%), the existence of low excess air burners at the smoke point is also demonstrated. It is suggested, therefore, that where the efficiency gains from emulsions have been reported, the best explanation for the improvement could be that the emulsions are doing what could equally well be done by better atomizer/mixer design. We are faced otherwise with an incompatibility in the numbers for the thermal balances that is rendered worse if we then take into account the possibility of reduced flame emissivity in the emulsions.

Alternative explanations for improved efficiency focus on the possibility of improved atomization, but here again there are problems. With a well designed, maintained, and operated burner, the combustion efficiency should be in the region of 99+% at excess air levels above the smoke point. The scope for gain in combustion efficiency by improved atomization, at the same excess air point, is marginal to zero. Where improved combustion efficiency is reported it must mean that the burner was being operated away from its design point (gas turbines for jet engines operated at the equivalent to take off power would be an exception). Alternatively, better atomization can mean faster burning, which means a more compact, and therefore hotter flame. Even with a lower exhaust temperature, the overall or mean temperature can be higher, resulting in increased heat transfer and higher efficiency, so there is scope for improvement on that score.

Improved atomization, however, has not yet been demonstrated. The problem of possibly increased viscosity that may increase drop size from the atomizer was mentioned in the Introduction; the point bears closer examination. Alternatively, it has been suggested that the

phenomenon of "microexplosions" described by Ivanov et al (21) will improve atomization. Photographs show that the oil drops may be ruptured as they heat up, the rupturing being attributed to the water droplets as they flash into steam. This has also been a common explanation for behavior of oil drops containing a range of boiling points. To the extent that this occurs in flames, it would offset any adverse effects of poorer atomization from increased viscosity, if this is a factor.

In summary, therefore, best available evidence would suggest the following. Addition of water will tend to reduce emissivity by interfering with formation of some radiating species (describable as the soot precursor). Addition of water must at least be offset by reduced excess air, and this requires very substantial reductions at high water content of the emulsions, in the region of 10 to 25% excess air points for 30% water, depending on exhaust temperature. If there is scope for such reductions without going fuel rich, either the system is being operated at unnecessarily high levels of excess air, so that considerable savings would be possible without going to emulsions, or else the burner (atomizer/mixing) pattern is of poor design and needs replacing. The viscosity of the emulsion may be higher than that of the pure oil, and atomization will correspondingly suffer. This could be offset by "self-atomization" due to vaporization of the water (microexplosions). Better atomization should lead to faster burning, and this could give higher peak flame temperatures. If the outcome is indeed better heat transfer and higher thermal efficiency, it is concluded, therefore, that most probably it has to be due to higher peak flame temperatures. This identifies a critical point for future investigation in those systems in which higher thermal efficiency is claimed. Little improvement in combustion efficiency can be expected; elimination of even heavy smoke

generally represents only a fraction of one percent improvement in combustion efficiency.

(2) From these results it appears that there can be good reasons for using emulsions in certain circumstances. The most adverse condition would be use of an emulsion in place of pure oil where there are no particular objections to using oil without treatment. There could be a small thermal efficiency penalty. An acceptable trade-off for this could be the tendency to control or eliminate carbon build-up, which might pay off in reduced maintenance.

A positive reason for adopting emulsions in place of pure oil would be a case where the oil flame characteristics are undesirable in some respect. Such is the case for replacement of natural gas by oil in firing radiant tubes in metallurgical and other furnaces. With many burners, oil tends to produce local hot spots in the tube close to the burner which burns out the tube. In field tests currently in progress by SMS Associates, using an emulsifier of the same design as that described in this paper (built by Chemcut Corporation of State College, Pa.), a single unit was found to be capable of firing four radiant tubes (of 90,000 Btu/hr demand each) in the same furnace in heat treatment of small alloy-steel parts. Operation was on-off, and on the basis of tests so far completed, seems to be satisfactory without evidence of hot spot destruction of the tubes.

With a trace of solids, notably coal, in the emulsion, the reduced emissivity can be restored. Efficiency rises to match the reduced emissivity. This suggests that one of the chief advantages of emulsions may be the flexibility in the use of coal and oil, and the potential for tailoring the flame characteristics to suit requirements. It encourages us therefore, to investigate further the additional flame characteristics of the emulsions

with other grades of fuel oil, and with heavier loadings of coal, together with a detailed examination of the viscosity characteristics of the different possible emulsions, fuels, and other mixtures as detailed in the Introduction.

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Table 1

Analysis and Calorific Value of No. 2 Fuel Oil

Elemental Analysis

Carbon	87.11%
Hydrogen	12.52%
Oxygen	0.117%
Nitrogen	0.003%
Sulfur	0.19%
Ash	None Found

Calorific Value

Btu/lb	19,336 (Gross)
Btu/lb	18,176 (Net)
Btu/gal	133,232 (Gross)
Btu/gal	121,727 (Net)
Sp.Gr.	0.835

Source: Pittsburgh Testing Laboratory, Pittsburgh, Pa.

Fig. 1 - Schematic Diagram of Furnace (scale: half inch equals 10")

1. Burner
2. 1 to 24 roof thermocouples
3. 1 to 17 water cooled tubes
4. Gas sampling probe
5. Suction pyrometer
6. Particulate collector
7. Obscuration meter (smoke meter)

Fig. 2 - Double Vortex Burner

Fig. 3 - Fuel Atomizer (oil/emulsion supply holes at throat of venturi pick-up: four at 0.040" dia)

Fig. 4 - Microgas Dispersion Generator (SMS Associates)

Fig. 5 - Schematic of the Structure of a Microgas Dispersion of Colloidal Gas Bubbles in Separate Water and Oil Phases.

Note: Water and Oil Are Both Continuous Phases.

Fig. 6 - Variation of Smoke Meter Reading (Percent Obscuration) with Excess Air for Oil, Emulsions at 12.5%, 25%, and 37.5% Water, and a Chemical Emulsion

Fig. 7 - Variation of Soot Concentration with Smoke Meter Reading (Percentage Obscuration) for Oil and Emulsions at 12.5% and 25% Water

Fig. 8 - Variation of Carbon Monoxide Emitted as a Function of Excess Air for Pure Oil, Three Levels of Water Percent in the Emulsions, and the Chemical Emulsion

Fig. 9 - Variation of Carbon Monoxide Emitted as a Function of Smoke Meter Reading (Percent Obscuration)

Fig. 10 - Variation of Heat Absorbed by Each Water Tube on the Furnace Floor, for All Runs at 12.5% Water in Emulsion (Scatter Plot)

Fig. 11 - Variation of Roof Temperature with Distance Along the Furnace, for Five 12.5% Water in Emulsion (Scatter Plot)

Fig. 12A - Effect of Water Content of Emulsions on Variation of Heat Flux to Water Tubes with Distance Along Furnace for Pure Oil, and Three Levels of Water Percentage at 1.25×10^6 Btu/hr Thermal Input [Error bars denote standard error]

Fig. 12B - Comparison of Heat Flux Profiles for Oil and Natural Gas at 500,000 Btu/hr (and for oil at 0.5×10^6 and 1.25×10^6 Btu/hr) [Error bars denote standard error]

Fig. 13 - Variation of Center Line Roof Temperature with Distance Along the Furnace for Oil and Water Emulsion [Error bars denote standard error]

Fig. 14 - Variation of Exhaust Gas Temperature with Water Percentage in Emulsion [Error bars denote standard error]

Fig. 15A - Variation of Effect of Coal (and MgO) Addition to Heat Flux Profile Along Furnace (at two levels of coal: for effect of higher levels see Fig. 15B) [Error bars denote standard error]

Fig. 15B - Variation of Effect of Coal Addition to Heat Flux Profile Along Furnace at Three Levels of Coal Addition to Emulsion with 12.5% Water [Error bars denote standard error]

Water %	0	10	12.5	20	25	30	37.5	40	50
Number of Runs	8	1	9	2	6	1	4	1	1

Fig. 16 - Variation of Thermal Efficiency with Percent Water in Emulsion [Error bars denote standard error]

Fig. 17 - Suggested schematic of alternate reaction paths (I and IIA) to yield combustion products by blue flame and/or yellow flame combustion, or reaction path (IIB) to smoke and soot. Path II B is controlled by dilution (presumably temperature control); Path II A is controlled by oxygen concentration (< 17%) (see text).

Fig. 18 - Required Percentage Point Drop in Excess Air to Offset Extra Thermal Loading of Water in Emulsions
T_g: Exit Gas Temperature