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FIXED-BED GASIFICATION RESEARCH USING U.S. COALS, VOLUME 7 GASIFICATION OF PINEY TIPPLE BITUMINOUS COAL

Contract H0222001
Black, Sivalls, and Bryson, Incorporated

BUREAU OF MINES
UNITED STATES DEPARTMENT OF THE INTERIOR



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16. Abstract (Limit: 200 words) A single-staged, fixed-bed Wellman-Galusha gasifier coupled with a hot, raw gas combustion system and scrubber has been used to gasify numerous coals from throughout the United States. The gasification test program is organized as a cooperative effort by private industrial participants and governmental agencies. The consortium of participants is organized under the Mining and Industrial Fuel Gas (MIFGa) Group. This report is the seventh volume in a series of reports describing the atmospheric pressure, fixed-bed gasification of U.S. coals. This specific report describes the gasification of Piney Tipple bituminous coal. The period of the gasification test was July 18-24, 1983.			
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FOREWORD

This report was prepared by Black, Sivalls, and Bryson, Inc., Houston, Texas under USBM contract number H0222001. The contract was administered under the technical direction of the Twin Cities Research Center with Mr. Robert Zahl acting as Technical Project Officer. Mr. Frank Pavlich was the contract administrator for the Bureau of Mines. This report is a partial summary of the work recently completed as a part of this contract during the period June 1982 to May 1984. This final report was submitted by the authors on May 1, 1985.

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The University of Minnesota, Particle Technology Laboratory, Minneapolis, Minnesota, a subcontractor to Black, Sivalls, and Bryson, Inc., participated in preparation of this report.

The Piney Tipple bituminous coal gasified during this test was donated by C & K Coal Company, Clarion, Pennsylvania.

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INTRODUCTION

The United States Department of Interior, Bureau of Mines, Twin Cities Research Center, Minneapolis, Minnesota is the site of a 6.5 foot diameter Wellman-Galusha gasifier, installed in 1977-78. This gasifier, combustor/incinerator, and flue gas scrubber system in the past had been operated jointly by Bureau of Mines personnel, personnel from member companies of the Mining and Industrial Fuel Gas Group (MIFGa), and United States Department of Energy (DOE) personnel-consultants. Numerous tests using a variety of coals have to date been performed.

In May of 1982, Black, Sivalls & Bryson, Incorporated (BS&B) was awarded the contract to plan, execute, and report gasification test performance data from this small industrial fixed-bed gasification test facility. BS&B is responsible for program administration, test planning, test execution, and all documentation of program activities and test reports. The University of Minnesota, Particle Technology Laboratory (UMPTL) is subcontractor to BS&B to monitor process parameters, and provide analysis for material inputs and outputs.

This report is the seventh volume in a series of reports describing the fixed-bed gasification of U.S. coals at the Bureau of Mines, Twin Cities Research Center. This report covers the test period identified as BOM/FGT-006, gasification of Piney Tipple Bituminous Coal. The time period covered is July 18-24, 1983.

Section 1 gives a brief summary of test. Section 2 identifies test objectives. Section 3 contains a description of the fuels. Sections 4 and 5 describe the facility and monitoring systems. Sections 6 and 7 describe the conduct and results of the tests. Section 8 presents conclusions. Test data is included in the Appendices.

SECTION 1

TEST SUMMARY

The Piney Tipple Bituminous coal gasified during BOM/FGT-006 is a high-swelling, western Pennsylvania coal. The coal has an FSI of 6 1/2, somewhat lower than the Stahlman Stoker bituminous coal (FSI - 8 1/2) gasified previously (Volume 5, Thimsen, Maurer et al, 1985). Gasification of this coal expands the fixed-bed gasification data base with regard to high-swelling coals. This coal is a low-moisture, low-ash, medium-ash fusion temperature, high-volatile A bituminous coal.

The testing of Piney Tipple bituminous coal involved gasification of the coal in a 6.5 foot I.D. Wellman-Galusha, atmospheric pressure, air-blown, fixed-bed gas producer equipped with a rotating agitator arm to break up coal agglomerations inside the retort. The hot, raw gas was partially cleaned of dust in a cyclone and incinerated in a cylindrical combustion chamber. The products of combustion were quenched and cleaned of particles and sulfur dioxide in a wet caustic scrubber.

The coal gasified poorly. While maximum throughputs (0.68 tn/hr) were 15-20% higher than those attained gasifying Stahlman Stoker bituminous coal, they were less than 1/3 of the maximum throughputs achieved when gasifying low-swelling bituminous coals. The agitator with which this gasifier is equipped was not able to effectively manage coal agglomeration in the top of the fuel bed. Consequently, gas quality was moderate to poor (129 BTU/dscf) due to gas channeling around the relatively impervious agglomerations. Table 1-1 gives the maximum observed throughput operating conditions.

This coal is not recommended as a deep, fixed-bed gasifier feedstock with the existing agitator design due to limited throughput and low gas quality observed during this test.

Table 1-1

Maximum Observed Throughput Operating Characteristics for
Gasification of Piney Tipple Bituminous Coal

Coal Throughput - 0.67 tons/hour (40.4 lb/hr/sq ft grate)		
Air/Coal	3.309	lb/lb
Steam/Coal	.610	lb/lb
Blast Saturation Temperature	145	deg F
Gas Offtake Temperature	987	deg F
Wet Gas/Coal	71.7	scf/lb
Gas Dewpoint	119	deg F
Tar Yield	8.5	lb/100lb coal
Tar Analysis		
HHV (dry)	15672	Btu/lb
Pourpoint	75	deg F
Viscosity (210 F)	116	SUS
Specific Gravity (60/60 F)	1.1521	
Dry Gas Composition (mol%)		
Hydrogen	14.3	
Carbon Monoxide	20.7	
Methane	1.12	
Ethane	.108	
Ethylene	.160	
Propane	.028	
Propylene	.064	
Carbon Dioxide	8.98	
Nitrogen + Argon	53.9	
Water	5.84	lb/1000 dscf
Dry Gas HHV	134	Btu/dscf
Dry Gas LHV	125	Btu/dscf
Thermal Efficiencies		
Hot, Raw	83 %	
Cold, with Tar	71 %	
Cold, without Tar	61 %	

SECTION 2

TEST OBJECTIVES

2.1 Selection of Coal for Testing

Piney Tipple bituminous coal is a high-swelling western Pennsylvania coal. Preliminary indications were that the free swelling index of this coal was 7 - 7 1/2. This is slightly lower than the 8 1/2 FSI of Stahlman Stoker bituminous coal gasified previously as part of the current program (Volume 5, Thimsen, Maurer et al, 1985). The difficulties experienced gasifying the Stahlman Stoker were primarily attributable to agglomeration of the coal inside the retort. The Piney Tipple coal offered slightly lower FSI compared to the Stahlman Stoker coal and hence a slightly reduced tendency to agglomerate. This coal was selected in order to gauge the swelling characteristics of coals that make them acceptable or unacceptable as deep, fixed-bed gasification feedstocks.

2.2 Test Objectives

- A. Evaluate the suitability of a highly agglomerating coal (FSI = 7) for gasification in a deep, fixed-bed gasifier with agitation.
- B. Determine preliminary gasifier performance (including throughput and conversion efficiency) gasifying this highly agglomerating coal.
- C. Identify operational requirements for gasifying highly agglomerating coals.

2.3 Test Plan

This test was limited to the gasification of 170 tons of coal, and was to serve as a screening test. If the screening test showed acceptable performance of the coal, a longer test would be undertaken. The coal throughput was to be maintained near 1 ton per hour for the entire test. Variations in blast saturation temperature (steam/air ratio), agitator speed and vertical travel, and the coal screen size were left to the facility manager's judgment based on observed performance during operations. Ash depth was to be maintained at 12 inches plus or minus 3 inches.

The spacings between the grate levels were set at 6 inches plus or minus 1/8 inch between the middle and lower grate levels and 5 1/2 inches plus or minus 1/8 inch between the middle level and the top cone.

SECTION 3

DESCRIPTION OF FUEL TESTED

The Piney Tipple bituminous coal tested during BOM/FGT-006 is a high-swelling, high-volatile A bituminous coal. The coal is surface mined from the Brookville and Clarion seams in Clarion county, Pennsylvania as indicated in Figure 3-1. The coal is blended from mines at several locations. Mine reserves are larger than 30,000,000 tons with annual production greater than 2,500,000 tons. The total mine output is currently used as steam coal.

The Piney Tipple coal is routinely shipped as 1 1/2 inch by 0 inch. The coal gasified during BOM/FGT-006 was scalped from the pile to provide a minimum of undersized material. 170 tons of the coal was shipped by rail from Clarion, Pennsylvania on June 23, 1983. It arrived in the Twin Cities on July 6, 1983 and was transported by truck to the test site on July 8, 1983.

A complete analysis of the coal gasified during this test is given in Table 3-1. The results shown are for analysis of one sample composited from individual samples collected over the test period. Table 3-2 shows how the coal fits into the coal test objective matrix.

The coal held together well during transportation and handling, but a dust layer was found to be clinging to the coal particles.

Contact for this coal is:

C & K Coal Company
P.O. Box 69
Clarion, Pennsylvania 16214
(814) 226-6911

Figure 3-1
Location of Piney Tipple Mine

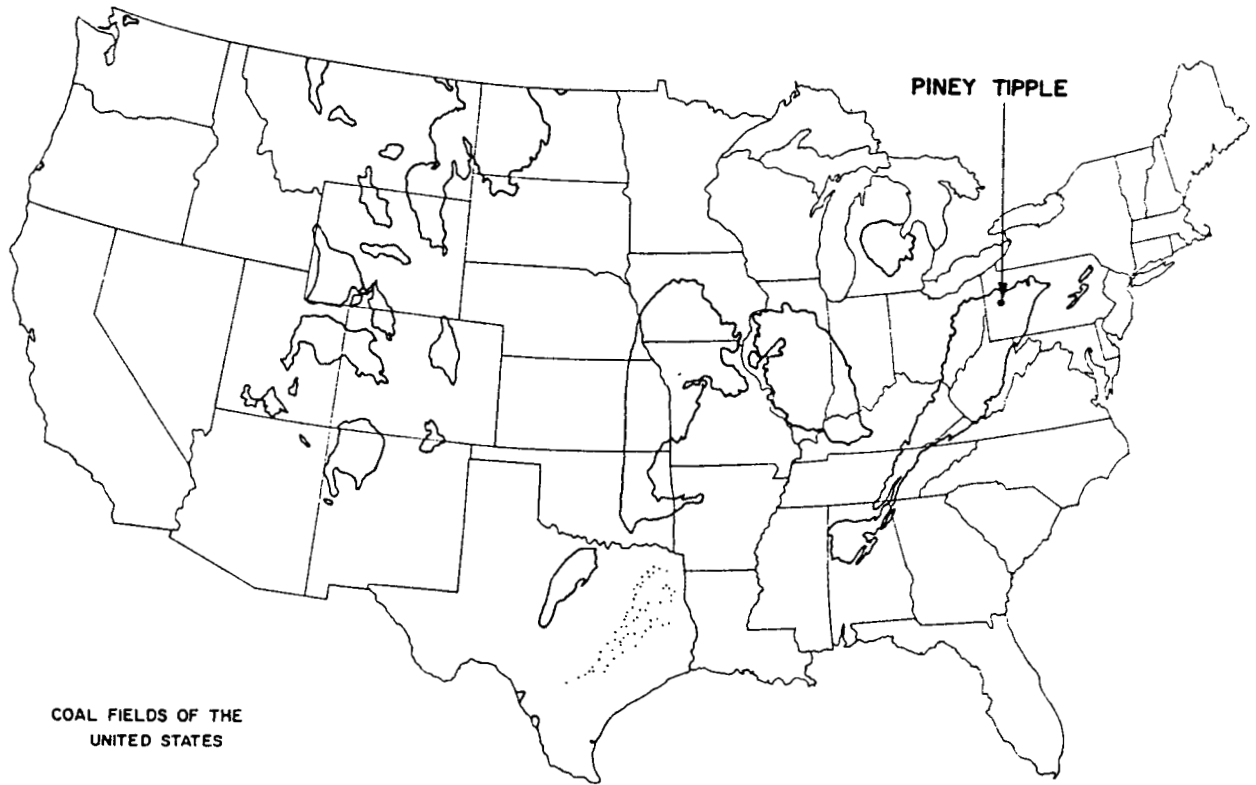


Table 3-1

Average Analysis of Piney Tipple Bituminous Coal

Proximate Analysis (%)		
Volatile Matter		37.70
Fixed Carbon		50.99
Ash		9.39
Moisture		1.92
Sulfur		2.95
Heating Value (Btu/lb)		13427
Ultimate Analysis (%)		
Carbon		73.61
Hydrogen		5.24
Nitrogen		1.27
Sulfur		2.95
Oxygen		5.63
Ash		9.39
Moisture		1.92
Ash Fusion Temperatures (deg F):		
	Oxidizing	Reducing
Initial deformation	2454	2120
Softening	2565	2235
Hemispherical	2580	2330
Fluid	2615	2430
Free Swelling Index:	6 1/2	

Table 3-2

Characteristics of Piney Tipple Bituminous Coal with Regard to the Coal Test Objective Matrix.

COAL TEST OBJECTIVE MATRIX									
PHYSICAL CHARACTERISTICS		COAL RANK							
TYPE	RANGE	BITUMINOUS	SUB-BITUMINOUS			LIGNITE	PEAT/BIO MASS	PETROLEUM COKE	BRIQUETTES
			A	B	C				
ASH CONTENT	H + 20%								
	M 10 - 20%								
	L - 10%	006							
ASH FUSION	H + 2700 F								
	M 2300-2700 F	006							
	L - 2300 F								
FREE SWELLING INDEX	H 3 +	006							
	M 1 - 3								
	L 0 - 1								
MOISTURE CONTENT	H + 15%								
	M 5 - 15%								
	L - 5%	006							
FRIABILITY (GRINDABILITY)	H								
	M								
	L	006							

SECTION 4

FACILITY DESCRIPTION

The USBM/TCRC gasification facility is described in detail in Volume 1 of this series (Thimsen, Maurer et al, 1984). A brief description of the equipment and monitoring systems is given here.

4.1 Test Facility

The gasification test facility includes a 6.5 foot diameter Wellman-Galusha gas producer, a combustion chamber and a wet caustic scrubber. The site also includes an iron ore pelletizing kiln which was not used during this test. The entire stream of producer gas was consumed in the combustion chamber. A process flow schematic is shown in Figure 4-1. A bottom size screen removes fine material prior to transport to the overhead storage bin by bucket elevator.

The facility is equipped with standard industrial monitoring equipment for measurement of temperatures, pressures, flows, and process conditions. These are recorded by an automatic data acquisition system for subsequent process analysis.

4.1.1 Gas Producer

The gas producer is a 6.5 foot ID Wellman-Galusha, single-staged, fixed-bed, atmospheric pressure gasifier. The gasifier has a gravity fuel feed system, a rotating water-cooled agitator for managing coal agglomeration, and an eccentric step type grate for ash removal. The retort is water jacketed and has no refractory lining. Steam generated in the water jacket is mixed with blast air. Steam/air ratio in the blast is measured and controlled by the temperature of the saturated steam/air mixture. Steam is imported if that generated in the water jacket is not adequate.

4.1.2 Gas Combustor

The gas combustor includes a baffle burner and a refractory-lined combustion chamber, and is designed to burn the full gas output of the gasifier at a rated capacity of 30 MMBTU/hour. The combustion products exhaust through an impingement tray-type wet caustic scrubber for sulfur dioxide and particulate removal. An induced draft fan is used to exhaust the scrubbed products of combustion through a flue stack.

4.2 Gas Sampling and Conditioning System

Figure 4-2 is a schematic of the gas sampling and conditioning system. The sampling port is thermally insulated to prevent

Figure 4-1

Coal Gasifier Process Flow Schematic
U. S. Bureau of Mines, Twin Cities Research Center

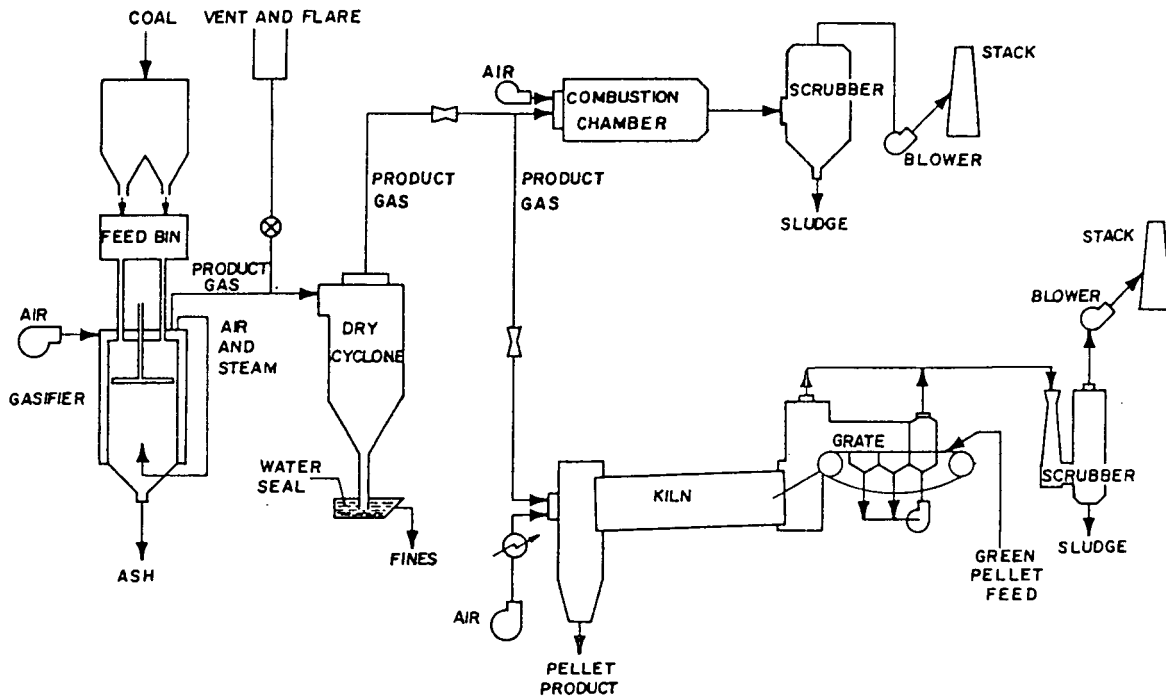
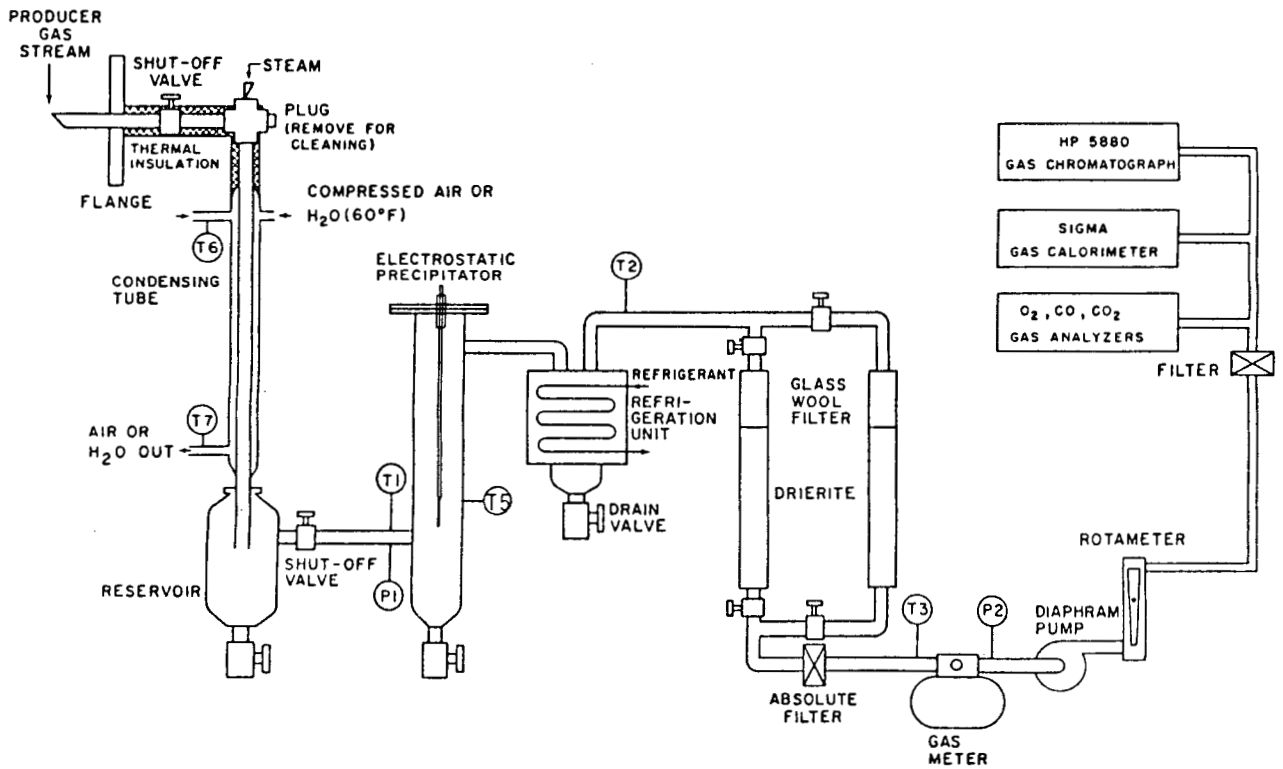


Figure 4-2

Schematic Diagram of the Gas Sampling and Conditioning System



condensation. The hot producer gas is quenched rapidly upon entering the surface condenser, which is cooled by cold water or cold, compressed air. The rapid quenching causes tar, oil, and water to condense on the inner surface of the condenser tube. The tar fog generated during cooling is removed in the electrostatic precipitator. The detarred gas is refrigerated and dessicated to remove water remaining in the gas stream. The dry, detarred gas is metered and transported to the instruments. Condensate samples are collected from traps in the condenser, electrostatic precipitator, and refrigerator.

4.3 Gas Analysis Equipment

Carbon dioxide and carbon monoxide concentrations are continuously measured with individual Beckman 864 non-dispersive infrared (NDIR) analyzers. Oxygen is monitored continuously with a Beckman 755 paramagnetic oxygen analyzer. Higher heating value of the sample gas is measured with a SIGMA continuous flow calorimeter. These signals are all recorded by the automatic data acquisition system.

Detailed gas composition is determined every 18 minutes with a Hewlett-Packard model 5880A gas chromatograph. The principal features of this chromatograph are listed in Table 4-1.

Table 4-1

Principal Features of the
HP 5880A Gas chromatograph.

1. Columns used:
 - a. 1-10 ft x 1/8 inch SS Porapak Q
 - b. 1-10 ft x 1/8 inch SS Molecular Seive 5A
 - c. 2-18 ft x 1/8 inch SS 2% OV-101 on WHP
2. Dual detectors - flame ionization detector in series with thermal conductivity detector
3. Set up for analysis of the following species:
Hydrogen, Carbon dioxide, Ethylene, Ethane,
Propane, Propylene, Oxygen, Nitrogen, Methane, and
Carbon monoxide
4. Argon Carrier Gas - flow rate of 28 ml/min
5. Programmed Temperature from 75 C to 165 C to 135 C
6. 1.0 ml sample
7. 18 minute analysis time

SECTION 5

TEST PROCEDURES

Test procedures are described in detail in Volume 1 of this series (Thimsen, Maurer et al, 1984). The following is a summary of the procedures including specific procedures used in this test only.

5.1 Test Teams

5.1.1 Gasifier Operation and Overall Coordination

The gasifier operations team was organized by Black, Sivalis & Bryson, Incorporated (BS&B) and consisted of the facility manager, facility engineers, three shift lead operators and additional helpers as required. The gasifier was staffed with a lead operator and two helpers, three shifts each day.

The gasifier operations team was responsible for overall operation of the gasifier and associated process equipment and coordination of all activities. This includes: gasifier start up, gas handling and incineration, exhaust gas cleanup, coal addition and sample collection, fire bed monitoring, process equipment maintenance and repair, operation of the boiler, changes in process conditions, sampling of waste streams, and measurement of retort temperature and pressure profiles.

5.1.2 Gasifier Monitoring

The gas sampling and data retrieval/monitoring team was organized by the University of Minnesota Particle Technology Laboratory, and consisted of persons with individual responsibility for:

- 1) sample gas cleanup
- 2) gas chromatograph
- 3) continuous gas analysis and SIGMA continuous calorimeter
- 4) data acquisition system

and such equipment operators as were necessary. The monitoring systems were staffed 24 hours per day.

The monitoring team was responsible for recording continuous process signals, operations of the gas chromatographs and continuous gas analysis equipment, operation of the gas sampling and conditioning system, collection of tar and oil samples, analysis of coal, ash, and cyclone dust samples, retort exhaust particle sampling and evaluation of health and safety measures.

5.1.3 Stack Gas Sampling

Interpoll, Incorporated, Circle Pines, Minnesota, a subcontractor to the University of Minnesota, brought a two-man team on site on July 20, 1983. They sampled for exhaust emissions from the gas combustor.

5.2 Gasifier Sampling and Data Acquisition Procedures

5.2.1 Continuous Data

An Analog Devices, Incorporated MACSYM 350 data acquisition system was installed for this test. Previously a MACSYM 2 system had been used. Continuous process signals are sampled once a minute. Ten-minute signal averages are recorded on floppy disc.

Thirty-minute signal averages are printed by line printer. The operations team also logs these signals hourly along with some twenty parameters not sampled by the data acquisition system.

5.2.2 Gas Analysis Data

The continuous gas analyzers are calibrated daily, according to the manufacturer's recommendations. Output signals are recorded by the data acquisition system.

The HP 5880A gas chromatograph is calibrated using a mixture of oxygen, carbon monoxide, carbon dioxide, hydrogen, methane, ethane, ethylene, propane, propylene, and nitrogen at concentrations which nearly duplicate the gasifier offgas. Another calibration mixture with the concentrations of all the species except nitrogen increased by about 50%, and the nitrogen correspondingly reduced, is used to check the linearity of the detectors.

5.2.3 Tar and Oil Data

The condensed tar, oil, and water are removed from the accumulation reservoirs twice daily. Water collected in the surface condenser and sample electrostatic precipitator is decanted from the tar and combined with the water from the refrigerator. Tar from the surface condenser is combined with tar and oil collected in the sample electrostatic precipitator. Condensate yields are measured by weighing both the tar/oil sample and the water sample.

5.2.4 Coal Data

Coal samples are taken from each of the two weigh bin legs by the operations team during coal addition to the lock hopper four times each shift. These four samples are stored in a sealed bucket and submitted as a composite shift sample for each weigh bin leg. Detailed chemical analysis of the coal is performed on

a composite of the shift samples.

5.2.5 Ash Data

An ash sample is taken by the operations team each time the ash is discharged and stored in a sealed container. For each ash sample the bulk density, particle size distribution, and carbon, sulfur, and moisture content of the ash are tabulated by the monitoring team. The carbon and sulfur content of each sample is determined from milled samples submitted by the monitoring team. The ash samples on which detailed elemental analyses are performed are composited over the same time periods used for compositing the coal samples.

5.2.6 Dust Data

Samples of cyclone dust are grabbed from the dust accumulation bin and composited into one sample over the entire test period.

5.2.7 Exhaust Gas Sampling

The gas combustor exhaust is analyzed by EPA methods 5 and 6 for sulfur dioxide, nitrogen oxides, and particulates once during the test.

5.2.8 Retort Particle Sampling

Sampling of the product gas for particulate loading was performed twice during the test. Particulate size distribution was measured for one of these samplings.

SECTION 6

CONDUCT OF TEST

The gasification of Piney Tipple bituminous coal, BOM/FGT-006 began on July 18, 1983. The modified start-up procedure used for BOM/FGT-005, gasification of petroleum coke, (Volume 6, Thimsen, Maurer et al, 1985) was also used for this test. This procedure involves laying the wooden wick boxes on top of the ash layer. The fuel oil soaked wicks are then lit from the top grate level access doors on the side of the gasifier. A more complete description of the start-up procedure is given in Volume 1 of this series (Thimsen, Maurer et al, 1984).

The gasifier was loaded with 9.7 tons of petroleum coke and the wicks were lit at 8:40 AM. The flare was ignited at 9:23 AM, and gas sent to the combustor at 10:30 AM. Initial targeted operating conditions were achieved in less than two hours for this cold startup. The Piney Tipple coal reached the retort at 6:00 PM and fully occupied the retort by about 2:00 AM on July 19. The grate drive was turned on at 6:00 AM on July 19.

Figure 6-1 gives the operating parameters achieved during this test. The initial saturation air flow was maintained at 1000 cfm and blast saturation temperature was set at 140-142 F (60-61 C). The agitator rate was adjusted to maintain 38 inches freeboard initially. The freeboard set point was moved to 34 inches on July 20, and 32 inches on July 21 to try to improve operation. Vertical travel of the agitator was 3 inches during the whole test.

There were no stable periods of operation during the 7 days of operation. Saturation temperatures in the range of 140-148 F (60-65 C) were used. Saturation air flows of 900-1000 cfm (producing coal consumptions of 0.5-0.6 tons per hour) were the maximum used. Throughput was limited by blowing through on top of the coal bed. The location of the blow holes was not constant. They appeared along the walls and in the middle of the coal bed at different times. Offtake temperatures varied from 900-1400 F (500-750 C), and were often above 1100 F (600 C).

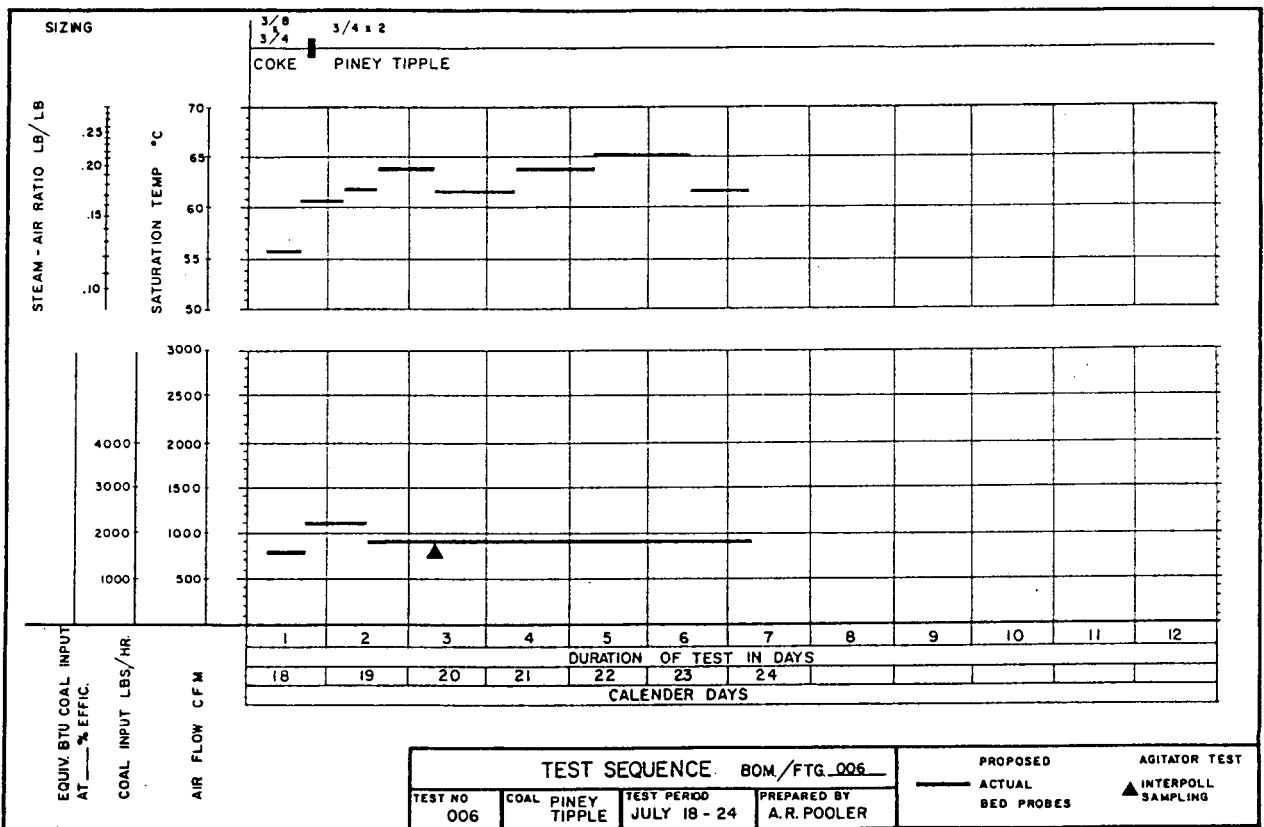
The fire test results varied from test to test. Some bars were cold, some were very hot, and some showed multiple incandescent zones. The results from a single hole would change from fire test to fire test. There was no discernible pattern to these changes. Hole number 7, in the center of the retort, was cold for most of the test.

Ash discharge during this test was granular with some fused chunks and some very large clinkers.

Cyclone dust was removed in fairly large quantities. It was of

Figure 6-1

Test History, BOM/FGT-006



a silty nature.

A port at a right angle elbow in the gas duct was cleaned periodically during the test. The globs of tar-dust mixtures removed at this location exhibited plastic behavior. Some of the chunks had a significant layer of black dust looking like lamp black. This is consistent with tar decomposition to amorphous carbon at some of the very high offtake temperatures (1200-1400 F, 650-750 C) noted during parts of the test.

The test was terminated at 1:30 AM on July 24, 1983. No new information was being gained, and it was decided to dump the gasifier to clean and prepare for BOM/FGT 007, gasification of River King Illinois No. 6 bituminous coal (Volume 8, Thimsen, Maurer et al, 1985).

Upon dumping the retort, three significant things were observed.

1. There was substantial large clinker that could not have moved through the grate.
2. There was a solid channel of ash 4 inches in diameter from the grate to the retort top that was fused to the wall of the gasifier near RAP number 2.
3. There was a fused, black carbon mass stuck to the grate and masking over half of the opening between the middle grate level and the top cone. This mass was stuck to a good portion of the top cone also, and undoubtedly caused the frequent cold fire test results for hole number 7.

SECTION 7

TEST RESULTS

7.1 Data Summary

7.1.1 Continuous Output Transducer Data

There were substantial problems operating the new MACSYM 350 data acquisition system during this test. In all, about 60 hours of data were not collected by the MACSYM. Table 7-1 shows the time periods over which the data acquisition system was not operating and the reasons for the data gaps. The vast majority of the problems were a result of bugs in the hardware and software supplied by the manufacturer. Several components of the new data acquisition system were replaced, some twice, and an entirely new compiler was supplied by the manufacturer.

For those time periods through July 21, 1983, during which the data acquisition system was inoperative, hand-logged data from the operations team was substituted. After July 21, 1983, a minimum program was installed on the MACSYM 350 that gave signal voltages for the most important parameters only. These voltages were logged hourly by the monitoring team during periods when the data acquisition system was inoperative.

Figure 7-1 gives the offtake temperature, fire loss pressure, and dry gas heating value along with operating parameters observed during the test. The dry gas heating value was relatively steady throughout the test (near 125-130 BTU/dscf). Fire loss pressure varied but was comparatively low. Offtake temperature rose steadily through the test suggesting increasingly poor gasification of the coal. None of these parameters showed a strong relationship to blast saturation temperature. Blast air flow was held relatively constant throughout the test.

(The periods over which hand-logged data were used are those where the signals show much less noise.)

7.1.2 Coal, Ash & Dust Data

A complete list of the tests performed on the bulk coal, ash and cyclone dust samples collected during BOM/FGT-006 together with the number of samples analyzed, is presented in Table 7-2.

7.1.2.1 Coal Data

The mass fraction of coal less than each of five indicated mesh sizes and the mean particle size are presented in Figures 7-2 and 7-3. As can be seen from these figures, the 3/4 inch undersize screen was very effective in removing undersize

Table 7-1

Data Acquisition Gaps for BOM/FGT-006

Date	Time	Length (min)	Reason
7/18/83	15:39	111	Start up problems
7/18/83	18:00	959	Data disc accidentally erased
7/19/83	10:24	143	Memory board replacement
7/20/83	9:08	223	CPU board replacement
7/20/83	17:46	197	Memory problem diagnostics
7/21/83	8:30	190	Diagnostics
7/21/83	13:35	95	Diagnostics and program development
7/21/83	15:59	156	Diagnostics and program development
7/22/83	8:57	107	System software bug
7/22/83	11:24	1413	Hardware memory errors

All the above gaps were filled with data from the BS&S operator's log and the U of Minnesota hourly log.

Through 7/21/83 15:30 AIN problems, signals seriously affected were replaced with data from BS&B operator's log.

7/22/83 11:00 to end Minimum program, hourly hand logged voltages for blast saturation temperature, offtake temperature, blast air flow, ambient temperature, and reference temperature. All other signals retrieved from BS&B Operator's Log and U of Minnesota hourly log.

Physical Characteristics of the Gasifier Operation.

Figure 7-1

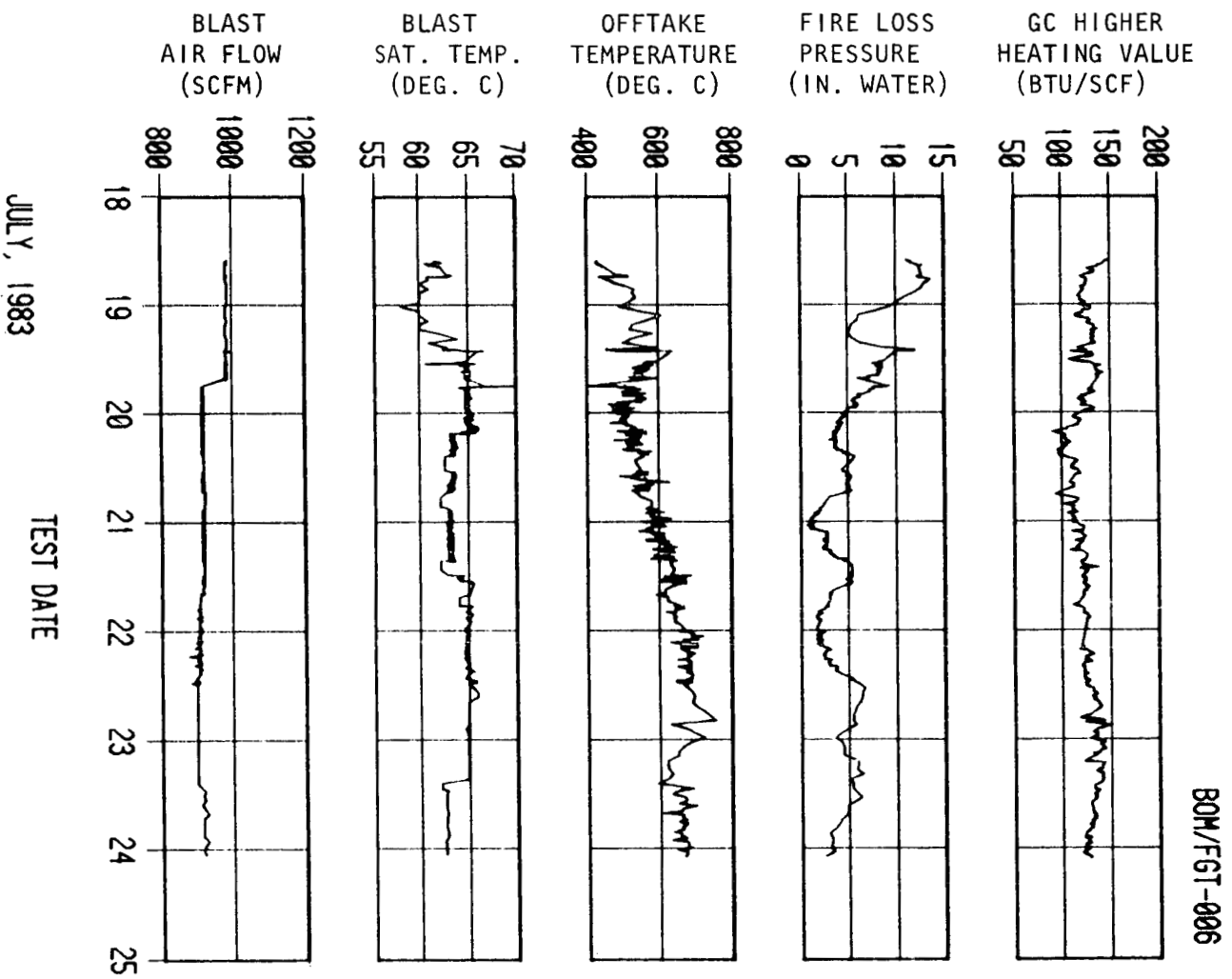


Table 7-2

Summary of Coal and Cyclone Dust Analyses

Material	Type of Analysis	Samples Collected and Analyzed	Composite Samples Analyzed
Coal	Particle Size Distribution	16	-
	Proximate Analysis	-	1
	Ultimate Analysis	-	1
	Heating Value	-	1
Ash	Particle Size Distribution	20	-
	Bulk Density	20	-
	Moisture Content	20	-
	Carbon Content	20	1
	Sulfur Content	20	1
	Elemental Analysis	-	1
Cyclone Dust	Proximate Analysis	-	1
	Ultimate Analysis	-	1

Figure 7-2

Feed Coal Size Distribution Analysis

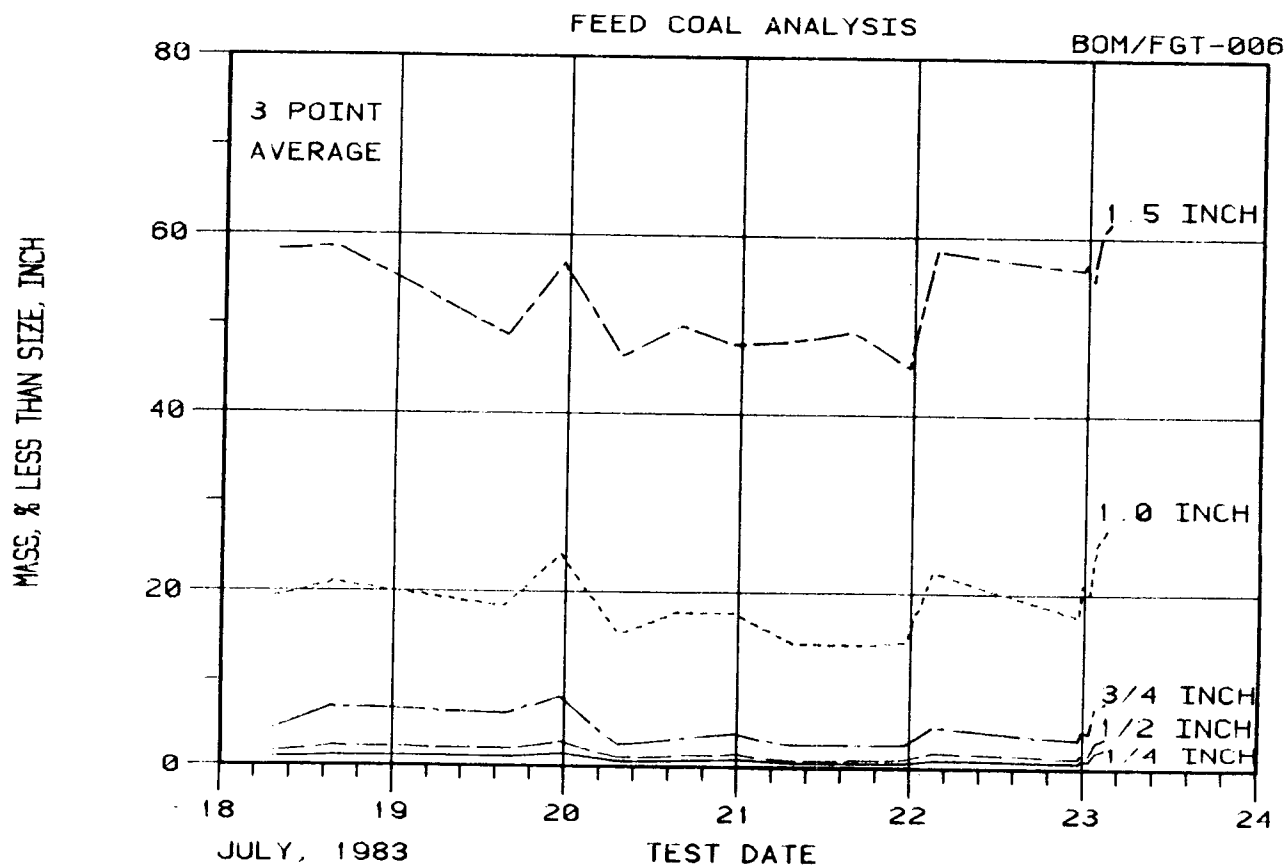
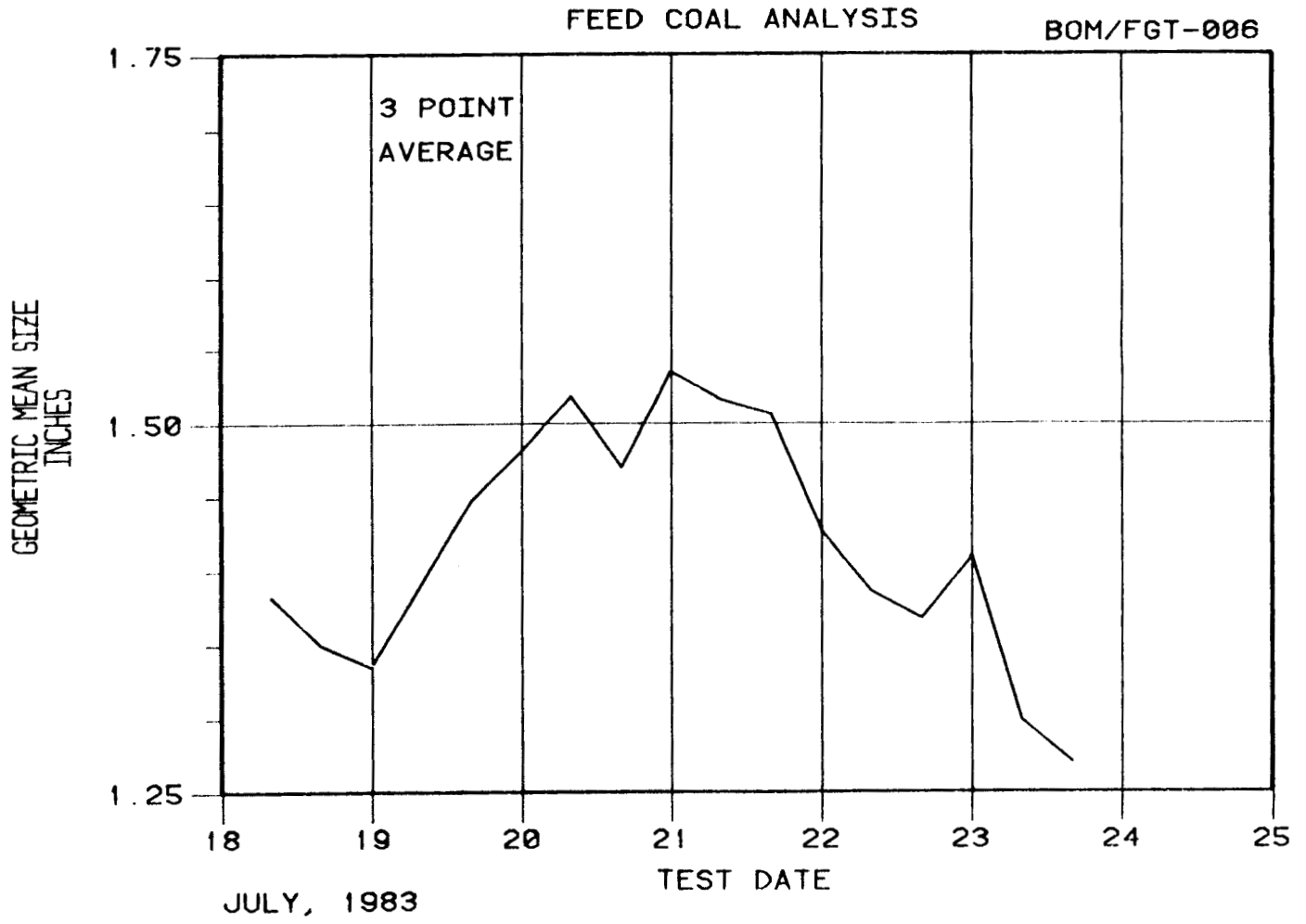


Figure 7-3

Geometrical Mean Coal Particle Size



material. As indicated by Figure 7-4, less than 5% of the coal entering the retort was smaller than 3/4 inch over the whole test.

The results of the chemical and physical analyses of a single coal sample composited from shift samples over the whole test period are given in Table 7-3.

7.1.2.2 Ash Data

The mass fraction of ash less than each of five indicated mesh sizes and the mean ash particle size are given in Figures 7-5 and 7-6. The mean ash particle size rose somewhat during July 20 and 21. This ash was generated just after the Piney Tipple coal entered the retort and represents some fusing of ash at the lower blast saturation temperatures in use July 18-19.

Figure 7-7 shows the physical and chemical characteristics of the ash with operating conditions. No obvious trends are present, except that sulfur content tends to track carbon content.

Table 7-4 shows the detailed chemical analysis of a single composite, moisture-free ash taken from all ash dumps except those that were predominantly ash charged to the gasifier at start-up.

7.1.2.3 Cyclone Dust

The chemical analysis of one cyclone dust sample is given in Table 7-3. The volatile matter to fixed carbon ratio for the dust is 0.066. The similar ratio for the feed coal is 0.739. This dramatic decrease in volatile matter relative to fixed carbon is consistent with partial devolatilization of the dust in the high temperatures of the upper retort and offtake ductwork.

The partial devolatilization of the dust is not adequate to explain the full increase in ash content, however. The ash to fixed carbon ratio of the dust is 0.197 while the similar ratio for the feed coal is .188. Higher ash material than the original coal is apparently blown out of the retort. These materials may come from the lower regions of the retort.

7.1.3 Gas Analysis Data

The NDIR carbon monoxide and carbon dioxide analyzers and the paramagnetic oxygen analyzer operated well during the test. The SIGMA continuous calorimeter showed a daily drift of 1-2%, probably due to a barometric pressure compensator malfunction. The HP 5880A gas chromatograph operated for the entire test except a 5.5 hour period from 2200 on July 21 to 0330 on July 22, during which a valve switching repair was made.

Figure 7-4

Average Particle Size Distribution of Feed Coal

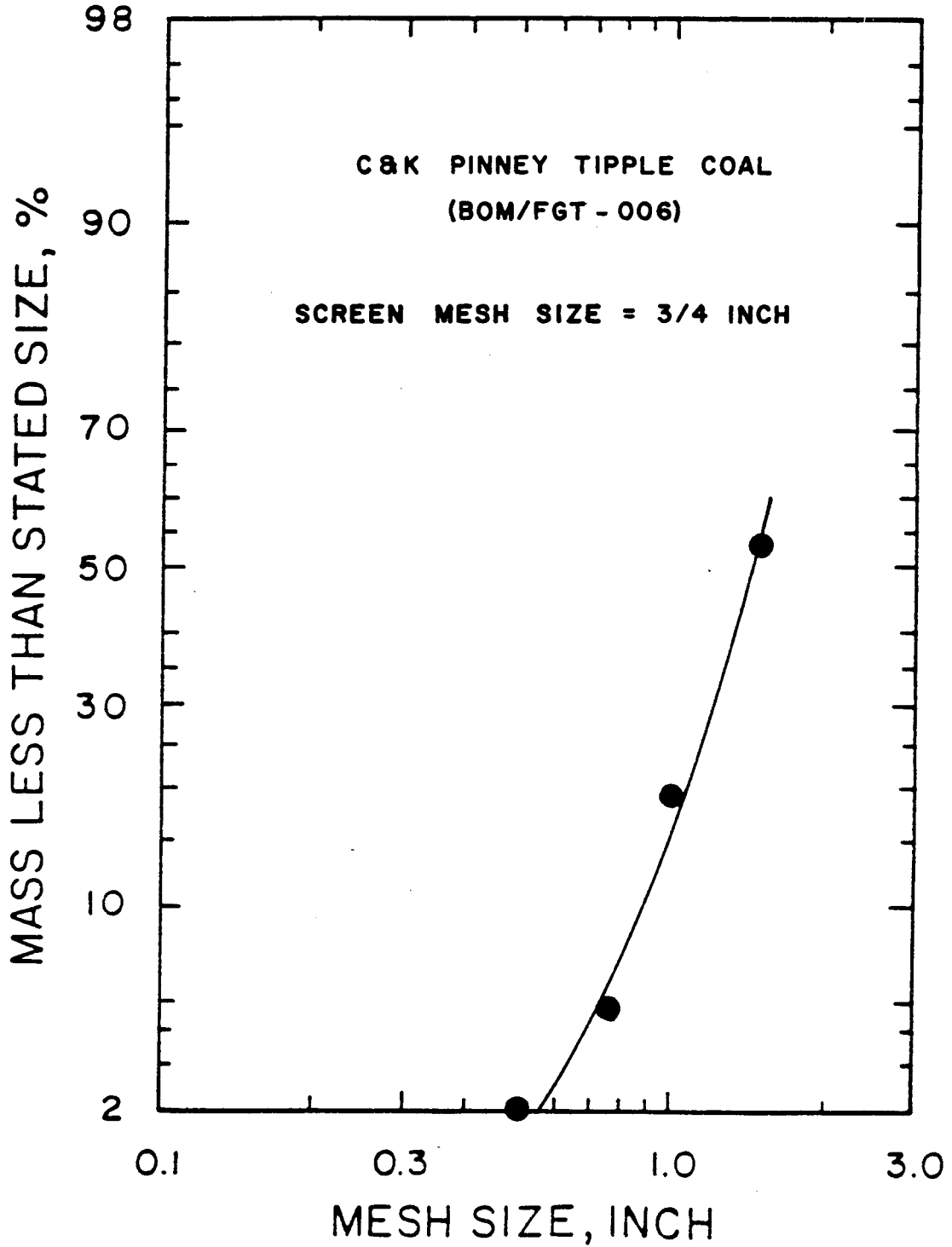


Table 7-3

Physical and Chemical Properties of Coal and Dust

Material	Coal (as received)	Cyclone Dust (dry basis)
Type of Analysis		
<u>Proximate Analysis, wt %:</u>		
Moisture	1.92	--
Volatile Matter	37.70	5.24
Ash	9.39	15.60
Fixed Carbon	50.99	79.16
<u>Ultimate Analysis, wt %:</u>		
Hydrogen	5.24	1.28
Carbon	73.61	78.50
Nitrogen	1.27	1.08
Sulfur	2.95	3.48
Oxygen	5.63	0.07
Ash	9.39	15.60
Mositure	1.92	--
<u>Heating Value, btu/lb.:</u>		
As Received	13,427	--
Moisture	13,689	12,106
<u>Ash Fusion Temp., F:</u>		
(Oxidizing Atmosphere)		
Initial Dif., IT	2545	-
Softening, ST	2565	-
Softening, HT	2580	-
Fluid, FT	2615	-
(Reducing Atmosphere)		
Initial Def., IT	2120	-
Softening, ST	2235	-
Softening, HT	2330	-
Fluid, FT	2430	-
Free Swelling Index	6 1/2	

Figure 7-5

Ash Size Distribution Analysis

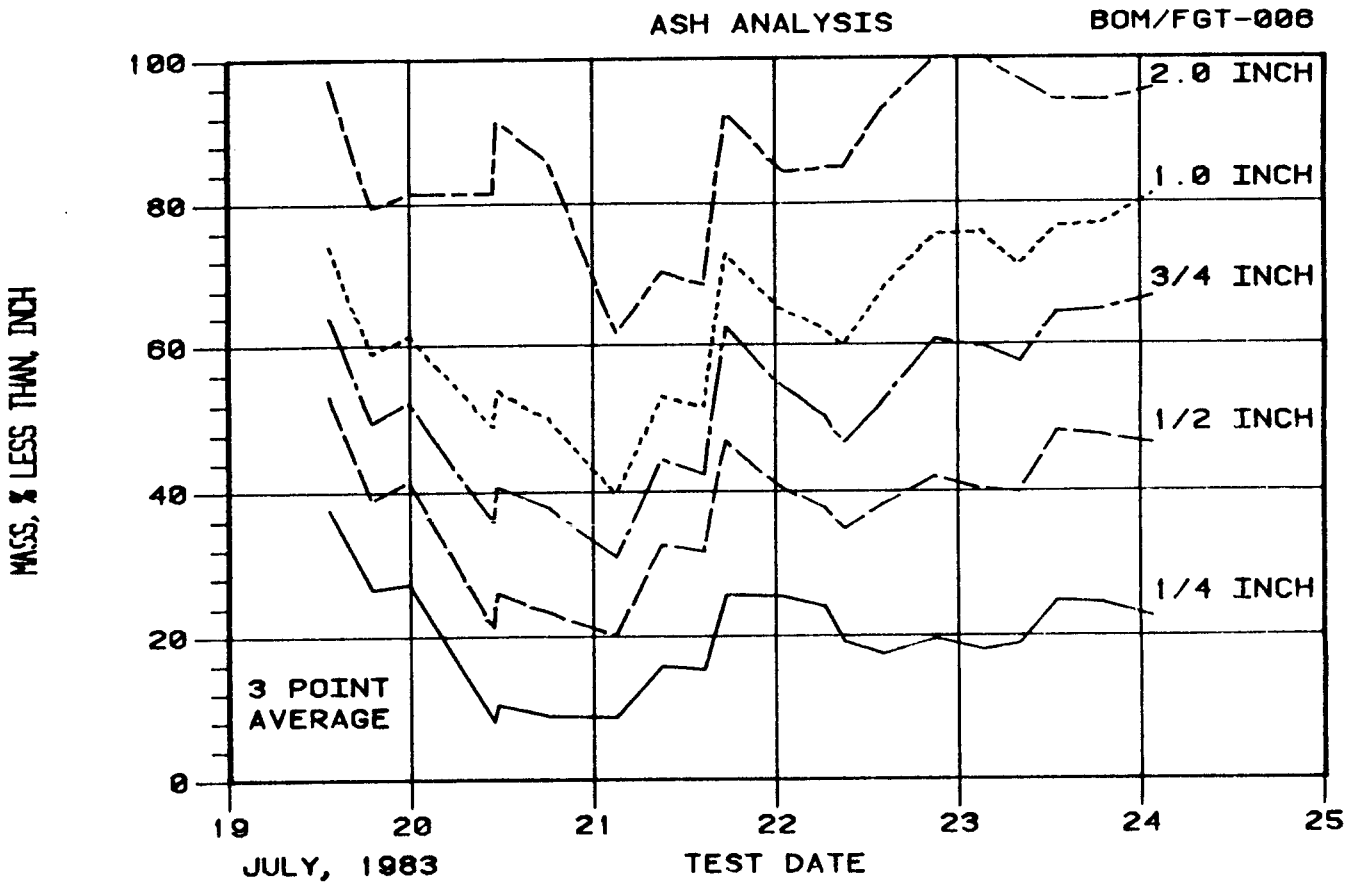


Figure 7-6

Geometrical Mean Ash Particle Size

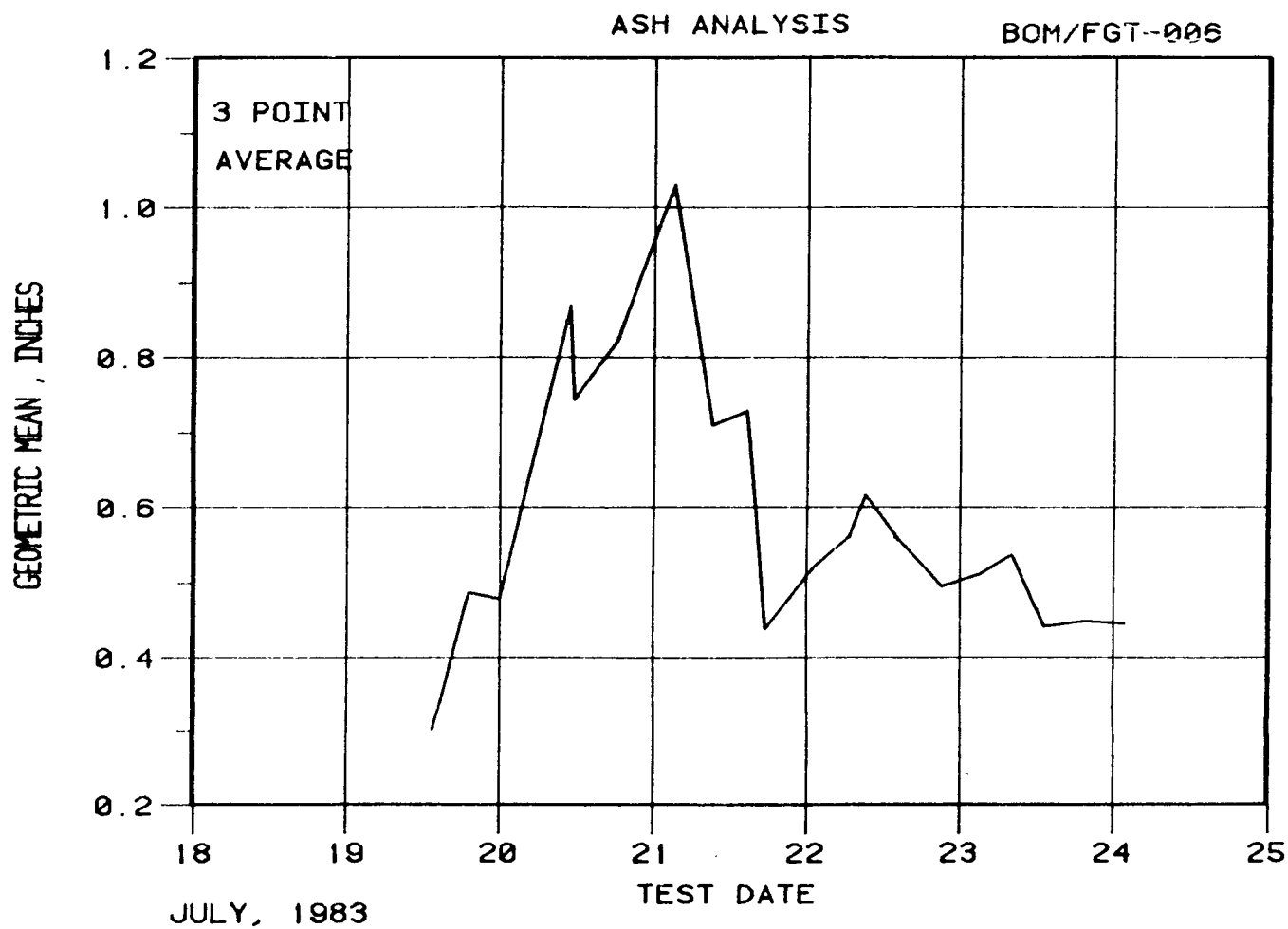


Figure 7-7

Ash Characteristics and Operating Conditions

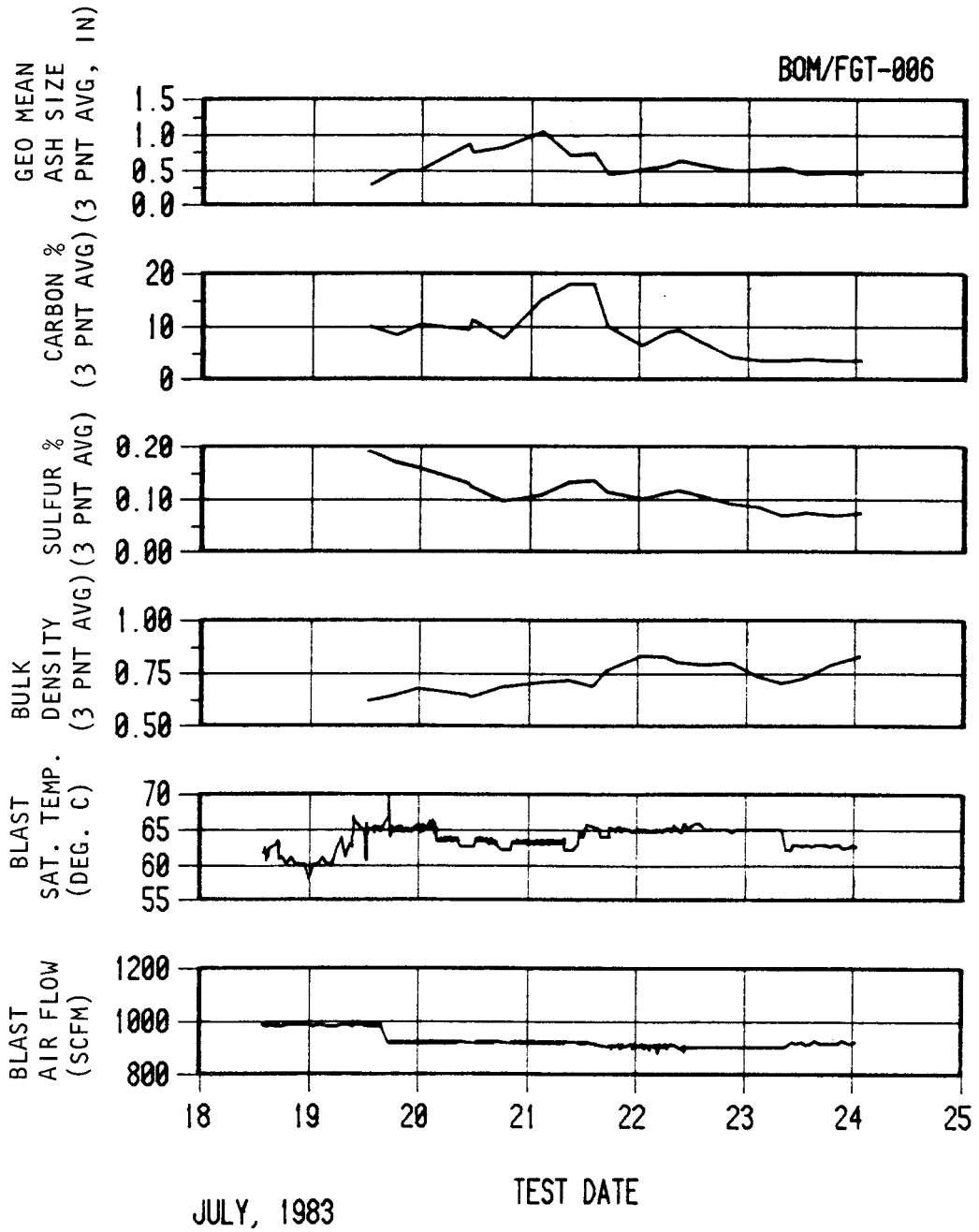


Table 7-4

Summary of Elemental Analysis of Moisture-Free Ash

Element	Mass Fraction, % (*)
Fe	22.5
Fe ²⁺	6.5
Si	19.6
Al	13.6
C	8.3
Ca	1.7
Mg	0.32
K	0.70
P	0.08
Na	0.12
S	0.10
Ti	0.76

(*) Unaccounted for mass is presumed to be oxygen bound onto the metals as oxides.

The concentrations of various species measured by the gas chromatograph are given in Figures 7-8 and 7-9. The rise in carbon dioxide and nitrogen and fall in hydrogen and carbon monoxide on early July 20 correspond to operator observations of excessive burning through in the bed. The increases in hydrocarbon concentrations July 19 correspond to increasing coal inventory in the retort due to increased grate speed and consequent accelerated ash removal. The wide fluctuations in hydrocarbon concentrations on July 22 correspond to fluctuations in coal feed rate due to bridging in the lower lock hopper and coal feed pipes.

The major gas species, along with dry gas HHV and operating parameters, is given in Figure 7-10. There is no strong correlation between the gas composition and operating parameters. It is clear that the gradual rise in dry gas heating value from July 21 on, corresponds to a rise in hydrogen content, but this is unexplained.

7.1.4 Tar and Water Yield Data

The gas sampling and conditioning system encountered several minor problems related to dust accumulations and tar clogging in the condenser due to cold walls. It was found, by trial and error, that a condenser outlet temperature of 90-100 degrees F was required to minimize the tar clogging problem. Table 7-5 shows the various efforts undertaken to remedy the problems along with the time periods that clean gas was unavailable to the gas analyzers. In all, there was less than 4 hours of down time.

Chemical and physical analyses of a single tar and water sample composited over the entire test are given in Table 7-6. The tar/oil and water yields with operating conditions are shown in Figure 7-11. Very little variation in condensate yields was noted.

7.2 Material and Energy Balances

The material and energy balance calculation procedures are described in Volume 1 of this series (Thimsen, Maurer et al, 1984). A brief description follows.

The measured data used to calculate material and energy balances around the gasifier include process temperatures, pressures, and flows, tar/water yields, material ultimate analyses and gas compositions. The calculations for this test also include the following assumptions:

- A. Dust carryover is estimated to be 2% of the coal feed rate based on operator observations.

Figure 7-8

Major Gas Species Measured by the Gas Chromatograph.

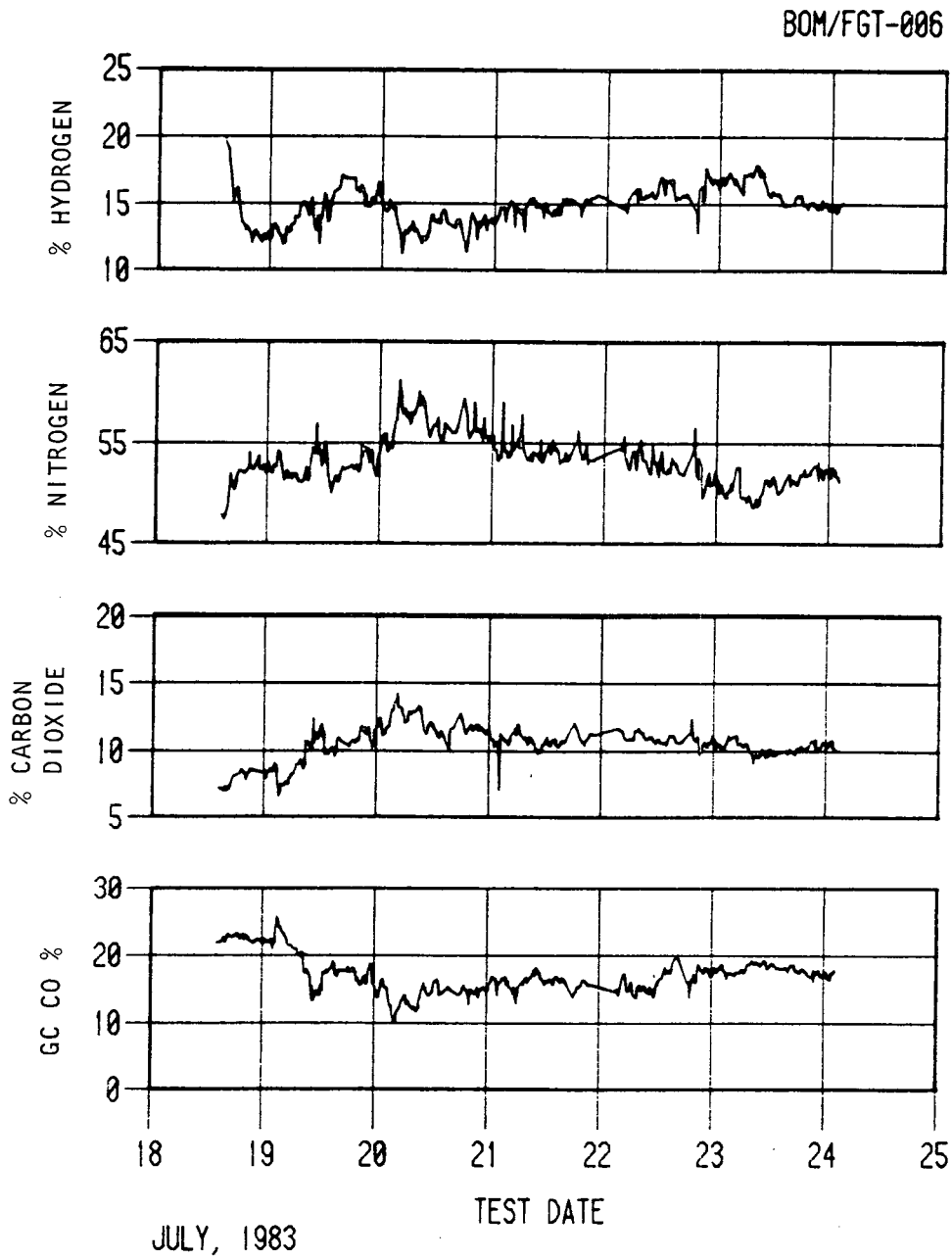


Figure 7-9

Minor Gas Species Measured by the Gas Chromatograph.

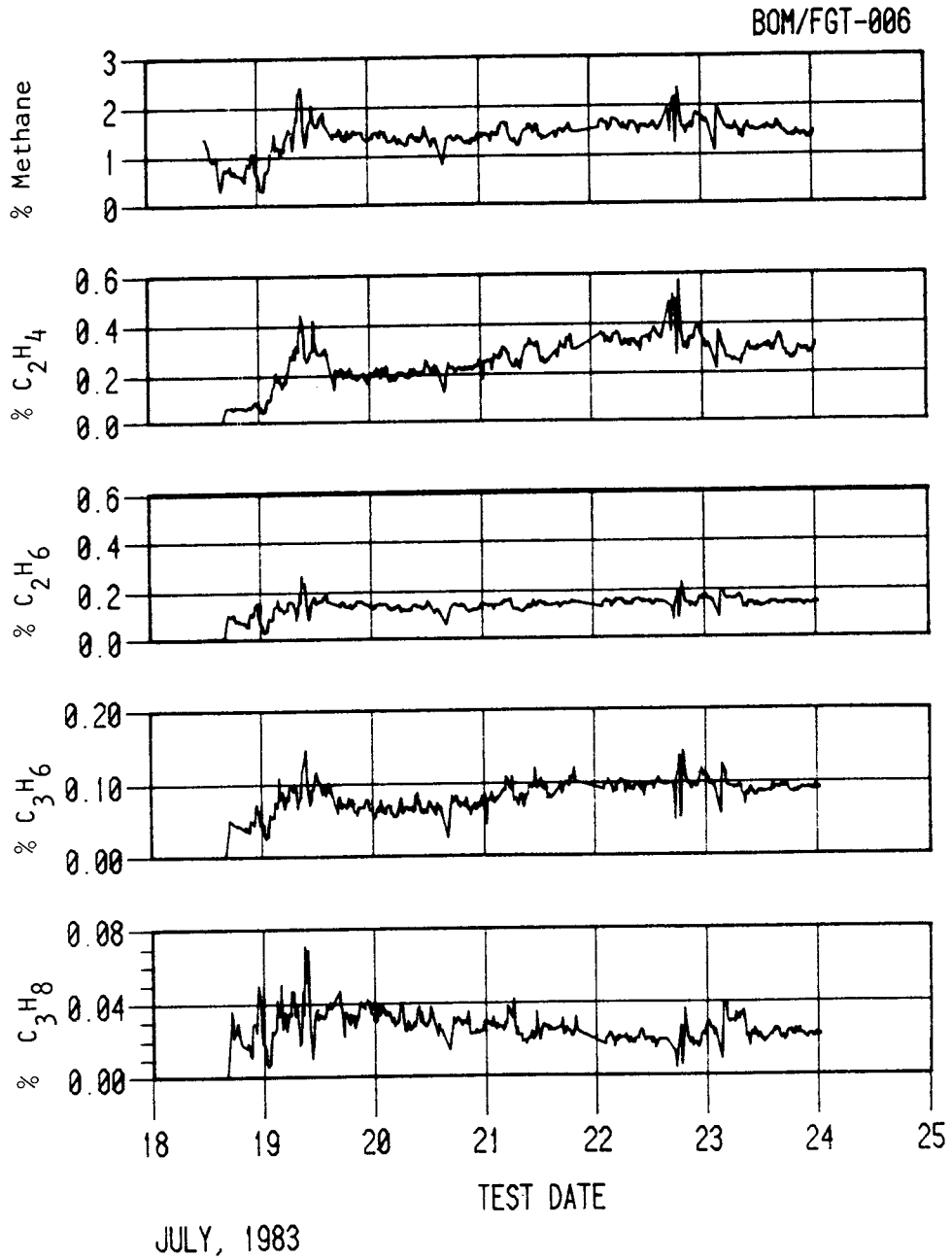


Figure 7-10

Dry gas HHV, Major Gas Species and Gasifier Operating Parameters.

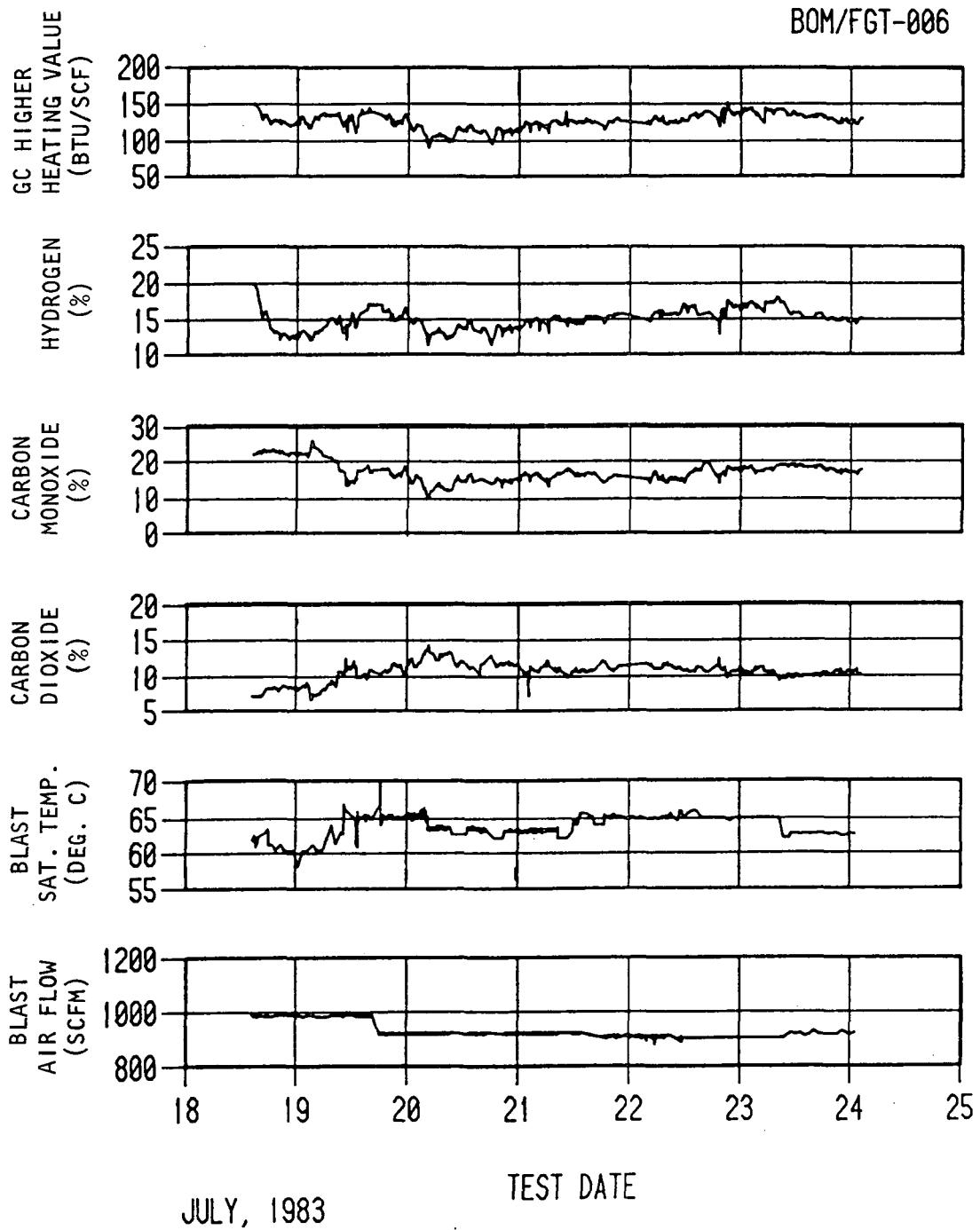


Table 7-5

Operation Summary for Gas Sampling System

7/20/83	8:20 - 8:40	Clogged between condensor and ESP line due to coke dust.
7/20/83	14:30 - 15:20	Condensor clogged: increased coolant temperature.
7/21/83	14:40 - 15:00	Sampling inlet clogged: rodded clean
7/22/83	7:00 - 7:30	Sampling inlet clogged: rodded clean
7/22/83	18:00 - 18:30	Condensor clogged: increased coolant temperature
7/23/83	4:15 - 4:40 14:00 - 14:50	Condensor clogged: increase coolant temperature

Table 7-6
Condensed Material Analyses

Water

Total organics, % 0.41

Tar

As Received

Dry Basis

Heating value, Btu/lb

13916

15672

Flash point, F

216

--

Water by distillation, %

11.21

--

Specific gravity, 60/60 F

1.1521

--

Pour point, F

75

--

Cold (solid) point, F

70

--

Viscosity at:

122 F Saybolt Furol, s

364

--

122 F Kinematic, centistokes

771

--

210 F Saybolt Universal, s

115.8

--

210 F Kinematic, centistokes

24.0

--

Ultimate Analysis, WT%

Hydrogen

5.85

6.59

Carbon

76.91

86.62

Nitrogen

1.24

1.40

Oxygen (by difference)

3.46

3.90

Sulfur

1.22

1.37

Moisture, Total

11.21

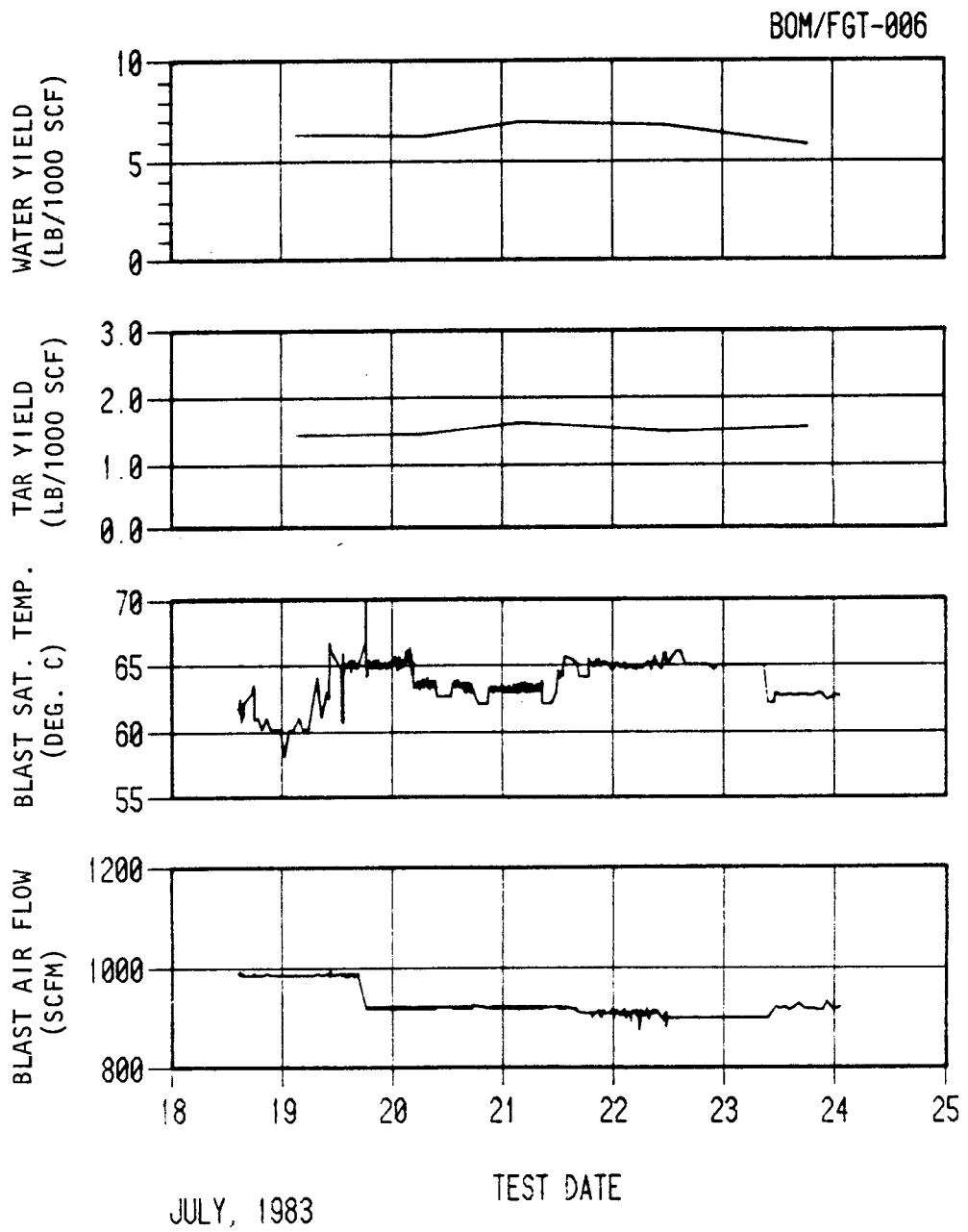
Ash

0.11

0.12

Figure 7-11

Tar/Oil Yield and Water Yield with Operating Conditions



- B. Coal bound sulfur not reporting to the tar, ash, or dust is reported as hydrogen sulfide in the gas. No measurements of gas phase sulfur were taken during this test.
- C. Coal gas flow and blast air flow are calculated assuming a simultaneous nitrogen and carbon balance around the gasifier. The air flow signal was reproducible but felt to be less precise than the coal flows recorded.
- D. The total gas analysis is normalized to 99.9 %.
- E. Ash flows are calculated to be coal ash not reporting to the dust added to carbon and sulfur from the ash composition determinations.

The continuous process variables of interest are the saturation air flow, blast saturation temperature, offtake temperature, ambient temperature, cooling water inlet and outlet temperatures, cooling water flow and saturation steam imported. Ten-minute averages are available for all of these parameters except the cooling water flow and saturation steam imported. Hourly totals and flow rates logged by the operators are used for these parameters.

Condensable yields in the gas stream were obtained from the gas sampling and conditioning system.

Ultimate analyses and heating values of the coal and moisture-free tar samples were used for the carbon-nitrogen balance calculations as well as the dry gas compositions from the gas chromatograph.

The balances were calculated over various time periods representing relatively steady operation. Each period is characterized by a coal throughput and blast saturation temperature (representing the blast steam/air ratio). Tables 7-7 to 7-11 show the results of these calculations. Table 7-12 shows the results of the calculations over the entire test period.

As can be seen from those calculations, substantial heat was transferred to the cooling water. There was also substantial sensible heat in the product gas. This heat production requires lower gas quality to satisfy energy conservation.

7.3 Grate Performance Model

A geometrical grate performance model was prepared and is described in Volume 1 of this series (Thimsen, Maurer et al, 1984). The model calculates the void volume swept by the grate and compares it to the volume of ash rejected by the grate. Each data point in Figure 7-12 represents a separate ash dump.

Table 7-7

Material Balance and Thermal Efficiency Calculation
0.67 tn/hr, 145 F

Input Data

Time period: 7/18/83 15:00 - 7/19/83 16:00 (25.0 hours)

Gasifier Operation:	Coal Data:
Coal feed, Ton/hour = 0.67	Type = Piney Tipple
Blast air flow (dry) , Scfm = 985.	Mass Fraction Carbon % = 73.6
Saturated air temperature, F = 145.	Mass Fraction Fixed Carbon = 50.99
Steam/Air Ratio (lb./lb.) = 0.18	Mass Fraction Moisture % = 1.92
Ambient air temperature, F = 81.	Mass Fraction nitrogen % = 1.27
Off-take temperature, F = 987.	Mass Percent sulfur = 2.95
	Heating value, Btu/lb = 13427

Tar and Water Yield (dry basis):	Ash and Dust Data:(dry basis)
Water yield, lb./1000 SCF = 5.84	Ash discharge ,lb/hour = 86.
Tar yield, lb/1000 SCF = 1.34	Ash carbon ,percent = 8.3
Carbon in Tar (percent) = 86.6	Ash sulfur ,percent = 0.17
Sulfur in Tar (percent) = 1.37	Ash moisture (wet),percent = 9.9
Tar HHV, thou. Btu/lb = 15.67	Cyclone dust,lb/hour(est.) = 27.

Gas Composition (Dry): (normalized to 99.90)

H2 % = 14.3	CH4 % = 1.12	H2S (est ppm) = 5096
CO % = 20.7	C2H4 % = 0.160	
CO2 % = 8.98	C2H6 % = 0.108	
N2 % = 53.3	C3H6 % = 0.064	
O2 % = 0.00	C3H8 % = 0.028	HHV, Btu/SCF = 134
Molec. Weight = 25.47	Argon(est. %) = 0.635	LHV, Btu/SCF = 125

Calculation Results (based on nitrogen and carbon balance)

Material Balance (Percent unaccounted for: 1.25)

Input,	lb/hr	% Total	Output,	lb/hr	% Total
Coal	= 1343.	20.3	Dry gas	= 5749.	88.1
Steam (total)	= 820.	12.4	Water in gas	= 500.	7.7
Air (calc,dry)	= 4444.	67.3	Oil and tar	= 115.	1.8
			Ash(calc,dry)	= 134.	2.1
			Dust	= 27.	0.4
Total	= 6607.		Total	= 6524.	

Energy Balance (Percent unaccounted for: 7.62)

Input,	MM BTU/hr	Output,	MM Btu/hr	% Total
Coal	= 18.0	Dry coal gas	= 11.5	66.3
Air	= 0.037	Oil and tar	= 1.80	10.4
Steam(import)	= 0.545	Sensible	= 1.82	10.5
Cooling water	= 0.119	Latent	= 0.540	3.1
		Ash	= 0.160	0.9
		Dust	= 0.325	1.9
		Cooling water	= 1.188	6.9
Total	= 18.7	Total	= 17.3	

Performance Data

Cold gas efficiency,	percent = 61.2
Cold gas with tar efficiency,	percent = 70.8
Hot gas without tar efficiency	percent = 73.1
Hot gas with tar efficiency,	percent = 83.3
Air/Coal	(lb./lb.) = 3.309
Steam/Coal	(lb./lb.) = 0.610
Air/Fixed Carbon	(lb./lb.) = 6.489
Coal/Gasifier Area	(lb./hr./sqft) = 40.5
Fixed Carbon/Area	(lb./hr./sqft) = 20.6
Producer Gas/Coal	(SCF/lb.) = 71.7
Producer Gas/Fixed Carbon	(SCF/lb.) = 140.7
Tar Yield	(lb./lb. coal) = 0.085

Table 7-8

Material Balance and Thermal Efficiency Calculation
0.54 tn/hr, 148 F

Input Data

Time period: 7/19/83 20:00 - 7/20/83 16:00 (20.0 hours)

Gasifier Operation:		Coal Data:	
Coal feed, Ton/hour	= 0.54	Type = Piney Tipple	
Blast air flow (dry) , Scfm	= 918.	Mass Fraction Carbon %	= 73.6
Saturated air temperature, F=	148.	Mass Fraction Fixed Carbon	= 50.99
Steam/Air Ratio (lb./lb.)	= 0.20	Mass Fraction Moisture %	= 1.92
Ambient air temperature, F	= 77.	Mass Fraction nitrogen %	= 1.27
Off-take temperature, F	= 984.	Mass Percent sulfur	= 2.95
		Heating value, Btu/lb	= 13427

Tar and Water Yield (dry basis):		Ash and Dust Data:(dry basis)	
Water yield, lb./1000 SCF	= 5.82	Ash discharge ,lb/hour	= 63.
Tar yield, lb/1000 SCF	= 1.34	Ash carbon ,percent	= 8.7
Carbon in Tar (percent)	= 86.6	Ash sulfur ,percent	= 0.11
Sulfur in Tar (percent)	= 1.37	Ash moisture (wet),percent	= 17.3
Tar HHV, thou. Btu/lb	= 15.67	Cyclone dust,lb/hour(est.)	= 21.

Gas Composition (Dry): (normalized to 99.90)

H2 %	= 14.0	CH4 %	= 1.38	H2S (est ppm)	= 4685
CO %	= 14.5	C2H4 %	= 0.198		
CO2 %	= 11.97	C2H6 %	= 0.134		
N2 %	= 56.4	C3H6 %	= 0.066		
O2 %	= 0.00	C3H8 %	= 0.032	HHV, Btu/SCF	= 117
Molec. Weight=	25.97	Argon(est. %)	= 0.673	LHV, Btu/SCF	= 108

Calculation Results (based on nitrogen and carbon balance)

Material Balance (Percent unaccounted for: 4.18)

Input,	lb/hr	% Total	Output,	lb/hr	% Total
Coal	= 1071.	17.9	Dry gas	= 5077.	88.5
Steam (total)	= 836.	14.0	Water in gas	= 432.	7.5
Air(calc,dry)	= 4080.	68.1	Oil and tar	= 99.	1.7
			Ash(calc,dry)	= 107.	1.9
			Dust	= 21.	0.4
Total	= 5987.		Total	= 5736.	

Energy Balance (Percent unaccounted for: 3.98)

Input,	MM BTU/hr	Output,	MM Btu/hr	% Total
Coal	= 14.4	Dry coal gas	= 8.7	60.9
Air	= 0.022	Oil and tar	= 1.56	10.9
Steam(import)	= 0.261	Sensible	= 1.59	11.2
Cooling water	= 0.163	Latent	= 0.466	3.3
		Ash	= 0.134	0.9
		Dust	= 0.259	1.8
		Cooling water	= 1.561	11.0
Total	= 14.8	Total	= 14.2	

Performance Data

Cold gas efficiency,	percent	= 58.4
Cold gas with tar efficiency,	percent	= 69.0
Hot gas without tar efficiency	percent	= 71.5
Hot gas with tar efficiency,	percent	= 82.7
Air/Coal	(lb./lb.)	= 3.809
Steam/Coal	(lb./lb.)	= 0.781
Air/Fixed Carbon	(lb./lb.)	= 7.470
Coal/Gasifier Area	(lb./hr./sqft)	= 32.3
Fixed Carbon/Area	(lb./hr./sqft)	= 16.5
Producer Gas/Coal	(SCF/lb.)	= 77.9
Producer Gas/Fixed Carbon	(SCF/lb.)	= 152.7
Tar Yield	(lb./lb. coal)	= 0.093

Table 7-9

Material Balance and Thermal Efficiency Calculation
0.54 tn/hr, 147 F

Input Data

Time period: 7/20/83 19:00 - 7/21/83 11:00 (16.0 hours)

Gasifier Operation:		Coal Data:	
Coal feed, Ton/hour	= 0.54	Type = Piney Tipple	
Blast air flow (dry) , Scfm	= 919.	Mass Fraction Carbon %	= 73.6
Saturated air temperature, F	= 147.	Mass Fraction Fixed Carbon	= 50.99
Steam/Air Ratio (lb./lb.)	= 0.20	Mass Fraction Moisture %	= 1.92
Ambient air temperature, F	= 88.	Mass Fraction nitrogen %	= 1.27
Off-take temperature, F	= 1110.	Mass Percent sulfur	= 2.95
		Heating value, Btu/lb	= 13427

Tar and Water Yield (dry basis):		Ash and Dust Data:(dry basis)	
Water yield, lb./1000 SCF	= 6.38	Ash discharge ,lb/hour	= 81.
Tar yield, lb/1000 SCF	= 1.46	Ash carbon ,percent	= 14.6
Carbon in Tar (percent)	= 86.6	Ash sulfur ,percent	= 0.12
Sulfur in Tar (percent)	= 1.37	Ash moisture (wet),percent	= 16.2
Tar HHV, thou. Btu/lb	= 15.67	Cyclone dust,lb/hour(est.)	= 22.

Gas Composition (Dry): (normalized to 99.90)

H2 %	= 14.5	CH4 %	= 1.41	H2S (est ppm)	= 4850
CO %	= 15.6	C2H4 %	= 0.242		
CO2 %	= 11.17	C2H6 %	= 0.133		
N2 %	= 55.6	C3H6 %	= 0.089		
O2 %	= 0.00	C3H8 %	= 0.027	HHV, Btu/SCF	= 123
Molec. Weight	= 25.74	Argon(est. %)	= 0.663	LHV, Btu/SCF	= 114

Calculation Results (based on nitrogen and carbon balance)

Material Balance (Percent unaccounted for: 2.67)

Input,	lb/hr	% Total	Output,	lb/hr	% Total
Coal	= 1079.	18.8	Dry gas	= 4878.	87.2
Steam (total)	= 775.	13.5	Water in gas	= 459.	8.2
Air(calc,dry)	= 3895.	67.8	Oil and tar	= 105.	1.9
			Ash(calc,dry)	= 132.	2.4
			Dust	= 22.	0.4
Total	= 5748.		Total	= 5595.	

Energy Balance (Percent unaccounted for: 1.63)

Input,	MM BTU/hr	Output,	MM Btu/hr	% Total
Coal	= 14.5	Dry coal gas	= 8.9	59.4
Air	= 0.055	Oil and tar	= 1.65	11.0
Steam(import)	= 0.406	Sensible	= 1.80	12.0
Cooling water	= 0.217	Latent	= 0.495	3.3
		Ash	= 0.274	1.8
		Dust	= 0.261	1.8
		Cooling water	= 1.576	10.6
Total	= 15.2	Total	= 14.9	

Performance Data

Cold gas efficiency,	percent	= 58.5
Cold gas with tar efficiency,	percent	= 69.3
Hot gas without tar efficiency	percent	= 72.6
Hot gas with tar efficiency,	percent	= 84.3
Air/Coal	(lb./lb.)	= 3.610
Steam/Coal	(lb./lb.)	= 0.718
Air/Fixed Carbon	(lb./lb.)	= 7.081
Coal/Gasifier Area	(lb./hr./sqft)	= 32.5
Fixed Carbon/Area	(lb./hr./sqft)	= 16.6
Producer Gas/Coal	(SCF/lb.)	= 75.8
Producer Gas/Fixed Carbon	(SCF/lb.)	= 148.6
Tar Yield	(lb./lb. coal)	= 0.097

Table 7-10

Material Balance and Thermal Efficiency Calculation
0.59 tn/hr, 151 F

Input Data

Time period: 7/21/83 14:00 - 7/23/83 9:00 (43.0 hours)

Gasifier Operation:		Coal Data:	
Coal feed, Ton/hour	= 0.59	Type	= Piney Tipple
Blast air flow (dry) , Scfm	= 906.	Mass Fraction Carbon	% = 73.6
Saturated air temperature, F	= 151.	Mass Fraction Fixed Carbon	= 50.99
Steam/Air Ratio (lb./lb.)	= 0.23	Mass Fraction Moisture	% = 1.92
Ambient air temperature, F	= 83.	Mass Fraction nitrogen	% = 1.27
Off-take temperature, F	= 1238.	Mass Percent sulfur	= 2.95
		Heating value, Btu/lb	= 13427

Tar and Water Yield (dry basis):		Ash and Dust Data:(dry basis)	
Water yield, lb./1000 SCF	= 6.23	Ash discharge ,lb/hour	= 46.
Tar yield, lb/1000 SCF	= 1.36	Ash carbon ,percent	= 5.5
Carbon in Tar (percent)	= 86.6	Ash sulfur ,percent	= 0.09
Sulfur in Tar (percent)	= 1.37	Ash moisture (wet),percent	= 18.9
Tar HHV, thou. Btu/lb	= 15.67	Cyclone dust,lb/hour (est.)	= 24.

Gas Composition (Dry): (normalized to 99.90)

H2	% = 16.3	CH4	% = 1.63	H2S	(est ppm) = 4924
CO	% = 16.6	C2H4	% = 0.331		
CO2	% = 10.89	C2H6	% = 0.148		
N2	% = 52.8	C3H6	% = 0.098		
O2	% = 0.00	C3H8	% = 0.022	HHV,	Btu/SCF = 136
Molec. Weight= 25.21		Argon(est. %)	= 0.629	LHV,	Btu/SCF = 126

Calculation Results (based on nitrogen and carbon balance)

Material Balance (Percent unaccounted for: 2.49)

Input,	lb/hr	% Total	Output,	lb/hr	% Total
Coal	= 1180.	19.4	Dry gas	= 5176.	87.2
Steam (total)	= 902.	14.8	Water in gas	= 485.	3.2
Air(calc,dry)	= 4007.	65.8	Oil and tar	= 106.	1.8
			Ash(calc,dry)	= 147.	2.5
			Dust	= 24.	0.4
Total	= 6089.		Total	= 5937.	

Energy Balance (Percent unaccounted for: 1.67)

Input,	MM BTU/hr	Output,	MM Btu/hr	% Total
Coal	= 15.9	Dry coal gas	= 10.6	64.4
Air	= 0.039	Oil and tar	= 1.66	10.1
Steam(import)	= 0.677	Sensible	= 2.19	13.3
Cooling water	= 0.211	Latent	= 0.523	3.2
		Ash	= 0.118	0.7
		Dust	= 0.286	1.7
		Cooling water	= 1.092	6.5
Total	= 16.8	Total	= 16.5	

Performance Data

Cold gas efficiency,	percent = 63.3
Cold gas with tar efficiency,	percent = 73.2
Hot gas without tar efficiency	percent = 78.4
Hot gas with tar efficiency,	percent = 89.3
Air/Coal	(lb./lb.) = 3.394
Steam/Coal	(lb./lb.) = 0.764
Air/Fixed Carbon	(lb./lb.) = 6.656
Coal/Gasifier Area	(lb./hr./sqft) = 35.6
Fixed Carbon/Area	(lb./hr./sqft) = 18.1
Producer Gas/Coal	(SCF/lb.) = 74.8
Producer Gas/Fixed Carbon	(SCF/lb.) = 146.7
Tar Yield	(lb./lb. coal) = 0.090

Table 7-11

Material Balance and Thermal Efficiency Calculation
0.65 tn/hr, 147 F

Input Data

Time period: 7/23/83 10:00 - 7/24/83 2:00 (16.0 hours)

Gasifier Operation:

Coal feed, Ton/hour = 0.65
Blast air flow (dry) , Scfm = 918.
Saturated air temperature, F= 147.
Steam/Air Ratio (lb./lb.) = 0.20
Ambient air temperature, F = 83.
Off-take temperature, F =1225.

Coal Data:

Type = Piney Tipple
Mass Fraction Carbon % = 73.6
Mass Fraction Fixed Carbon = 50.99
Mass Fraction Moisture % = 1.92
Mass Fraction nitrogen % = 1.27
Mass Percent sulfur = 2.95
Heating value, Btu/lb = 13427

Tar and Water Yield (dry basis):

Water yield, lb./1000 SCF = 5.63
Tar yield, lb/1000 SCF = 1.50
Carbon in Tar (percent) = 86.6
Sulfur in Tar (percent) = 1.37
Tar HHV, thou. Btu/lb = 15.67

Ash and Dust Data:(dry basis)

Ash discharge ,lb/hour = 66.
Ash carbon ,percent = 3.7
Ash sulfur ,percent = 0.07
Ash moisture (wet),percent = 10.6
Cyclone dust,lb/hour(est.) = 26.

Gas Composition (Dry): (normalized to 99.90)

H2	%	= 15.4	CH4	%	= 1.49	H2S	(est ppm)=	5030
CO	%	= 18.0	C2H4	%	= 0.299			
CO2	%	= 10.34	C2H6	%	= 0.140			
N2	%	= 53.0	C3H6	%	= 0.090			
O2	%	= 0.00	C3H8	%	= 0.023	HHV,	Btu/SCF =	136
Molec. Weight=		25.35	Argon(est. %)=		0.632	LHV,	Btu/SCF =	126

Calculation Results (based on nitrogen and carbon balance)

Material Balance (Percent unaccounted for: 1.53)

Input,	lb/hr	% Total	Output,	lb/hr	% Total
Coal	= 1298.	20.1	Dry gas	= 5589.	87.7
Steam (total)	= 355.	13.2	Water in gas	= 471.	7.4
Air (calc,dry)	= 4319.	66.7	Oil and tar	= 125.	2.0
			Ash (calc,dry)	= 161.	2.5
			Dust	= 26.	0.4
Total	= 6471.		Total	= 6373.	

Energy Balance (Percent unaccounted for: 3.37)

Input,	MM BTU/hr	Output,	MM Btu/hr	% Total
Coal	= 17.4	Dry coal gas	= 11.4	64.1
Air	= 0.042	Oil and tar	= 1.97	11.1
Steam(import)	= 0.680	Sensible	= 2.31	13.1
Cooling water	= 0.171	Latent	= 0.509	2.9
		Ash	= 0.088	0.5
		Dust	= 0.314	1.8
		Cooling water	= 1.153	6.5
Total	= 18.3	Total	= 17.7	

Performance Data

Cold gas efficiency, percent = 62.0
Cold gas with tar efficiency, percent = 72.7
Hot gas without tar efficiency percent = 76.3
Hot gas with tar efficiency, percent = 88.0
Air/Coal (lb./lb.) = 3.327
Steam/Coal (lb./lb.) = 0.658
Air/Fixed Carbon (lb./lb.) = 6.524
Coal/Gasifier Area (lb./hr./sqft) = 39.1
Fixed Carbon/Area (lb./hr./sqft) = 19.9
Producer Gas/Coal (SCF/lb.) = 72.2
Producer Gas/Fixed Carbon (SCF/lb.) = 141.6
Tar Yield (lb./lb. coal) = 0.097

Table 7-12

Material Balance and Thermal Efficiency Calculation
Piney Tipple Overall Average

Input Data

Time period: Overall Average (120.0 hours)

Gasifier Operation: Coal feed, Ton/hour = 0.60 Blast air flow (dry) , Scfm = 928. Saturated air temperature, F= 148. Steam/Air Ratio (lb./lb.) = 0.21 Ambient air temperature, F = 82. Off-take temperature, F = 1122.	Coal Data: Type = Piney Tipple Mass Fraction Carbon % = 73.6 Mass Fraction Fixed Carbon = 50.99 Mass Fraction Moisture % = 1.92 Mass Fraction nitrogen % = 1.27 Mass Percent sulfur = 2.95 Heating value, Btu/lb = 13427
---	--

Tar and Water Yield (dry basis): Water yield, lb./1000 SCF = 6.02 Tar yield, lb/1000 SCF = 1.38 Carbon in Tar (percent) = 86.6 Sulfur in Tar (percent) = 1.37 Tar HHV, thou. Btu/lb = 15.67	Ash and Dust Data:(dry basis) Ash discharge ,lb/hour = 64. Ash carbon ,percent = 8.1 Ash sulfur ,percent = 0.12 Ash moisture (wet),percent = 14.9 Cyclone dust,lb/hour(est.) = 24.
---	--

Gas Composition (Dry): (normalized to 99.90)

H2 % = 15.1	CH4 % = 1.43	H2S (est ppm) = 4929
CO % = 17.2	C2H4 % = 0.255	
CO2 % = 10.61	C2H6 % = 0.134	
N2 % = 53.9	C3H6 % = 0.083	
O2 % = 0.00	C3H8 % = 0.026	HHV, Btu/SCF = 131
Molec. Weight= 25.48	Argon(est. %) = 0.642	LHV, Btu/SCF = 121

Calculation Results (based on nitrogen and carbon balance)

Material Balance (Percent unaccounted for: 2.43)

Input,	lb/hr	% Total	Output,	lb/hr	% Total
Coal	= 1198.	19.4	Dry gas	= 5298.	87.7
Steam (total)	= 849.	13.7	Water in gas	= 475.	7.9
Air(calc,dry)	= 4143.	66.9	Oil and tar	= 109.	1.8
			Ash(calc,dry)	= 134.	2.2
			Dust	= 24.	0.4
Total	= 6190.		Total	= 6040.	

Energy Balance (Percent unaccounted for: 3.65)

Input,	MM BTU/hr	Output,	MM Btu/hr	% Total
Coal	= 16.1	Dry coal gas	= 10.3	63.6
Air	= 0.021	Oil and tar	= 1.71	10.5
Steam(import)	= 0.544	Sensible	= 1.97	12.1
Cooling water	= 0.180	Latent	= 0.512	3.2
		Ash	= 0.156	1.0
		Dust	= 0.290	1.8
		Cooling water	= 1.259	7.8
Total	= 16.8	Total	= 16.2	

Performance Data

Cold gas efficiency,	percent = 61.3
Cold gas with tar efficiency,	percent = 71.4
Hot gas without tar efficiency	percent = 75.1
Hot gas with tar efficiency,	percent = 86.1
Air/Coal	(lb./lb.) = 3.457
Steam/Coal	(lb./lb.) = 0.709
Air/Fixed Carbon	(lb./lb.) = 6.780
Coal/Gasifier Area	(lb./hr./sqft) = 36.1
Fixed Carbon/Area	(lb./hr./sqft) = 18.4
Producer Gas/Coal	(SCF/lb.) = 74.3
Producer Gas/Fixed Carbon	(SCF/lb.) = 145.7
Tar Yield	(lb./lb. coal) = 0.091

Figure 7-12

Comparison of the Grate Performance Model with Ash Removal Rates

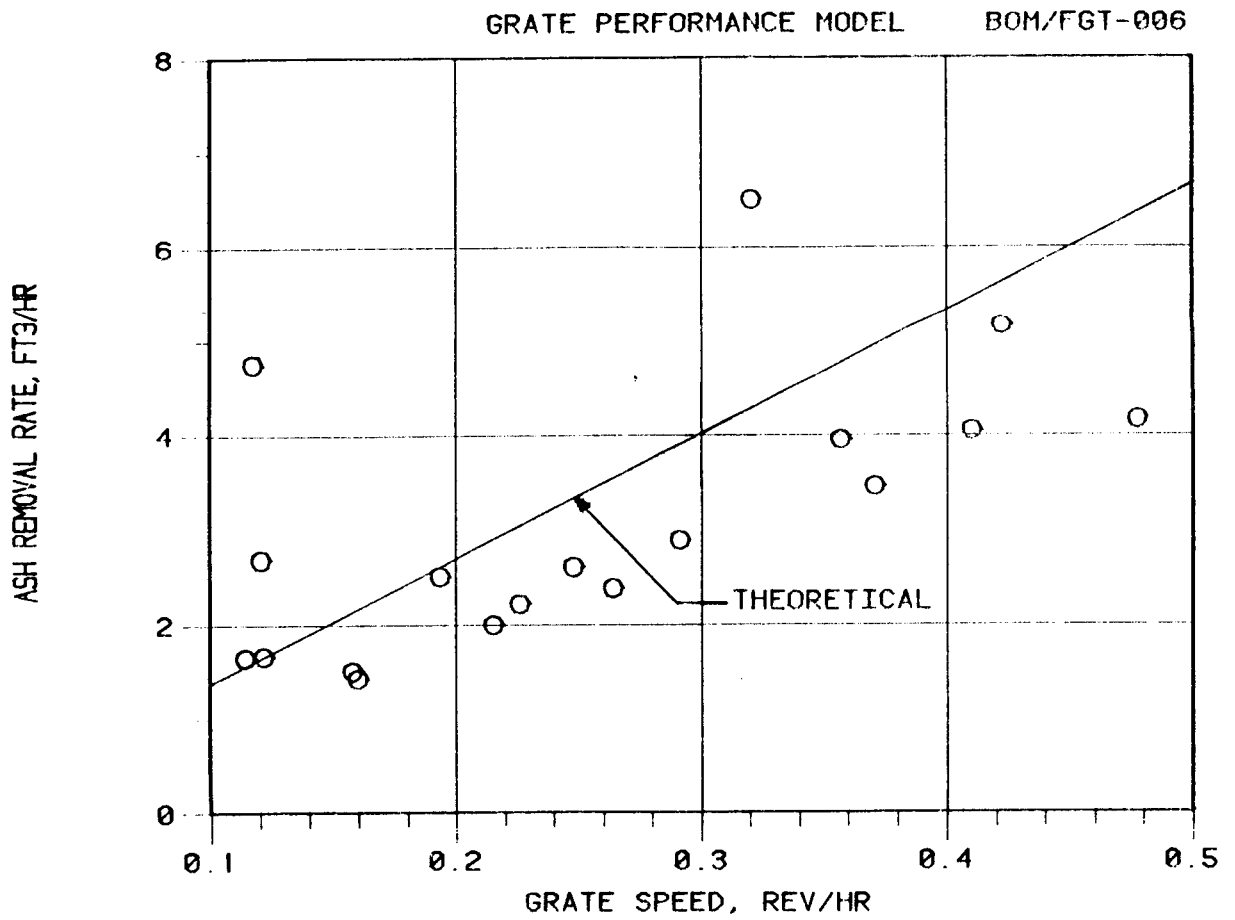
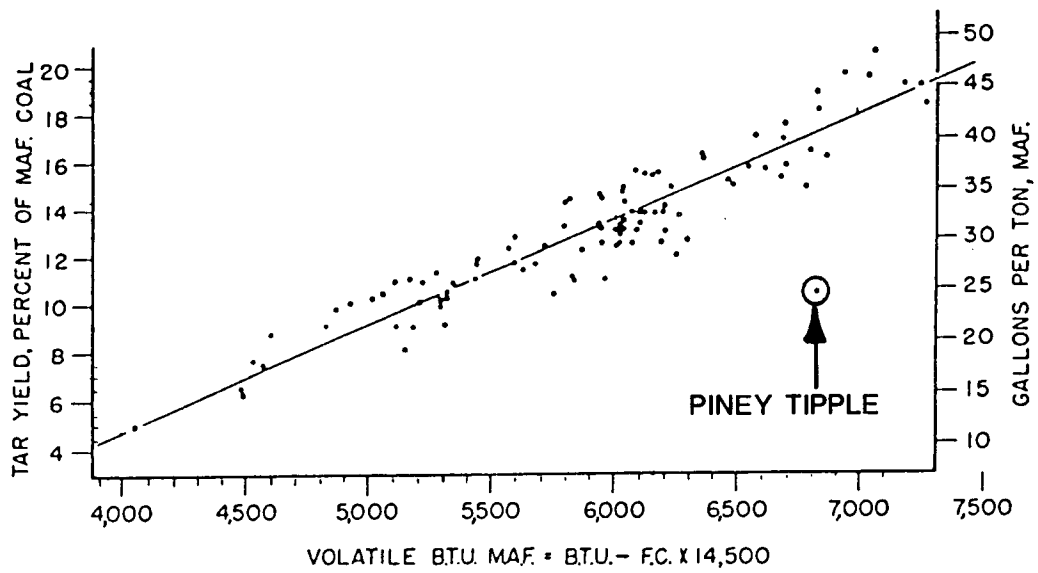


Figure 7-14

Tar/Oil - Volatile Btu Correlation

Reference: Gomez et al, 1958



7.6 Retort Particle Sampling

Developmental efforts to characterize the particle size distributions of the dust in the product gas were continued during this test. The sampling procedures are described in Volume 1 of this series (Thimsen, Maurer et al, 1984).

Two dust loading measurements were made on July 22, 1983. The data collected during these measurements are shown in Appendix K. The dust to coal ratio was calculated to be 1.5% and 1.8% for the two measurements respectively.

Particle size distributions were determined for one of the sampling periods described above. For particulate larger than 53 um the size distribution was determined by wet sieving. For particles less than 100 um the particle size distribution was determined by optical microscopy. The sieves used had square openings, thus the particle size for the sieving data is shifted to match that of the microscopy data.

The shifted seive data and the microscopy data are combined to give a single cumulative particle size distribution as shown in Figure 7-15. It can be seen that most of the particle mass (over 98 %) is located in the size range greater than 100 um.

Figure 7-16 shows a modal fitting analysis of the size distribution data. An explanation of the fit parameters is given in Table 7-13. The experimental size distribution is best fitted with a bimodal size distribution. The two modes have mass (volume) mean diameters of 15.2 and 525 um respectively.

Figure 7-15

Cumulative Size Distribution of Overhead Dust

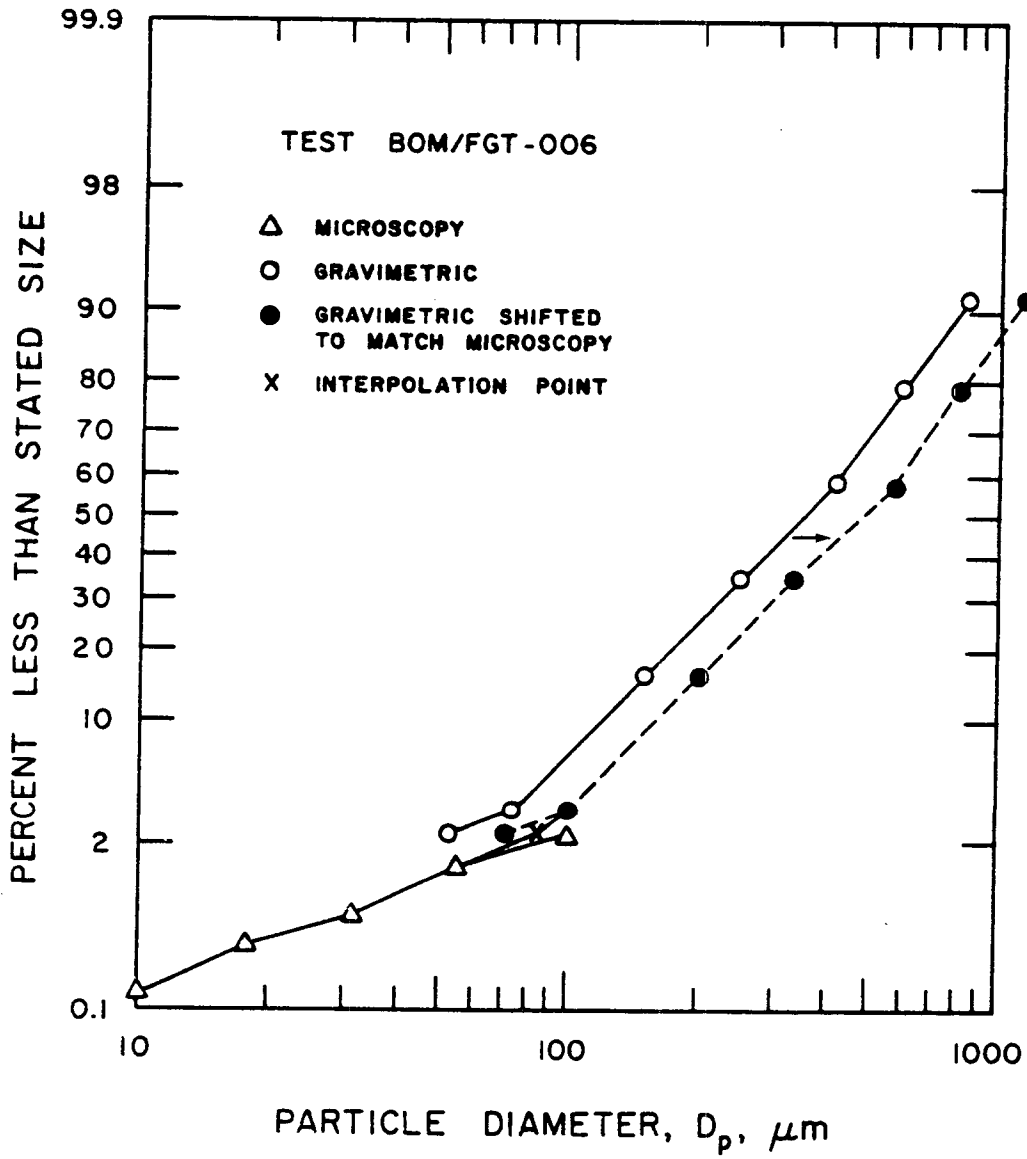
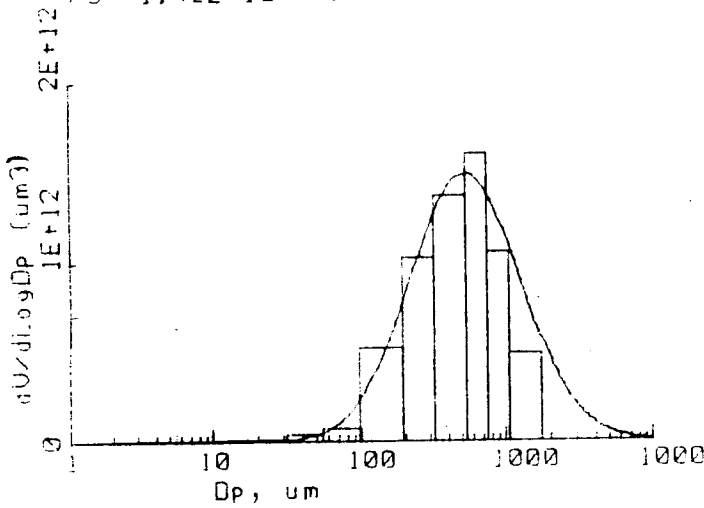


Figure 7-16

Modal Analysis of Overhead Dust Size Distribution

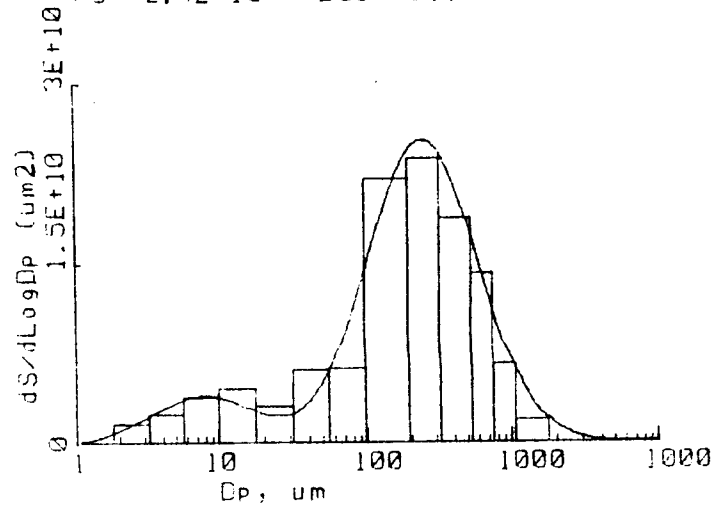
006-01 VOLUME DIST.

CHN= .025 CHS= .042 CHU= .031
 F1= 0 DG1= 1 SG1= 2
 F2= 6.43E+09 DG2= 15 SG2= 2.3
 F3= 1.42E+12 DG3= 525 SG3= 2.4



006-01 SURFACE DIST.

CHN= .025 CHS= .042 CHU= .031
 F1= 0 DG1= 1 SG1= 2
 F2= 3.6E+09 DG2= 7.6 SG2= 2.3
 F3= 2.4E+10 DG3= 244 SG3= 2.4



006-01 NUMBER DIST.

CHN= .025 CHS= .042 CHU= .031
 F1= 0 DG1= 1 SG1= 2
 F2= 7.9E+07 DG2= 1.3 SG2= 2.3
 F3= 590000 DG3= 52.7 SG3= 2.4

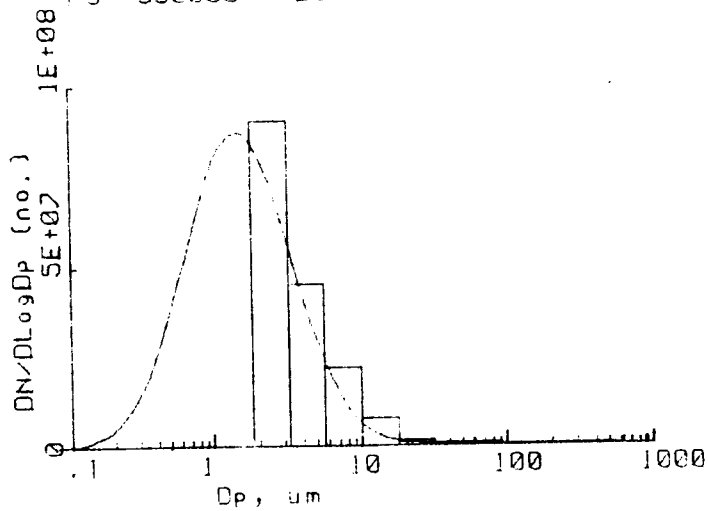


Table 7-13

Description of Modal Fitting Parameters
(Associated with Figure 7-16)

CHN: CHI square for the number distribution
CHS: CHI square for the surface distribution
CHV: CHI square for the volume distribution

If CHI square is less than 0.04 the fit is good.
If CHI square is less than 0.15 the fit is fair.

F1: Total number, surface, or volume of Mode 1 for the
respective weighting. (*)
F2: Total number, surface, or volume of Mode 2 for the
respective weighting.
F3: Total number, surface, or volume in Mode 3 for the
respective weighting.

DG1: Geometrical mean diameter of Mode 1 for the given
weighting (*)
DG2: Geometrical mean diameter of Mode 2 for the given
weighting
DG3: Geometrical mean diameter of Mode 3 for the given
weighting

SG1: Geometric Standard Deviation of Mode 1 (*)
SG2: Geometric Standard Deviation of Mode 2
SG3: Geometric Standard Deviation of Mode 3

(*) Unused modes are set to $F1 = 0$, $DG1 = 1$, and $SG1 = 2$, etc.

SECTION 8

CONCLUSIONS

1. The maximum throughput observed was 0.67 tn/hr (40.4 lb/hr/sq ft grate). Attempts to increase the throughput beyond this level resulted in excessive channeling and burning through. Based on this throughput and a blast saturation temperature of 145 F (62.3 C) the following material and energy flows can be expected:

Material In (lb/lb coal)		Energy In (Million Btu/hr)	
Air	3.309	Coal	18.0
Steam	0.611	Steam	0.55

Material Out (lb/lb coal)		Energy Out (Million Btu/hr)	
Dry Gas	4.28	Dry Coal Gas	11.5
Tar/oil	0.091	Tar/oil	1.8
Water	0.372	Sensible Latent Heat	2.4
Dust	0.020	Dust	0.3
Ash	0.099	Ash	0.2
		Cooling Water	1.2
		Unaccounted for	1.2

2. Blast saturation temperatures between 140 and 149 F (60 and 65 C) were used. At the lower blast saturation temperatures some clinkering of ash occurred.
3. The mass weighted average tar/oil yield was 9.1 lb tar/oil per 100 lb coal input. This represents 10.6% of the energy in the coal.
4. The ash removal rate is generally predicted by the geometrical grate performance model.
5. Significant agglomerations of coal ash and char were detected in the retort during and after the test. These agglomerations undoubtedly affected the gas flow through the fuel bed causing channeling and incomplete gasification of the coal, resulting in low gas quality (129 Btu/dscf).
6. Large amounts of heat were rejected to the water jacket consistent with conclusion 5.
7. The agitator was not adequate to break up agglomerations of the coal, and maintain a fuel bed with uniform cross section.
8. Particles leaving the retort had a mass mean diameter near 500 um.

9. Particle emissions from the coal gas flame were 0.18 lb per million Btu input. Sulfur dioxide emissions were 4.4 lb per million Btu input; essentially all of the sulfur in the coal.
10. The lower gas quality and restricted throughput make it difficult to recommend this fuel as a deep, fixed-bed gasifier feedstock based on the results of this test. A different agitator design may improve gas quality and increase throughput if it could break up the coal agglomerates formed; which would improve gas distribution, increase residence time and minimize channeling and blowing through.

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APPENDIX A

Gasifier Operator's Log

These are the comments recorded by the gasifier operators during the course of the test.

BOM/FGT 006 PINEY TIPPLE

Test Log

July 18, 1983

- 0730 Poured fuel oil over the charcoal. Started the caustic pump and one scrubber.
- 0800 Dropped 9.69 tons of petroleum coke into the retort.
- 0840 Lit the fire boxes.
- 0923 Lit the roof flare.
- 0945 The primary combustor fan is on at 3000 cfm. The secondary combustor fan is on at 8000 cfm.
- 0955 The I.D. fan is on and balances at 2 inches w.g. Set it to control at -0.5 inches w.g.
- 0958 Second scrubber pump is now on.
- 1005 Drained the cyclone. The water will not overflow.
- 1007 Closed the vent valve. Gas is going downstream.
- 1015 The agitator is on at 2.0.
- 1030 Increased the saturation air flow to 800 cfm.
- 1115 Checked and repaired the thermocouple wires for T-705 (offtake temperature) on the third floor of the gasifier.
- 1215 Started coaling up - weight is .08 tons.
- 1300 Adjusted the agitator up and down positions on the shaft. The agitator speed is 3.0 sweeps/hour.
- 1315 The agitator speed is 2.0 sweeps/hour.
- 1330 Increased the saturation airflow to 1000 cfm.
- 1340 The saturation temperature is being controlled manually. Increased the jacket water flow from 12 gpm to 14 gpm to lower the saturation temperature from 64 degrees C to 60 degrees C.
- 1345 Increased the jacket water flow to 16 gpm.
- 1400 We are leaving the fire test bars in for 3 minutes. The firetest average was 12.7 inches. Freeboard av-

eraged 38 inches.

- 1405 Increased the primary combustor fan from 2000 cfm to 3500 cfm. Increased the secondary combustor fan from 3500 cfm to 8000 cfm. This was done to lower the scrubber inlet temperature which was reading 316 degrees C.
- 1420 Finished coaling up - weight is 10.75 tons. With the 3/4 inch screen on about 25% is going through.
- 1445 Flushed the cyclone. There was about a three gallon pail of floating particulate.
- 1455 Increased the water jacket flow from 16 gpm to 17 gpm.
- 1530 Dumped the cyclone and found very little particulate. We are still cycling coke. The coal leg temperature is at 43 degrees C.
- 1550 Increased the jacket water from 17 gpm to 18 gpm in an attempt to lower the saturation temperature from 62 degrees C to 60 degrees C.
- 1600 The firetest averaged 10.3 inches. The freeboard average was 40 inches. Increased the agitator speed to 3.0 sweeps/hr to bring the freeboard back to 38 inches.
- 1625 Cut back on the jacket water from 18 gpm to 17 gpm to increase the saturation temperature from 58.5 degrees C to 60 degrees C.
- 1630 Still cycling the coal valves. Can hear the coke dropping into the retort. The coal leg temperature is down to 40 degrees C. By touch and hammer, the north leg is emptying. The saturation temperature is now back up to 60 degrees. The scrubber inlet thermocouple periodically swings from 425 - 70 degrees C and then back to the 275-325 degrees C range.
- 1700 The freeboard average is 40.5 inches. Increased the agitator speed to 3.5 sweeps/hr.
- 1715 The north coal legs are hot to the touch. We cycled the valves and banged on the pipes. Noticed very little coke falling down the legs.
- 1730 The coal leg temperature is up to 77 degrees C. Both legs are hot to the touch. Cycled the valves again.
- 1745 The coal leg temperatures are increasing abruptly after falling to 48 degrees C following the last cycling. The offtake temperature is up to 509 degrees C. Coal leg temperature is now 97 degrees C. The

lower bin is empty of coke.

- 1752 Dropped the first of the Piney Tipple into the lower bin. Cycled all the valves twice. It took 5.43 tons. The coal leg temperature is 102 degrees C. The off-take temperature is 517 degrees C.
- 1755 Coal leg temperature is down to 87 degrees C. The offtake is 447 degrees C.
- 1800 Coal leg temperature is 77 degrees C. Offtake temperature is 457 degrees C. Freeboard average is 41 inches. Ash average at the fire test is 11 inches.
- 1815 Emptied the ash cone. Found it to be 160 pounds of water.
- 1820 In 5 minutes the ash weight went from 35 pounds to 145 pounds.
- 1830 Coal feed took .26 tons.
- 1900 The freeboard is now 39.5. Leaving the agitator at 3.5 sweeps/hr. The pH is 5.9.
- 1930 Coal feed is .36 tons. The coal leg temperature is back at 49 degrees C. The offtake temperature is 492 degrees C.
- 2000 Freeboard average is 37.5 inches. Slowed the agitator to 2.5 sweeps/hour. Fire test average drops to 9.6 inches. Noticed double fire zones on #1 & #6. The south side of the bed is glowing brightly.
- 2030 Coal feed took .24 tons. Saturation temperature is fluctuating between 59 degrees C and 61 degrees C. Jacket water is at 17.5 gpm. The agitator inlet thermocouple is not working.
- 2040 Started coaling up at 4.46 tons. Larger chunks are not passing through the hopper opening.
- 2100 Opened the gas control valve to 28% open, reducing the cyclone outlet pressure from 2.2 inches w.g. to 1.7 inches w.g. The freeboard average is 36 inches. Reduced the agitator speed to 2.0 sweeps/hour.
- 2117 Offtake temperature is 562 degrees C.
- 2130 Coal feed drops .23 tons. Saturation temperature is at 60 degrees C. Jacket water is 18 gpm. Offtake temperature is 530 degrees C.
- 2147 Stopped coaling up at 10.77 tons.

- 2200 Freeboard average is 39 inches. Fire test shows 10.4 inch ash average.
- 2220 Repaired the agitator inlet thermocouple. The housing was full of water. One wire was corroded off the terminal. It now reads 22 degrees C.
- 2230 Coal feed is .18 tons. The pH is 6.2. North leg slide gate hangs up when trying to close after the coal feed. It has been sticking since 1930 hours.
- 2310 Increased the agitator to 9.8 from 9 sweeps/hour. Freeboard average is 36 inches.
- 2329 Dumped the cyclone and found a small amount of particulate floating and approximately 1/2 rakefull on the bottom.

July 19, 1983

- 0000 Fire test average is 10.6 inches. Number 6 was a dirty bar. Freeboard average is 36 inches. Decreased the agitator speed from 9.8 to 4.9 sweeps/hour.
- 0017 Decreased jacket water flow from 18 gpm to 17 gpm. Saturation temperature is 59 degrees C.
- 0042 Decreased the agitator speed to 2.8 sweeps/hour. Freeboard average is now 32 inches.
- 0200 Fire test shows an average of 10.6 inches. Freeboard average is 30 inches. The agitator is working as slowly as it will at .7 sweeps/hour. We are dropping the fire loss pressure steadily since the last fire test. It is now 6.2 inches w.g. Offtake temperature is still climbing at 623 degrees C. The ash pit pressure is running 8.3 inches w.g.
- 0245 Changed the caustic barrel. The pH is 4.0. Changed the caustic setting from 35/40 to 35/35.
- 0410 The fire test ash average is 9.3 inches. The freeboard average is 40.5 inches.
- 0415 Increased the agitator to 4.0 from 3.0.
- 0420 The offtake temperature is 528 degrees C. The fire loss pressure is at 5.8 inches w.g. The firebed is now settling down and no burning through is apparent. The saturation temperature is 60 degrees C.
- 0600 The fire test average is 12.5 inches.
- 0610 Started the grate at 1/2.5.

- 0615 Changed the saturation temperature to 62 degrees C. The bars are coming out very hot.
- 0616 Closed the large jacket water bypass valve. Opened the small bypass valve to aid in controlling the saturation temperature.
- 0730 The freeboard average is 43 inches. Increased the agitator from 4.0 to 7.0 sweeps/hour. Flushed the cyclone and found very little particulate in the water. The scrubber inlet thermocouple is not reading correctly. Increased the jacket water flow to 13 gpm.
- 0800 The freeboard average is 41.5 inches. Fire test ash average is 21.4 inches. The ash has increased over the last nine hours. In two hours we will increase the grate drive to 2/3.0.
- 0830 Opened the gas control valve manually. The gas supply pressure is now 1.4 inches w.g.
- 0835 Slowed the jacket water to 12 gpm. Saturation temperature is 59 degrees C. The slide gate on the south coal leg was plugged. It is now free.
- 0850 Saturation water line pressure is down to 35 pounds.
- 0900 The freeboard average is 43.5 inches. Increased the agitator speed to 8.5 from 7.0.
- 0940 The saturation water flow is 13.5 gpm. Saturation temperature is running 62-63 degrees C.
- 0950 Greased the outside fan bearings, safety and control valves. Blew down the boiler.
- 0955 The saturation temperature is up to 65 degrees C. Offtake temperature is 600 degrees C. Fire is burning through between holes number 3 & 4. A hollow core had developed about 10 inches in diameter and 2 feet down.
- 1000 Saturation temperature is 61 degrees C. Offtake temperature is 496 degrees. The freeboard average is 43 inches. Increased the agitator speed from 8.0 to 9.5 sweeps/hour. Fire test average is 19 inches. The bars are still going in easily.
- 1025 Increased the jacket water flow to 15 gpm from 13.5 gpm. Changed the grate drive to 4/2.0 from 2/3.0.
- 1035 The firebed is channeling through on numbers 6 & 7. Let the agitator run at high speed for two revolutions to level the top of the bed. Poked and raked holes number 6 & 7. Will leave the agitator running at 16

sweeps/hour.

- 1050 Slowed the jacket water to 14 gpm.
- 1055 Freeboard average is 35 inches. Will slow the agitator down from 16 to 10.5 sweeps/hour.
- 1105 Fire is channeling through between holes Number 3 & 4.
- 1200 Freeboard average is 28.5 inches. Slowed the agitator down from 10.5 to 2.0 sweeps/hour. Fire test showed an average of 18.2 inches. The bed feels spongy and the bars are getting difficult to put in. The first five feet feels like hard pan. Increased the grate speed to 3.5 from 2.0.
- 1230 Reduced the jacket water to 13 gpm. Will try to maintain the saturation temperature at 64 degrees C. The average freeboard is 40.5 inches. Increased the agitator speed to 6.0 sweeps/hour. Ran the vibrator with the coal up.
- 1250 Slowed the jacket water down to 12.5 gpm.
- 1255 Started coaling up - weight 6.57. Will wash the coal.
- 1300 Again reduced the jacket water flow. Now it is at 11.5 gpm. Freeboard average is 39.5 inches.
- 1315 Saturation water flow is 20 gpm. Put the saturation steam on at 64 degrees C.
- 1330 Coal up weight - 10.54. The south coal leg is plugged up. The coal leg temperature is 70 degrees C. Turned on the vibrator and the coal leg freed up.
- 1335 Dump ash - weight 625 pounds. Freeboard average is 40.5 inches. Increased the agitator speed to from 6.0 to 7.5 sweeps/hour. Flushed the cyclone and the valve stuck. The particulate is black in color and about half floating.
- 1400 Freeboard average is 40.0 inches. Will increase the agitator to 9.5 from 7.5 sweeps/hour in attempt to lower the freeboard to 38 inches. Fire test average is 18.7 inches. Increased the grate drive to 4.5 from 3.5 to lower the ash depth to 14 inches.
- 1500 Freeboard average is 39 inches. Opened the gas supply valve 10%. Lowered the gas supply from 1.9 to 1.2 inches w.g. Will try to hold it below 2 inches w.g.
- 1530 Coal feed weight - 1.19 tons. Used the vibrator. Freeboard average is 38 inches.

- 1600 Fire test ash average is 11.1 inches. Multiple zones were apparent. Slowed the grate to 5/2.5. The freeboard average is 37.5 inches. Will change the freeboard limits to get a 34 inch freeboard.
- 1630 Power outage due to storming. Combustor is down. Starting the shut down procedure. ID fan is off. Blower is off. Vent valve is open. The flare is lit.
- 1632 Cyclone and water jacket are flooded.
- 1700 Changed freeboard limits to reach a 34 inch average freeboard. Changing the agitator stroke limits to 35-37 inches. T-714 is up to 101 degrees C. Dropped .83 tons of coal.
- 1705 Freeboard average is 37.5 inches.
- 1724 Power is back on. Start up procedure is instituted. Saturation air flow is set at 200 cfm on automatic. The valve is 10% open. ID fan and blowers are on. Primary and secondary fans are on.
- 1730 Attempted to restart combustor.
- 1738 Flame safety system will not purge.
- 1740 Lit the Combustor.
- 1743 Drained the cyclone.
- 1745 Increased the saturation air flow to 400 cfm. Closed the vent valve. Gas is going downstream.
- 1753 Increased the saturation air flow to 600 cfm.
- 1755 Increasing the saturation air flow to 900 cfm.
- 1758 Saturation air flow is at 900 cfm and the temperature is 64 degrees C.
- 1800 Freeboard average is 36.5 inches. Fire test average is 10.9 inches. Multiple zones were noticed on holes number 2,4 & 5.
- 1810 Saturation temperature is 71 degrees C. Increased the jacket water flow to 20 gpm. Trying to maintain a 64 degree C saturation temperature.
- 1816 Saturation air flow is at 900 cfm. Saturation temperature is 64 degrees C. Offtake temperature is 500 degrees C.
- 1830 Coal feed took .44 tons. Continuing the use of the vibrator. Freeboard average is now 37 inches. In-

creased the agitator speed to 9.0 sweeps/hour to lower the freeboard.

- 1855 Dumped 845 pounds of ash. It was dry and powdery with a few small chunks.
- 1900 Freeboard average is 35.5 inches. The pH is 6.8. Caustic line is still in place after the storm.
- 1930 Coal feed was .65 tons. Freeboard average is 32.0 inches on the holes opposite the agitator arm. Reduced the agitator speed to 7.0 sweeps/hour to come back to the target of a 34 inch freeboard.
- 2000 Fire test ash average is 12.4 inches. Numbers 3 & 5 were dirty bars. Leaving the grate at 5/2.5. Freeboard average is 33 inches. Leaving the agitator speed at 7 sweeps/hour.
- 2030 Freeboard average is 33.5 inches. Closed the gas control valve manually to maintain at least 2 inches w.g. on P-705 and 1.5 inches w.g. on P-706. P-705 was down to 1.4 inches w.g. and P-706 was down to 0.7 inches w.g.
- 2100 Freeboard average is 34 inches. Started coaling up at 5.33 tons. Washing the coal.
- 2155 Stop coal up at 11.21 tons.
- 2200 Fire test shows a precipitous drop in ash. It dropped over 6 inches. Some clinkering is evident. Change the grate from 4/2.50 to 2/1.25. With the rapid decrease in ash the freeboard had gone up to 36.5 inches. Increasing the agitator speeds to 9.0 sweeps per hour.
- 2230 Dumped the cyclone and found 2 inches of floating particulate and none on the bottom.
- 2300 Freeboard average is 34 inches.
- 2340 Changed the caustic barrels. The caustic pump is set at 30/30.
- 2345 Slowed the agitator down to 8.0 from 9.0 sweeps/hour. Freeboard average is 34 inches.
- 2351 Cyclone dump looks like Nestle's Quick.

July 20, 1983

0015 Fire test ash average is 5 inches.

- 0017 Decreased the agitator speed to 7.5 from 8.0 sweeps/hour. Freeboard average is 33 inches.
- 0200 Fire test ash average is 9.7 inches. Freeboard average is 35.5 inches.
- 0215 Increased the agitator speed to 8.0 from 7.5 sweeps/hour.
- 0300 Increased the agitator speed to 8.5 sweeps/hour.
- 0345 Increased the jacket water flow to 21 gpm. Saturation temperature is 65 degrees C.
- 0415 Fire test ash average is 9.4 inches. Freeboard average is 34 inches. The bars are going in fairly easily.
- 0425 Dropped the saturation temperature to 62 degrees C.
- 0435 Decreased the agitator speed to 7.5 from 8.5 sweeps/hour. Freeboard average is 29 inches.
- 0613 Fire test ash average is 8.6 inches.
- 0615 Started loading coal at 6.37 tons.
- 0652 Stopped loading coal - weight 10.78 tons.
- 0730 Freeboard average is 30.5 inches. Flushed the cyclone. Found 2 inches of floating particulate and three rakes full on the bottom.
- 0800 Freeboard average is 28.5 inches. Will slow the agitator speed down to 4.0 from 7.0 sweeps/hour. We are attempting to maintain a 34 inch freeboard.
- 0815 Interpoll will start taking samples from now until approximately 1300.
- 0830 Freeboard average is 35.5 inches. Increasing the agitator speed to 5.5 from 4.0 sweeps/hour.
- 0900 Fire test ash average is 12.5 inches. Number 1 bar burned off 16 inches! This after leaving it in for 6 minutes as there was no reading after 3 minutes. Hitting clinkers on holes number 1, 2 & 5.
- 0915 Cleaned the downcomer and took a sample. The combustor was fairly clean, but cleaned it anyway. Blew down the boiler and greased both 24 inch valves. Cycled the safety valve. Increased the grate speed from 1.25 to 2.75. Trying to break up the clinkers on top of the grate. The coal leg thermocouple showed a reading of 75 degrees C due to steam being on for the fire test.

- 1000 Fire test ash average is 7.9 inches.
- 1015 Changed the agitator depth setting from 35-37 to 37-39 and lowered it 2 inches into the bed. Slowed the grate down from 2/1.75 to 2.1.35 to build ash up to approximately 13 inches.
- 1030 Freeboard average is 35 inches.
- 1100 Flushed the cyclone with the manual spray nozzles. (10 gallons each) The cone weight was 563 pounds. Ash was mostly clinkers. Most clinkers were 1 1/2 inch in size. There were, however, a few 3 inches in diameter. Freeboard average is 34 inches. Fire is channelling through on numbers 2,3 & 6.
- 1130 Freeboard average is 31 inches.
- 1200 Freeboard average is 36 inches. Fire test ash average is 9.3 inches. The last half of each bar is going in with difficulty.
- 1240 Opened the gas supply valve 10% from 35 to 45. Lowered the pressure from 2.0 to 1.6 inches w.g. Freeboard average is 33.5 inches. Flushed the cyclone and found 1 inch of black silt floating on top of the water.
- 1300 Freeboard average is 35 inches.
- 1310 Changed the agitator depth from 37-39 inches to 37-41 inches.
- 1330 Freeboard average is 31.5 inches. Started coaling up. Start weight is 7.37 tons.
- 1400 Fire test ash average is 12.7 inches. Clinkering was apparent in hole number 5 and could not drive the bar in for the last 20 inches. Pulled the bar out and waited for the agitator, then used a new bar with no hammer.
- 1415 Finished coaling up - weight 11.17 pounds.
- 1430 Freeboard average is 31.5 inches. Slowed the agitator down from 5 to 4.5 sweeps/hour. Dumped 553 pounds of ash.
- 1500 Freeboard average is 35 inches.
- 1530 Freeboard average is 34.5 inches. Agitator speed is at 4.5 sweeps/hour. Cyclone particulate is light. Very little on the top or bottom. Used the vibrator with the coal feed. (1/2 ton)

- 1600 Freeboard averaged 35 inches. Increased the agitator speed from 4.5 to 5.0 sweeps/hour. Fire test average is 23.8
- 1620 Increased the grate speed to 4/2.20.
- 1630 Dropped coal and used the vibrator for 15-20 seconds. Freeboard average is 35 inches.
- 1640 Countermand the 1620 increase in the grate as there is some suspicion over drastic increase in ash average with other indicators remaining constant on strip charts and readouts. Reverting back to 2/2.20. Will do another fire test at 1700.
- 1700 Freeboard average is 33.5 inches. Fire test ash average is 11.3 inches.
- 1713 Saturation blower kicked off during the fire test. Possible flame out or overload on the motor? Shutdown procedure is in effect. Attempts to restart the blower are not possible as the valve closes too quickly. Gas is pushed upstream back through the cyclone. Flame safety system works.
- 1730 Cyclone flooded.
- 1740 Combustor has been relit. It was a power blip, as both the agitator and grate quit running. Switches are still in the "on" position.
- 1745 Agitator will not restart. Shut down everything once more and flood the cyclone. Check the magnetic coil in the breaker box.
- 1815 Combustor is lit. Cyclone has been drained, blower is on and the gas is going downstream. All is running again. Grate and agitator is running with the grate at 2/1.35 and the agitator at 5.3 sweeps/hour. Freeboard average is 35.5 inches.
- 1820 Saturation air flow is back to 900 cfm. Saturation temperature is 62 degrees C. Offtake temperature is 567 degrees C.
- 1825 Dumped 578 pounds of ash. Found it to be mostly water.
- 1830 Dropped 0.67 tons of coal.
- 1900 Freeboard average is 36.5 inches. Increasing the speed of the agitator to 6.5 sweeps/hour. Fire test average is 7.5 inches. The grate is running at 2/1.35.

1930 Freeboard average is 35.5 inches. Limits are set between 35 & 37 inches travel. Fire loss pressure is down to 2.7 inches w.g.

2000 Fire test ash average is 10.3 inches. Large clinkers were evident in holes number 1 & 6. Freeboard average is 34 inches.

2030 Coal feed is still running around .5 tons per hour. Freeboard average is 33.5 inches. Fire loss continues to decrease. Now it is 2.4 inches w.g. Glowing on top of the bed is evident in holes number 1,3,5 & 6.

2100 Dumped 522 pounds of ash and water. (352 pounds was water, leaving 170 pounds of ash. The pH is 6.5.

2200 Freeboard average is 31.5 inches. Slowed the agitator down to 5.5 sweeps/hr. Firetest average is 12 inches.

2210 Start coaling up at 7.28 tons.

2230 Freeboard average is 33.5 inches. Fire loss is continuing it's downward slide. Now it is reading 1.7 inches w.g. Offtake temperature is 593 degrees C.

2240 Stopped coaling up at 11.18 tons.

July 21, 1983

0000 Fire test average is 10.4 inches.

0130 Tightened the packing on the badly leaking cyclone valve.

0200 Fire test average is 12.5 inches.

0345 Dumped ash.

0400 Fire test ash average is 11.7 inches. Freeboard average is 36 inches.

0600 Fire test ash average is 11.3 inches.

0615 Increase the agitator to 10.0 sweeps/hour. Freeboard average is 34.0 inches.

0730 Freeboard average is 29 inches. The pH is 5. The caustic barrel is empty. Grate drive is at 2/1.35. Flushed the cyclone. Found 1 inch of floating particulate and just a trace amount on the bottom.

0800 Will attempt to hold the freeboard average at 32 inches. It is now 31 inches. Changing the agitator

from 35-37 to 33-35. Fire test average is 12.3 inches. Increased the grate to 2/2.0. The bars are going in with difficulty on holes number 2 & 4.

- 0830 Opened the gas supply valve 5%. Lowered the gas supply pressure from 2.1 to 1.9 inches w.g. Freeboard average is 32 inches.
- 0900 Freeboard average is 32.5 inches. Dumped 537 pounds of ash. Flushed the cone with three nozzles and 30 gallons of water. Ash was mostly clinkers approximately 3 inches in diameter. A large amount of fine matter came down after the flushing.
- 0935 Freeboard average is 33.5 inches. Slowed the agitator down to 7.0 from 7.5. Loading up coal fines for NSP.
- 1000 Freeboard average is 33.5 inches. Fire test average is 14.5 inches. Increased the grate speed from 2.0 to 2.5 inches w.g.
- 1040 Increased the saturation temperature to 63 degrees C. Freeboard average is 36 inches. Increased the agitator from 7.0 to 8.0 sweeps/hour. Trying to maintain a 32 inch average for the freeboard.
- 1130 Opened the gas supply valve 20% to 70% open. Lowered the gas supply pressure to 1.5 inches w.g. from 2.1 inches w.g. North coal leg is plugged. Coal leg temperature is 63 degrees C. Ran the vibrator and this freed it up.
- 1200 Freeboard average is 34 inches. Fire test ash average is 10.9 inches. There was a fair amount of difficulty in getting the bars to go down. Numbers 1 & 2 had to be pounded in.
- 1230 Freeboard average is 33 inches.
- 1245 Poked and raked holes number 1 & 7. Clinkers were evident in number 2 and between 1 & 6. Hole number 6 was burning through. Offtake temperature dropped from 675 degrees C. to 618 degrees C.
- 1300 Increased the saturation steam temperature from 63 degrees C. to 64 degrees C.
- 1330 Freeboard average is 34.5 inches. Will increase the agitator to 9.0 sweeps/hour. Still trying to maintain a 32 inch freeboard average.
- 1335 Started coaling up - weight 6.85 tons.
- 1400 Freeboard average is 35 inches. Increased the agitator from 9 to 10 sweeps/hour. Fire test ash average

- is 18.7 inches. Increased the grate speed to 2/2.65.
- 1415 Finished coaling up with 10.76 tons.
- 1430 Freeboard average is 32 inches.
- 1445 Dump 565 pounds of ash. The ash was mostly fine particles with only a few 2 inch clinkers.
- 1500 Freeboard average is 33.5 inches.
- 1530 Freeboard average is 32.5 inches. Both numbers 3 & 6 are glowing brightly on top. Fire loss in on the decline. It is now 3.7 inches w.g. Offtake temperature is 620 degrees C. Coal feed took only .43 tons. Coal is hanging up in the south coal leg. The coal leg temperature is 73 degrees C. Used the vibrator.
- 1600 Fire test average is 6.6 inches.
- 1630 Freeboard average is 32 inches. Cyclone particulate is light. (2 scoops on the bottom) Coal feed took 3/4 ton. P-704 is down to 3.1 inches w.g. Fire loss pressure is going down and the offtake temperature is going up. The CO₂ is going up slightly and the CO is decreasing.
- 1700 Freeboard average is 33 inches. Dumped 530 pounds of ash. Found it to still be mainly water. There were mostly 1 inch chunks, but a few in the 3-5 inch range.
- 1800 Fire test ash average is 15.6 inches. No clinkers were apparent this time. Freeboard average is 32 inches.
- 1815 Increased the grate speed to 2/2.20 from 2/1.90.
- 1830 Freeboard average is 31.5 inches. Noticed some channeling on number 5 hole. Number 6 hole is glowing brightly. Poked both holes. The offtake temperature came down 30 degrees. It is now 632 degrees C.
- 1900 Numbers 5 & 6 are still hot on top. Poked and raked. The offtake temperature is down from 650 degrees C to 632 degrees C.
- 1915 CO & CO₂ have made their swing back the positive direction.
- 1930 Continuing to poke and rake numbers 5 & 6. Offtake drops and then goes right back up to the 660 degrees C. area.
- 2000 Freeboard average is 33.5 inches. Fire test average is 13.1 inches. Will leave the grate at 2/2.20.

2100 Freeboard average is 33.0. Start coaling up at 6.87 tons. Coal is being washed.

2130 Freeboard average is 32.75 inches.

2155 Stop coaling up at 11.62 tons.

2200 Fire test ash average is 7.6 inches. Slowed the grate to 2/1.50.

2230 Freeboard average is 32 inches. The pH is running between 6.2 & 6.5.

2300 Freeboard average is 32.25 inches. Oftake temperature is 678 degrees C. The top is alive on numbers 5 & 6.

2307 Offtake temperature is 680 degrees C.

July 22, 1983

0000 Fire test ash average is 17.9 inches. Freeboard average is 34.5 inches.

0130 Dumped ash.

0200 Fire test ash average is 19.3 inches.

0220 Increased the grate speed to 2/2.0.

0330 Decreased the agitator speed to 16 sweeps/hour. Freeboard average is 31.5 inches.

0400 Fire test ash average is 12.6 inches. All bars have a very wide incandescent zone.

0730 Gas supply pressure is 2.6 inches w.g. Opened the gas supply control valve wide open and the pressure is 2.5 inches w.g. now. Flushed the cyclone. The manhole on the cyclone is leaking gas again. Readjusted the belt on the conveyor. It is riding towards the left side.

0800 Freeboard average is 30 inches. Slowed the agitator down to 10 sweeps/hour. Fire test ash average is 3.1 inches.

0810 Slowed the grate speed down from 3/4.0 to 3/2.0.

0815 Increased the saturation steam temperature to 65 degrees C.

0820 The first load of Illinois # 6 just arrived.

0825 Increased the induced draft fan from 95 to 110 to lower the gas out let pressure from 2.9 to 2.4 inches

w.g.

- 0830 Flushed the cyclone. Found 1/2 inch of black silt floating and thirteen rakes full on the bottom. The freeboard average is 31.5 inches.
- 0900 Freeboard average is 31 inches. Dumped 617 pounds of ash. Klinkers were in the 1-2.5 inch range, and reddish brown in color.
- 0930 Flushed the cyclone again and found a large amount of particulate both floating and submerged. Freeboard average is 30.5 inches.
- 1000 Freeboard average is 31 inches. Fire test average is 13.6 inches. The bed is very uneven.
- 1030 The south coal leg is jammed up. Ran the vibrator and dislodged it. The coal leg temperature is 88 degrees C. Freeboard average is 30 inches. Flushed the cyclone and found 2 inches of floating black silt. There were 5 rakes full on the bottom. Cleaned the bottom out.
- 1045 Changed the caustic barrel. Changed the agitator depth from 33-35 inches to 35-37 inches.
- 1100 Freeboard average is 28.5 inches. Slowed the agitator down from 10 to 9 sweeps/hour. Dumped 517 pounds of ash and water. Drained 349 pounds of water leaving 168 pounds of ash. Steam control valve is 100% open. Slowed the jacket water flow from 24.5 to 20 gpm.
- 1130 Slowed the jacket water flow down to 16 gpm.
- 1200 Freeboard average is 28.5 inches. Slowed the agitator down to 8 sweeps/hour. Fire test average is 10 inches. The ash is fairly even except for number 4.
- 1220 Steam control valve is now taking over at 85 % open.
- 1300 Freeboard average is 32 inches.
- 1315 Took 10 inches of belting out of the conveyor and realigned it using large alligator splices.
- 1330 Freeboard average is 31.5 inches. Started coaling up at 6.09 tons.
- 1400 Freeboard average is 32 inches. Fire test average is 13.4 inches. Will increase the grate speed to 3/2.25. Number 5 rod bent like a rubber pipe after removing it.
- 1415 Dumped 585 pounds of ash. Found a few 3 inch clinkers. Stopped coaling up at 11.31 tons.

- 1430 Coal is hung up in the south leg coal pipe. Ran the vibrator but it did not help. Rapped it with the hammer and broke it loose. Freeboard average is 30 inches.
- 1530 Freeboard average is 34 inches. Dumped the cyclone and found 2 rakes full on the bottom and one inch of floating silt. The south coal leg is considerably warmer than the other. Used both the hammer and the vibrator to loosen it up. Coal leg temperature is 74 degrees C. Upper level CO alarms are going off periodically. The cyclone manhole is still leaking.
- 1600 Freeboard average is 31.25 inches. Fire test ash average is 8.3 inches. The bars slid right in with the exception of number 4. Number seven bar was wet on the bottom and a totally cold bar.
- 1620 The CO alarm continues to go off. Stuffed asbestos into the large corner hole on the cyclone cover. This forces the gas back through smaller holes around the manhole. Bolts are tight all around.
- 1630 The gas control valve is 100% open. Increasing the furnace pressure to 150 to reduce the offtake pressure. This should reduce the amount of gas coming through the gasket leaks around the cyclone cover. Offtake temperature is 703 degrees C. CO₂ is 11% and CO is 16%. Freeboard average is 31.75 inches.
- 1655 Offtake temperature is 712 degrees C. The bed is glowing all around.
- 1700 Freeboard average is 35.25 inches.
- 1725 Offtake temperature is 724 degrees C.
- 1726 Offtake temperature is 732 degrees C.
- 1730 Freeboard average is 33 inches.
- 1800 Fire test ash average is 13.7 inches. The bars are coming out hot and the consistency of rubber hose.
- 1810 The agitator stopped turning. The circuit had tripped. Freeboard average is 33 inches.
- 1822 Restarted the agitator. Increased the agitator speed to 9.5 sweeps/hour. The offtake temperature is 813 degrees C.
- 1830 Freeboard average is 36 inches. The offtake temperature is down to 680 degrees C.

- 1845 The offtake temperature is on the way back up.
- 1854 The offtake temperature is 800 degrees C.
- 1900 The offtake temperature is at 833 degrees C and the coal leg temperature is 93 degrees C. Freeboard average is 41 inches. Increased the agitator speed to 13.0 sweeps/hour.
- 1902 Offtake temperature is 845 degrees C. The south coal leg was hot. Rapped it with the hammer on the lower elbow and the coal dropped.
- 1910 The offtake temperature is 731 degrees C. The coal leg temperature is 68 degrees C.
- 1915 Freeboard average is 40 inches. Increased the agitator speed to 13 sweeps/hour.
- 1926 The grate motor stopped. Nothing tripped this time. Everything was in the on position.
- 1930 Offtake temperature is 756 degrees C.
- 1936 Got the grate going again. Leaving the speed and stroke at 3/1.65.
- 1940 Offtake temperature is down to 651 degrees C.
- 1945 Freeboard average is 34.5 inches.
- 2000 Freeboard average is 36.9 inches. Offtake temperature is climbing back toward 800 degrees C. Fire test ash average is 10.4 inches.
- 2015 Freeboard average is 36.9 inches. Offtake temperature is 803 degrees C. Coal leg temperature is 90 degrees C. Coal is apparently hanging up. Used the hammer and vibrator to free it up.
- 2030 Coal leg temperature is 54 degrees C. Offtake temperature is back down to 630 degrees C. Freeboard average is 34.75 inches.
- 2045 Freeboard average is 32.4 inches.
- 2100 Freeboard average is 31.9 inches. Slowed the agitator down to 8.5 sweeps/hour. Start coaling up at 7.49 tons. Dumped 677 pounds of ash and took a sample. Tonight the ash is totally dry and only fine size chunks.
- 2130 Freeboard average is 31 inches. Stopped coaling up at 11.52

tons. The fire seems to have leveled out. No more 800+ degree swings in the offtake temperature are occurring.

2150 Grate speed control kicks out. Too much heat is generated at low speeds (i.e. 3/1.65).

2155 Changed the grate speed to 1/5.00.

2200 Freeboard average is 30 inches. Agitator speed is 8.0 sweeps/hour. Fire test ash average is 19.7 inches.

2230 Freeboard average is 32.5 inches. Higher heating value is 123 BTU/ft³. Lower heating value is 133/BTU³.

July 23, 1983

0000 Fire test ash average is 14.7 inches. Freeboard average is 34 inches.

0015 Increased the agitator speed to 9 sweeps/hour to raise the freeboard average.

0100 Freeboard average is 33 inches.

0105 Increased the agitator speed to 10 sweeps/hour.

0130 Increased the agitator to 12 sweeps/hour.

0200 Fire test ash average is 17.6 inches. Freeboard average is 32 inches.

0217 Decreased the agitator speed to 11 sweeps/hour.

0220 Increased the grate speed to 3/3.0.

0230 Coal up - weight .68 tons. Freeboard average is 32 inches.

0248 There is a fair amount of gas leakage from the upper coal bin. The coal leg temperature is 4 degrees C. This has been going down over the last half hour.

0300 Dumped 728 pounds of ash. Freeboard average is 32 inches.

0320 Coal leg temperature is 42 degrees C. Still quite a bit of gas leakage around the upper bin.

0330 Coal up - weight .64 tons. Freeboard average is 32 inches.

- 0400 Fire test ash average is 20.3 inches. Freeboard average is 32.5 inches.
- 0415 Increased the grate drive to 3.5.
- 0417 Increased the agitator speed to 15 sweeps/hour.
- 0430 Coal up - weight .65 tons. Freeboard average is 33.5 inches.
- 0500 Freeboard average is 33 inches.
- 0530 Coal up - weight .68 tons. Freeboard average is 32 inches.
- 0542 Slowed the agitator speed to 14.5 sweeps/hour.
- 0600 Fire test ash average is 14.7 inches. Freeboard average is 32 inches. Slowed the grate down to 3/3.0 and the agitator to 13 sweeps/hour.
- 0730 Dumped 675 pounds of ash. The grate drive was at 2 teeth and driving with one dog. Slowed the grate speed down to adjust it. D.C. stopped. Switched the leads and now it is running o.k. Increased the grate speed to 3.25 to make up for the down time. Flushed the cyclone. Found 2 inches of floating silt and it took 27 rakes full to clear the bottom.
- 0800 South coal leg is plugged. CO₂ alarm has been going off for the last 45 minutes. Freeboard average is 31 inches. Fire test ash average is 14 inches. Bars are going in with a limited amount of force.
- 0815 About 1/2 of the allen head screws were loose and 8 are missing from the retort access ports. Replaced the missing screws and tightened the remaining.
- 0820 CO₂ alarm is on. The North upper coal valve is leaking badly. Ran a bar into the valve next to the gasifier on the north coal leg and freed the coal up.
- 0830 Freeboard average is 32 inches.
- 0835 Dropped the saturation temperature to 62 degrees C. Trying to stop the gas leak in the upper bin.
- 0840 Flushed the cyclone and found 1.5 inches of floating particulate and 2 rakes full on the bottom.
- 0845 Increased the jacket water flow from 17 to 20 gpm.
- 0855 CO₂ alarm is going off less frequently. Cycling on and off.

- 0900 Freeboard average is 29 inches. We are leaking gas from the mounting plate on the number 7 retort access port. Can not tighten it sufficiently.
- 0930 Freeboard average is 27 inches. Slowed the agitator down to 7.5 sweeps/hour.
- 0940 Will haul the remaining Piney Tipple coal down to the open cement pad where the petroleum coke screenings were.
- 1000 Freeboard average is 31 inches. Stopped the gas leak on the number 7 retort access port by filling the crack with silicone. Reduced the grate speed to 3/2.85. Fire test ash average is 7.2 inches.
- 1100 Freeboard average is 33.5 inches. Plan to shut down tomorrow morning when the coal is used up.
- 1130 Freeboard average is 34 inches.
- 1200 Freeboard average is 34 inches. Slowed the grate down to 2/2.85. Fire test ash average is 6.6 inches. Slowed the agitator down to 7.5 sweeps/hour. Opened the induced draft fan from 40% to 60% open.
- 1230 Freeboard average is 34 inches.
- 1245 Dumped 640 pounds of ash. There were some large (6"), but it was mostly 1 inch in diameter.
- 1300 Freeboard average is 34 inches.
- 1330 Freeboard average is 34 inches. Slowed the agitator to 6.5 sweeps/hour.
- 1345 Changed the caustic barrel. The pH is 5.7.
- 1400 Freeboard average is 34 inches. Slowed the agitator to 5 sweeps/hour. Fire test average is 9.4 inches. Number 5 bar fell in, but number 4 bar had to be driven in with a maul. Offtake temperature is 704 degrees C.
- 1500 Freeboard average is 36 inches. Increased the agitator to 7 sweeps/hour. Increased the grate to 2/3.0
- 1526 Noticed gas coming from the center stack on the roof. The 10 inch vent valve was partially open. Closed it. CO monitor is going off constantly. Concentrations are between 300 & 500 ppm.
- 1530 Freeboard average is 33 inches. Coal feed was 0.68 ton.

- 1600 Fire test ash average is 11.4 inches. The bars are going in with difficulty for the last 2 feet. Freeboard average is 34 inches.
- 1620 Started moving the remaining 30 tons of Piney Tipple.
- 1630 Freeboard average is 33 inches. CO alarm continues to sound off periodically. Gas seems to be escaping from the north side coal valve.
- 1700 Freeboard average is 32.5 inches. The pH is 7.0.
- 1730 Freeboard average is 33 inches.
- 1800 Freeboard average is 35 inches. Put the agitator at 8 sweeps/hour. Fire test ash average is 7.1 inches. Must hammer the bars from the last 4 feet on holes 1 & 2. The others are going in easily. Slowed the grate to 3/2.50.
- 1830 CO alarm continues to go off every 10-15 seconds. Trying day shift's suggestion of raking number 7.
- 1900 Dump 625 pounds of ash. Ash was dry with no large chunks.
- 1930 Freeboard average is 32.25 inches.
- 1947 CO alarm is quiet for the first period in over an hour.
- 1952 Spoke too soon! Alarm is on again after 5 minutes of quiet.
- 2000 Fire test ash average is 8.6 inches. Slowed the grate to 2/2.30. Hit a hard crust about half way down on most holes. Freeboard average is 33.75 inches.
- 2030 Freeboard average is 32 inches. Down to 1.64 tons in the weigh bin.
- 2200 Fire test ash average is 10.3 inches. Leaving the grate at 2/2.30. Freeboard average is 33.5 inches.
- 2230 The upper bin is emptying out. Dropped .4 tons. The pH is 5.9. Caustic pump is set at 30/30.

July 24, 1983

- 0000 Fire test ash average is 8.3 inches.
- 0030 Dumped the last of the coal in the weigh bin.
- 0110 Checked and found the upper bin to be empty.

- 0130 Dumped ash.
- 0145 Took a walk around checking pumps, fans and combustor.
- 0200 Started flooding the cyclone for shut down. Lit the flare andd opened the vent slightly.
- 0212 Cyclone is flooded.
- 0213 Shut down the saturation air blower, grate drive, and the agitator. Opened the banking disc.
- 0215 Opened the vent completely.
- 0220 Opened the downcomer. Checked the 24 inch gas line and found no build up downstream or up from the downcomer. Gas supply valve reading has been found to be in error. The valve has 100% travel from 0-50% instead of 0-100% as shown on the slide wire reading in the control room. The grate has a large amount of build up plugging 60% of the spacing. Grate cap had 3 inches of build up. We used a crow bar, impact drill, hammer and chisel to clean it.

END OF BOM/FGT 006 PINEY TIPPLE

APPENDIX B

Weather Data for Testing Days

These data were taken from NOAA weather station 72658
approximately 3 miles from the test site.

Note: Barometric pressure has been adiabatically normalized to
sea level from 840 feet elevation and ambient temperature.

Temperature in degrees Fahrenheit

Relative Humidity in %

Barometric Pressure in inches mercury

Precipitation in inches

HOUR TEMP RELATIVE BAROMET RAIN
HUMIDITY PRESS SNOW

DATE: JULY 18, 1983

0700	73	90	29.125	
0800	78	77	29.120	
0900	81	72	29.115	
1000	83	70	29.110	
1100	86	65	29.105	
1200	87	66	29.085	
1300	88	68	29.050	
1400	90	68	29.005	
1500	91	70	29.015	
1600	69	76	29.105	0.28
1700	73	73	28.935	.10
1800	75	67	28.995	T
1900	75	76	29.015	T
2000	74	79	29.025	T
2100	75	76	29.055	
2200	73	81	29.055	
2300	71	84	29.065	
2353	71	84	29.065	

General Conditions: Foggy sunrise and clear sunset. 591 minutes of sunshine (65%). Maximum wind speed was 41 mph.

HOUR TEMP RELATIVE BAROMET RAIN
HUMIDITY PRESS SNOW

DATE: JULY 19, 1983

0100	67	90	29.140	
0200	68	87	29.125	
0300	68	87	29.095	
0400	68	87	29.095	
0500	67	90	29.125	
0600	68	87	29.130	T
0700	69	87	29.160	0.2
0800	71	84	29.130	
0900	72	81	29.085	T
1000	73	82	29.065	T
1100	73	82	29.095	
1200	77	74	29.105	
1300	77	76	29.115	
1400	80	72	29.115	
1500	80	72	29.105	
1600	81	72	29.095	
1700	80	74	29.085	
1800	81	72	29.085	
1900	80	74	29.085	
2000	77	79	29.095	
2100	76	79	29.105	
2200	75	82	29.115	
2300	74	84	29.115	
2350	72	87	29.125	

General Conditions: Cloudy sunrise and clear sunset. 642 minutes of sunshine (70%). Maximum wind speed was 18 mph.

HOURLY TEMPERATURE RELATIVE HUMIDITY BAROMETRIC PRESSURE RAINFALL SNOWFALL

Date: July 20, 1983

0100	70	84		
0200	70	84		
0300	68	90		
0400	66	90		
0500	67	87		
0600	69	84		
0700	71	87		
0800	74	79		
0900	78	74		
1000	81	72		
1100	83	59		
1200	82	65		
1300	84	63		
1400	87	61		
1500	88	61		
1600	90	60		
1700	90	64		
1800	89	70		
1900	88	72		
2000	85	80		
2100	84	80		
2200	83	82		
2300	83	80		
2355	81	77		

HOURLY TEMPERATURE RELATIVE HUMIDITY BAROMETRIC PRESSURE RAINFALL SNOWFALL

Date: July 21, 1983

0100	83	70	28.995	
0200	82	69	28.985	
0300	81	72	28.985	
0400	80	72	28.975	
0500	80	69	28.975	
0600	81	69	28.965	
0700	83	67	28.965	
0800	86	61	28.965	
0900	88	58	28.975	
1000	88	59	28.965	
1100	91	54	28.965	
1200	93	54	28.960	
1300	94	53	28.965	
1400	92	60	28.975	
1500	90	66	28.975	
1600	92	62	28.985	
1700	92	64	28.975	
1800	91	64	28.975	
1900	86	77	28.985	
2000	85	75	28.995	
2100	85	72	29.015	
2200	83	77	29.035	
2300	81	79	29.035	
2350	79	82	29.045	

General Conditions: Clear sunrise and clear sunset. 939 minutes of sunshine (100%). Maximum wind speed is 23 mph.

General Conditions: Clear sunrise and sunset. 939 minutes of sunshine (100%). Maximum wind speed is 17 mph.

HOUR TEMP RELATIVE BAROMET RAIN
HUMIDITY PRESS SNOW

HOUR TEMP RELATIVE BAROMET RAIN
HUMIDITY PRESS SNOW

Date: July 22, 1983

Date: July 23, 1983

0100	77	82	29.045	
0200	75	82	29.040	
0300	74	82	29.050	
0400	73	84	29.060	
0500	73	84	29.070	
0600	73	79	29.080	
0700	73	79	29.075	
0800	76	79	29.095	
0900	78	76	29.095	
1000	82	72	29.085	
1100	85	65	29.085	
1200	87	63	29.080	
1300	89	61	29.070	
1400	89	61	29.055	
1500	90	64	29.045	
1600	89	59	29.035	
1700	88	63	29.025	
1800	88	63	29.015	
1900	86	65	29.015	
2000	81	67	29.015	
2100	80	65	29.035	
2200	79	64	29.065	
2300	79	62	29.060	
2350	76	69	29.060	

0100	74	74	29.060	
0200	73	74	29.045	
0300	73	76	29.045	
0400	73	76	29.045	
0500	74	71	29.055	
0600	72	79	29.055	
0700	77	67	29.065	
0800	79	58	29.055	
0900	81	53	29.060	
1000	82	53	29.055	
1100	84	48	29.050	
1200	85	48	29.045	
1300	86	46	29.045	
1400	86	45	29.040	
1500	84	45	29.050	
1600	83	49	29.065	
1700	80	54	29.075	
1800	82	51	29.075	
1900	80	51	29.075	
2000	77	54	29.085	
2100	75	56	29.105	
2200	74	60	29.115	
2300	73	62	29.125	
2350	72	64	29.120	

General Conditions: Cloudy sun-rise and cloudy sunset. 728 minutes of sunshine (81%). Maximum wind speed is 13 mph.

General Conditions: Cloudy sun-rise and cloudy sunset. 811 minutes of sunshine (90%). Maximum wind speed is 21 mph.

APPENDIX C
Coal Analysis Data

Feed Coal Size Distribution for BOM/FGT-006

Sample Number	Date	Shift Start Time	Cumulative Mass Fraction, % less than stated mesh size, inch				
			1/4	1/2	3/4	1	1 1/2
1	7/18/84	8:00	0.9	1.3	3.3	13.8	55.0
2	7/18/84	16:00	1.5	2.7	6.2	25.7	62.0
3	7/19/84	0:00	2.0	3.9	11.5	24.1	59.6
4	7/19/84	16:00	1.6	2.8	6.8	23.2	50.5
5	7/20/84	0:00	0.3	0.4	1.0	8.3	37.0
6	7/20/84	8:00	1.1	2.0	4.7	21.5	55.9
7	7/20/84	16:00	0.8	1.5	3.4	16.3	47.3
8	7/21/84	0:00	0.6	1.0	2.7	15.5	45.8
9	7/21/84	8:00	0.5	0.7	2.8	12.2	43.3
10	7/21/84	16:00	0.4	1.0	3.3	15.8	57.5
11	7/22/84	0:00	0.7	1.4	2.9	14.8	49.3
12	7/22/84	8:00	0.8	1.4	4.5	21.3	60.9
13	7/22/84	16:00	1.3	2.4	5.5	24.1	58.7
14	7/23/84	0:00	0.6	1.5	4.8	19.8	54.3
15	7/23/84	8:00	0.6	1.0	2.6	14.5	50.3
16	7/23/84	16:00	3.7	5.9	11.3	35.6	69.1
OVERALL AVERAGE			1.2	2.1	5.0	19.7	53.8

BOM/FGT 006 Piney Tipple

COAL FEED

DATE	TIME	SAMPLE NUMBER	SCREEN IN	WASH?	START WT.	STOP WT.	NET WT.	
07-18	0800	COKE	-- --	NO	10.30	.61	9.69	
07-18	1030	COKE	-- --	NO	.61	.25	.36	
07-18	1130	COKE	-- --	NO	.25	.08	.17	
07-18	1230	CYCLE VALVES		CYCLE VALVES				
07-18	1750	006-C2	.75	NO	10.75	5.32	5.43	
07-18	1830	006-C2	.75	NO	5.32	5.06	.26	
07-18	1930	006-C2	.75	NO	5.06	4.70	.36	
07-18	2030	006-C2	.75	NO	4.70	4.46	.24	
07-18	2130	006-C2	.75	NO	9.11	8.88	.23	
07-18	2230	006-C2	.75	NO	10.77	10.59	.18	
07-18	2330	006-C3	.75	NO	10.59	10.31	.28	
07-19	0030	006-C3	.75	NO	10.34	10.16	.18	
07-19	0130	006-C3	.75	NO	10.16	9.61	.55	
07-19	0230	006-C3	.75	NO	9.61	9.49	.12	
07-19	0330	006-C3	.75	NO	9.49	9.25	.24	
07-19	0430	006-C3	.75	NO	9.25	8.90	.35	
07-19	0530	006-C3	.75	NO	8.90	8.05	.85	
07-19	0630	006-C3	.75	NO	11.62	11.47	.15	
07-19	0730	006-C4	.75	NO	11.21	10.59	.62	
07-19	0830	006-C4	.75	NO	10.59	9.97	.62	
		SLIDE GATE PLUGGED						
07-19	0930	006-C4	.75	NO	9.80	8.84	.96	
07-19	1030	006-C4	.75	NO	8.84	7.34	1.50	
07-19	1130	006-C4	.75	NO	7.34	6.99	.35	
07-19	1230	006-C4	.75	NO	6.99	6.57	.42	
07-19	1330	006-C4	.75	YES	10.54	9.92	.62	
07-19	1430	006-C4	.75	YES	9.92	9.23	.69	
07-19	1530	006-C5	.75	YES	9.23	8.04	1.19	
07-19	1630	006-C5	SHUT DOWN - POWER OUTAGE - STORM					
07-19	1700	006-C5	.75	YES	8.03	7.20	.83	
07-19	1745	006-C5	.75	YES	7.20	6.98	.22	
07-19	1830	006-C5	.75	YES	6.98	6.54	.44	
07-19	1930	006-C5	.75	YES	6.54	5.89	.65	
07-19	2030	006-C5	.75	YES	5.89	5.34	.55	
07-19	2130	006-C5	.75	YES	9.88	9.45	.43	
07-19	2230	006-C5	.75	YES	11.21	10.50	.71	
07-19	2330	006-C5	.75	YES	10.48	9.71	.77	
07-20	0030	006-C5	.75	YES	9.70	9.13	.57	
07-20	0130	006-C5	.75	YES	9.12	8.60	.52	
07-20	0230	006-C5	.75	YES	8.60	7.94	.66	
07-20	0330	006-C5	.75	YES	7.94	7.31	.63	
07-20	0430	006-C5	.75	YES	7.30	6.83	.47	
07-20	0530	006-C5	.75	YES	6.82	6.37	.45	
07-20	0630	006-C5	.75	YES	8.42	7.97	.45	
07-20	0730	006-C6	.75	YES	10.78	10.26	.52	
07-20	0830	006-C6	.75	YES	10.26	9.83	.43	

APPENDIX D

Coal Consumption Log

Coal Weights are given in short tons.

DATE	TIME	SAMPLE NUMBER	SCREEN IN	WASH?	START WT.	STOP WT.	NET WT.
07-20	0930	006-C6	.75	YES	9.83	9.45	.38
07-20	1030	006-C6	.75	YES	9.45	9.05	.40
07-20	1130	006-C6	.75	YES	9.05	8.44	.61
07-20	1230	006-C6	.75	YES	8.44	7.93	.51
07-20	1330	006-C6	.75	YES	7.93	7.37	.56
07-20	1430	006-C6	.75	YES	11.18	10.66	.52
07-20	1530	006-C7	.75	YES	10.66	10.16	.50
07-20	1630	006-C7	.75	YES	10.16	9.59	.57
SHUT DOWN 1713 TO 1815							
07-20	1830	006-C7	.75	YES	9.59	8.92	.67
07-20	1930	006-C7	.75	YES	8.92	8.33	.59
07-20	2030	006-C7	.75	YES	8.33	7.81	.52
07-20	2130	006-C7	.75	YES	7.81	7.29	.52
07-20	2230	006-C7	.75	YES	9.37	8.86	.51
07-20	2330	006-C8	.75	YES	11.17	10.72	.45
07-21	0030	006-C8	.75	YES	10.72	10.22	.50
07-21	0130	006-C8	.75	YES	10.22	9.62	.60
07-21	0230	006-C8	.75	YES	9.61	8.92	.69
07-21	0330	006-C8	.75	YES	8.90	8.53	.37
07-21	0430	006-C8	.75	YES	8.53	7.79	.74
07-21	0530	006-C8	.75	YES	7.79	7.22	.57
07-21	0630	006-C8	.75	YES	9.60	9.10	.50
07-21	0730	006-C9	.75	YES	10.75	10.17	.58
07-21	0830	006-C9	.75	YES	10.17	9.6	.51
07-21	0930	006-C9	.75	YES	9.66	9.21	.45
07-21	1030	006-C9	.75	YES	9.21	8.72	.49
07-21	1130	006-C9	.75	YES	8.72	8.11	.61
07-21	1230	006-C9	.75	YES	8.11	7.59	.52
07-21	1330	006-C9	.75	YES	7.59	6.85	.74
07-21	1430	006-C9	.75	YES	10.76	10.16	.60
07-21	1530	006-C10	.75	YES	10.16	9.73	.43
07-21	1630	006-C10	.75	YES	9.73	8.95	.78
07-21	1730	006-C10	.75	YES	8.95	8.47	.48
07-21	1830	006-C10	.75	YES	8.47	8.02	.45
07-21	1930	006-C10	.75	YES	8.02	7.40	.62
07-21	2030	006-C10	.75	YES	7.40	6.87	.53
07-21	2130	006-C10	.75	YES	9.99	9.47	.52
07-21	2230	006-C10	.75	YES	11.62	11.06	.56
07-21	2330	006-C11	.75	YES	11.06	10.57	.49
07-22	0030	006-C11	.75	YES	10.56	10.01	.55
07-22	0130	006-C11	.75	YES	10.01	9.43	.58
07-22	0230	006-C11	.75	YES	9.43	8.83	.60
07-22	0330	006-C11	.75	YES	8.82	8.27	.55
07-22	0430	006-C11	.75	YES	8.27	7.44	.83
07-22	0530	006-C11	.75	YES	7.44	6.95	.49
07-22	0630	006-C11	.75	YES	8.63	8.02	.61
07-22	0730	006-C12	.75	YES	10.18	9.61	.57
07-22	0830	006-C12	.75	YES	9.61	8.96	.65
07-22	0930	006-C12	.75	YES	8.96	8.55	.41
07-22	1030	006-C12	.75	YES	8.55	7.82	.73
07-22	1130	006-C12	.75	YES	7.82	7.22	.60

DATE	TIME	SAMPLE NUMBER	SCREEN IN	WASH?	START WT.	STOP WT.	NET WT.
07-22	1230	006-C12	.75	YES	7.22	6.67	.55
07-22	1330	006-C12	.75	YES	6.67	6.09	.58
07-22	1430	006-C12	.75	YES	11.31	10.71	.60
07-22	1530	006-C13	.75	YES	10.71	10.28	.43
07-22	1630	006-C13	.75	YES	10.28	9.76	.52
07-22	1730	006-C13	.75	YES	9.76	9.16	.60
07-22	1830	006-C13	.75	YES	9.16	8.72	.44
07-22	1930	006-C13	.75	YES	8.72	8.08	.64
07-22	2030	006-C13	.75	YES	8.08	7.50	.58
07-22	2130	006-C13	.75	YES	11.61	11.00	.61
07-22	2230	006-C13	.75	YES	11.52	10.75	.77
07-22	2330	006-C14	.75	YES	10.75	10.15	.60
07-23	0030	006-C14	.75	YES	10.14	9.58	.56
07-23	0130	006-C14	.75	YES	9.58	8.73	.85
07-23	0230	006-C14	.75	YES	8.73	8.05	.68
07-23	0330	006-C14	.75	YES	8.03	7.39	.64
07-23	0430	006-C14	.75	YES	7.39	6.74	.65
07-23	0530	006-C14	.75	YES	12.28	11.60	.68
07-23	0630	006-C14	.75	YES	11.60	10.79	.81
07-23	0730	006-C15	.75	YES	10.79	10.13	.66
07-23	0830	006-C15	.75	YES	10.13	9.43	.70
07-23	0930	006-C15	.75	YES	9.43	8.69	.74
07-23	1030	006-C15	.75	YES	8.69	8.11	.58
07-23	1130	006-C15	.75	YES	8.11	7.47	.64
07-23	1230	006-C15	.75	YES	7.47	6.78	.69
07-23	1330	006-C15	.75	YES	6.78	6.14	.64
07-23	1430	006-C15	.75	YES	6.14	5.53	.61
07-23	1530	006-C16	.75	YES	5.53	4.85	.68
07-23	1635	006-C16	.75	YES	4.85	4.06	.79
07-23	1730	006-C16	.75	YES	4.06	3.50	.56
07-23	1830	006-C16	.75	YES	3.50	2.85	.65
07-23	1930	006-C16	.75	YES	2.85	2.26	.59
07-23	2030	006-C16	.75	YES	2.26	1.64	.62
07-23	2130	006-C16	.75	YES	1.64	.94	.70
07-23	2230	006-C16	.75	YES	.94	.54	.40
07-23	2330	006-C16	.75	YES	.54	.25	.29
07-24	0030	006-C17	.75	YES	.25	.06	.19

END OF BOM/FGT 006 PINEY TIPPLE

APPENDIX E
Ash Analysis Data

ASH ANALYSIS FOR BOM/FGT-006

Sample Number	Date	Time	Cumulative Mass Fraction, % less than stated size, inch					Bulk Density gm/cc	Moisture content %	Carbon content %	Sulfur content %
			1/4	1/2	3/4	1	2				
1	7/19/84	13:30	13.3	26.6	43.3	59.6	94.2	0.50	13	8.7	0.18
2	7/19/84	19:00	61.7	79.2	84.4	88.3	100.0	0.74	9	11.4	0.20
3	7/19/84	23:50	4.1	9.8	20.6	28.4	43.7	0.69	7	4.7	0.12
4	7/20/84	11:00	15.8	35.1	52.0	66.9	100.0	0.60	21	14.9	0.15
5	7/20/84	11:30	3.9	18.2	34.1	51.3	100.0	0.64	24	8.6	0.12
6	7/20/84	18:20	11.1	23.7	35.4	42.5	73.8	0.66	20	10.6	0.10
7	7/21/84	3:00	11.2	27.3	43.3	55.8	82.6	0.76	15	4.5	0.07
8	7/21/84	9:00	3.6	8.8	13.6	20.1	28.3	0.00	13	30.3	0.16
9	7/21/84	14:30	32.3	61.5	76.1	82.2	100.0	0.69	22	19.6	0.17
10	7/21/84	17:29	9.6	23.9	36.8	52.0	77.2	0.00	15	4.1	0.07
11	7/22/84	1:00	35.0	55.1	73.7	84.0	100.0	0.84	32	6.3	0.09
12	7/22/84	6:34	30.8	41.5	51.4	58.7	75.5	0.83	36	9.2	0.13
13	7/22/84	9:00	5.6	15.4	24.9	43.3	78.8	0.79	14	11.2	0.11
14	7/22/84	14:00	20.5	47.0	63.7	76.9	100.0	0.77	18	7.5	0.11
15	7/22/84	21:00	25.4	51.5	67.4	83.0	100.0	0.81	15	2.4	0.10
16	7/23/84	3:00	11.8	27.4	50.2	66.6	100.0	0.81	13	2.8	0.06
17	7/23/84	8:00	16.0	41.8	60.6	77.7	100.0	0.59	22	5.0	0.09
18	7/23/84	13:00	28.0	49.9	61.5	68.9	90.3	0.71	12	2.9	0.06
19	7/23/84	19:00	30.2	52.7	71.5	82.9	91.4	0.87	13	3.6	0.07
20	7/24/84	1:29	14.7	39.8	61.9	78.8	100.0	0.78	9	3.7	0.08
Average (Samples 5-20)			18.1	36.6	51.6	64.1	87.4	0.75	18	8.3	0.10

APPENDIX F

Ash Removal Log

Ash weights are given in pounds.
(multiply by 1.24 to obtain corected load cell readings.)

Flush water is given in gallons.

BOM/FGT 006 PINEY TIPPLE

GASIFIER ASH

DATE	TIME	SAMPLE NUMBER	INITIAL DRY	FINAL DRY	NET DRY	INITIAL WET	FINAL WET	NET WET	NET DRY +NET WET	FLUSH WATER
07-19	1330	006-A1	625	58	567	684	42	642	1209	32
07-19	1900	006-A2	815	40	775	467	33	434	1209	30
07-20	0000	006-A3	585	42	543	511	43	468	1011	30
07-20	1100	006-A4	533	47	486	514	42	472	958	30
07-20	1130	006-A5	550	44	506	408	39	369	875	30
07-20	1820	006-A6	515	45	470	327	44	283	753	30
07-21	0300	006-A7	550	44	506	450	41	409	915	30
07-21	0900	006-A8	504	46	458	375	45	330	78	30
07-21	1430	006-A9	566	78	488	432	34	398	886	30
07-21	1730	006-A10	536	42	494	330	43	287	781	30
07-22	0100	006-A11	621	43	576	396	40	356	932	30
07-22	0635	006-A12	532	44	48	362	35	327	815	30
07-22	0900	006-A13	572	43	529	366	43	323	852	30
07-22	1400	006-A14	585	36	549	380	41	339	888	30
07-22	2100	006-A15	658	608	50	1001	39	962	1012	30
07-23	0300	006-A16	720	50	670	450	38	412	1082	30
07-23	0800	006-A17	706	53	653	430	40	390	1043	30
07-23	1100	006-A18	608	51	557	460	38	422	979	30
07-23	1900	006-A19	649	51	598	430	40	390	988	30
07-24	0130	006-A20	560	53	507	410	38	372	879	30

END OF BOM/FGT 006 PINEY TIPPLE

APPENDIX G

Operator Logged Data

Included are three tables of data:

G-1. Freeboard Data

G-2. Firetest Data

G-3. Operator Logged Data I

Water flows in gpm.

Water totals in gallons.

Steam flows in lb/min.

G-4. Operator Logged Data II

Agitator counter in (total revolutions * 2)

Grate Gear counter in (total grate revolutions * 116)

Further description of these data are given in Volume 1 of this series (Thimsen et al, 1984).

TABLE G-1

FREEBOARD

DATE	TIME	#1	#2	#3	#4	#5	#6	#7	AVE
07-18	1200	40			41				40.5
07-18	1300		38			37			37.5
07-18	1400			38			38		38.0
07-18	1500	38			38				38.0
07-18	1600		40			40			40.0
07-18	1700			40			41		40.5
07-18	1800	40			42				41.0
07-18	1900		40			39			39.5
07-18	2000			38			37		37.5
07-18	2100	36			36				36.0
07-18	2200		38			40			39.0
07-18	2300			36			36		36.0
07-19	0000	36			36				36.0
07-19	0100		31			29			30.0
07-19	0200			35			35		35.0
07-19	0300	40			40				40.0
07-19	0330		39			40			39.5
07-19	0400			40			41		40.5
07-19	0430	44			45				44.5
07-19	0500		40			42			41.0
07-19	0530			42			42		42.0
07-19	0600	38			39				38.5
07-19	0700		44			42			43.0
07-19	0800			42			41		41.5
07-19	0900	43			44				43.5
07-19	1000		43			43			43.0
07-19	1030			38		40			39.0
07-19	1100		36				34		35.0
07-19	1200	26			31				28.5
07-19	1215		36			34			35.0
07-19	1230			41			40		40.5
07-19	1300	39			40				39.5
07-19	1330		41			40			40.5
07-19	1400			42			38		40.0
07-19	1430	38			37				37.5
07-19	1500		41			37			39.0
07-19	1530			38			38		38.0
07-19	1600	38			37				37.5
07-19	1630		38			39			38.5
07-19	1700			37			38		37.5
07-19	1730		SHUT DOWN - POWER OUTAGE - STORM						
07-19	1800		36			37			36.5
07-19	1830	37			37				37.0
07-19	1900		35			36			35.5
07-19	1930			32			32		32.0
07-19	2000	32			34				33.0
07-19	2030		33			34			33.5

DATE	TIME	#1	#2	#3	#4	#5	#6	#7	AVE
07-19	2100			34			34		34.0
07-19	2130	33			39				36.0
07-19	2200		36			37			36.5
07-19	2230			32			36		34.0
07-19	2300	34			34				34.0
07-20	0000		34			32			33.0
07-20	0030			33			33		33.0
07-20	0100			34			33		33.5
07-20	0130	33			34				33.5
07-20	0230		35			36			35.5
07-20	0300			36			34		35.0
07-20	0330	34			37				35.5
07-20	0400		34			34			34.0
07-20	0430			30			28		29.0
07-20	0500	30			30				30.0
07-20	0600		32			33			32.5
07-20	0630			33			34		33.5
07-20	0700	34			34				34.0
07-20	0730		32			29			30.5
07-20	0800			31			26		28.5
07-20	0830	35			36				35.5
07-20	0900		35			30			32.5
07-20	0930			32			35		33.5
07-20	1000	34			32				33.0
07-20	1030		34			36			35.0
07-20	1100			34			34		34.0
07-20	1130	30			32				31.0
07-20	1200		36			36			36.0
07-20	1230			34			33		33.5
07-20	1300	35			35				35.0
07-20	1330		31			32			31.5
07-20	1400			31			32		31.5
07-20	1430	31			32				31.5
07-20	1500		35			35			35.0
07-20	1530			35			34		34.5
07-20	1600	35.5			34.5				35.0
07-20	1630		34.5			35.5			35.0
07-20	1700			34			33		33.5
07-20	1730		SHUT	DOWN			SHUT	DOWN	
07-20	1800	32			34				33.0
07-20	1830		35			36			35.5
07-20	1900		36			37			36.5
07-20	1930			36			35		35.5
07-20	2000	33			35				34.0
07-20	2030		33			34			33.5
07-20	2100			32			34		33.0
07-20	2130	30			32				31.0
07-20	2200		31			32			31.5
07-20	2230			33			34		33.5
07-20	2300	33			34				33.5
07-21	0000	34			33				33.5
07-21	0030		33			34			33.5

DATE	TIME	#1	#2	#3	#4	#5	#6	#7	AVE
07-21	0100			36			35		35.5
07-21	0130	32			36				34.0
07-21	0200		36			34			35.0
07-21	0300			35			33		34.0
07-21	0400	36			36				36.0
07-21	0500		35			36			35.5
07-21	0600			34			34		34.0
07-21	0730	28			30				29.0
07-21	0800		30			32			31.0
07-21	0830			32			32		32.0
07-21	0900	31			34				32.5
07-21	0930		32			35			33.5
07-21	1000			35			32		33.5
07-21	1030	36			36				36.0
07-21	1100		34			34			34.0
07-21	1130			33					33.0
07-21	1200	34			34				34.0
07-21	1230		32			34			33.0
07-21	1300			36			37		36.5
07-21	1330	34			35				34.5
07-21	1400		34			36			35.0
07-21	1430			32			32		32.0
07-21	1500	35			32				33.5
07-21	1530			31			34		32.5
07-21	1600	32.5			33.5				33.0
07-21	1630		31			33			32.0
07-21	1700			32			34		33.0
07-21	1730	33.5			31.5				32.5
07-21	1800		32			32			32.0
07-21	1830			31			32		31.5
07-21	1900	34			33				33.5
07-21	1930		30.5			33.5			32.0
07-21	2000			33.5			33.5		33.5
07-21	2030	36			35				35.5
07-21	2100		32			34			33.0
07-21	2130			32.5			33		32.75
07-21	2200	33.5			33				33.25
07-21	2230		32			32			32.0
07-21	2300			31.5			33		32.25
07-21	2330	31.5			33				32.25
07-22	0000		35			34			34.5
07-22	0030			34			33		33.5
07-22	0100	34			35				34.5
07-22	0130		37			37			37.0
07-22	0200			36			35		35.5
07-22	0230	34			33				33.5
07-22	0300		33			32			32.5
07-22	0330			31			32		31.5
07-22	0400	32			32				32.0
07-22	0430		33			35			34.0
07-22	0500			32			32		32.0
07-22	0530	32			31				31.5

DATE	TIME	#1	#2	#3	#4	#5	#6	#7	AVE
07-22	0630		32			30			31.0
07-22	0700			33			32		32.5
07-22	0730	31			31				31.0
07-22	0800		30			30			30.0
07-22	0830			31				32	31.5
07-22	0900	31			31				31.0
07-22	0930		30			31			30.5
07-22	1000			32			30		31.0
07-22	1030	30			30				30.0
07-22	1100		28			29			28.5
07-22	1130			30			30		30.0
07-22	1200	28			29				28.5
07-22	1230		32			32			32.0
07-22	1300			33			31		32.0
07-22	1330	33			30				31.5
07-22	1400		31			33			32.0
07-22	1430			32			28		30.0
07-22	1500	32			32				32.0
07-22	1530		34			34			34.0
07-22	1600			32.5			30		31.25
07-22	1630	32.5			31				31.75
07-22	1700		35	32		38	36		35.25
07-22	1730			32			34		33.0
07-22	1800	34			32				33.0
07-22	1830		36			36			36.0
07-22	1900			41			41		41.0
07-22	1930	40			40				40.0
07-22	1945	37.5	34.5	35	33	32	35		34.5
07-22	2000	37.5	36	38	37	36	37		36.9
07-22	2015	38.5	37	39.5	33	37	36.5		36.9
07-22	2030	38	35	32	33.5	36	34		34.75
07-22	2045	33.5	31	29.5	33.5	33.5	33.5		32.4
07-22	2100	33	33.5	32	30.5	29	33.5		31.9
07-22	2130		30.5			31.5			31.0
07-22	2200			30.5			29.5		30.0
07-22	2230	32.5			32.5				32.5
07-22	2300		33			33			33.0
07-22	2330			36			33		34.5
07-23	0000	33			35				34.0
07-23	0030		34			33			33.5
07-23	0100			33			33		33.0
07-23	0130	34			35				34.5
07-23	0200		32			32			32.0
07-23	0230			32			32		32.0
07-23	0300	32			32				32.0
07-23	0330		32			32			32.0
07-23	0400			33			32		32.5
07-23	0430	33			34				33.5
07-23	0500		33			33			33.0
07-23	0530			32			32		32.0
07-23	0600	32			32				32.0
07-23	0630		32			33			32.5

DATE	TIME	#1	#2	#3	#4	#5	#6	#7	AVE
07-23	0700			32			32		32.0
07-23	0730	31			31				31.0
07-23	0800		30			32			31.0
07-23	0830			32			32		32.0
07-23	0900	30			28				29.0
07-23	0930		27			27			27.0
07-23	1000			31			31		31.0
07-23	1030	34			31				32.5
07-23	1100		33			34			33.5
07-23	1130			34			34		34.0
07-23	1200	34			34				34.0
07-23	1230		34			34			34.0
07-23	1300			34			34		34.0
07-23	1330	34			34				34.0
07-23	1400		34			34			34.0
07-23	1430			34			34		34.0
07-23	1500	36			36				36.0
07-23	1530		34			32			33.0
07-23	1600			33			35		34.0
07-23	1630	32.5			33.5				33.0
07-23	1700		32.5			32.5			32.5
07-23	1730			32.5			33.5		33.0
07-23	1800	35			35				35.0
07-23	1830		33.5			33.5			33.5
07-23	1900			33			34		33.5
07-23	1930	33			31.5				32.25
07-23	2000		33.5			34			33.75
07-23	2030			32			32		32.0
07-23	2100	34			32.5				33.25
07-23	2130		34			34			34.0
07-23	2200			34			33		33.5
07-23	2230	34			32.5				33.25
07-23	2300		33			31			32.0
07-23	2330			32			32		32.0
07-23	0000	33			32				32.5
07-24	0030		33			32			32.5
07-24	0100			32			33		32.5
07-24	0130	33			33				33.0

TABLE G-2

FIRE TEST

Date	Time	Insertion Time (min)	#1	#2	#3	#4	#5	#6	#7	Average
07-18	1200	4.0	10	10	11	8	16	4	7	9.4
07-18	1400	3.0	18	12	8	14	12	12	13	12.7
07-18	1600	3.0	14	10	8	7	12	11	10	10.3
07-18	1800	3.0	12	13	9	8	14	13	8	11.0
07-18	2000	3.0	11D	9	8	10	12	12D	5	9.6
07-18	2200	3.0	11	12	11	6	12	14	7	10.4
07-19	0000	3.0	15	9	7	14	10	13D	6	10.6
07-19	0200	3.0	15	9	7	14	10	13	6	10.6
07-19	0400	3.0	5	8	8	16	10	12	6	9.3
07-19	0600	3.0	6	12	6	21	14	21	8	12.5
07-19	0800	3.0	13	14	30	23	14	34	22	21.4
07-19	1000	3.0	12	30	28	14	17	26	6	19.0
07-19	1200	3.0	34	14	19	19	16	16	10	18.2
07-19	1400	3.0	20	13	32	13	11	18	25	18.7
07-19	1600	2.5	10D	13D	17	10D	10D	14D	4	11.1
07-19	1800	2.5	18	12D	23	9D	6D	3	5	10.9
07-19	2000	2.5	19	16	13D	16	5D	18	0	12.4
07-19	2200	2.5	4	3	2D	6D	15D	12	0	6.0
07-20	0000	2.5	8	7	6	8	6	0	C	5.0
07-20	0200	2.5	8	10	18	10	6	10	6	9.7
07-20	0400	2.5	6	12	13	8	8	16	3	9.4
07-20	0600	2.5	8D	6D	10	12D	3D	18D	3	8.6
07-20	0800	2.5	7	15C	10	12	37	12D	C	13.3
07-20	1000	2.5	7C	11	15	17D	4D	1D	C	7.9
07-20	1200	2.5	21D	14	5D	10	6D	9	C	9.3
07-20	1400	2.5	6	14D	7D	8D	9D	11	34	12.7
07-20	1600	2.5	31	20	2C	21	24	7	23C	23.8
07-20	1700	2.5	10D	17D	9D	7D	12D	4	20C	11.3
07-20	2000	2.5	7D	8D	6D	10	11	13D	17D	10.3
07-20	2200	2.5	12C	16D	6	15D	18D	9D	8C	12.0
07-21	0000	2.5	3	13D	17D	26	5	7D	2D	10.4
07-21	0200	2.5	7	27	25	3	14	8	4	12.5
07-21	0400	2.5	6	12	16	15	18	9	6	11.7
07-21	0600	2.5	13	14	10	9	12	10D	0	11.3
07-21	0800	2.5	20	11	12D	29	3	11	C	12.3
07-21	1000	2.5	12C	32	25	13	5D	14	1	14.5
07-21	1200	2.5	11	31	4	7	12	11D	C	10.9
07-21	1400	2.5	36D	3D	13	27	45	7D	C	18.7
07-21	1600	2.5	9C	6D	4C	3D	9D	7	8C	6.6
07-21	1800	2.5	14D	10	8C	21D	28	26	2C	15.6
07-21	2000	2.5	38D	5D	6D	4D	26D	6D	7C	13.1
07-21	2200	2.5	6	11D	21D	4D	2D	7D	2C	7.6
07-22	0000	2.5	8D	10D	42D	9D	8D	44D	4	17.9
07-21	0200	2.5	3D	34D	28D	17	25D	22	6	19.3
07-22	0400	2.5	10D	10	14	8	8	24	4	12.6
07-22	0600	2.5	13	42D	12D	44	60D	26	6	29.0
07-22	0800	2.5	5	1	1D	12	2D	1D	1C	3.1

Date	Time	Insertion Time (min)	#1	#2	#3	#4	#5	#6	#7	Average
07-22	1000	2.5	2C	4D	5	36	19	29	C	13.6
07-22	1200	2.5	7D	7D	2	40D	10D	4D	C	10.0
07-22	1400	2.5	6	24D	6D	7	23	28	C	13.4
07-22	1600	2.5	4D	7D	7D	24D	10D	6	C	8.3
07-22	1800	2.5	10D	9D	8D	34D	26	9	C	13.7
07-22	2000	2.5	6D	10C	8D	20D	21C	8	C	10.4
07-22	2200	2.5	12D	24D	28	32	36	4	2	19.7
07-23	0000	2.5	15	38	23	3	11	7	6	14.7
07-23	0200	2.5	21	14	22D	23D	31	12	C	17.6
07-23	0400	2.5	22	26	34	24	26	10	C	20.3
07-23	0600	2.5	17	31	33	4	6D	12	C	14.7
07-23	0800	2.5	15	26	16D	26D	8	7D	5C	14.0
07-23	1000	2.5	15	5D	7D	5	3D	16	C	7.2
07-23	1200	2.5	2	20D	1D	7D	6	10D	C	6.6
07-23	1400	2.5	14	15	3	6	5D	11	12	9.4
07-23	1600	2.5	2D	7D	9	21D	27D	14	C	11.4
07-23	1800	2.5	9C	10D	5	4D	15D	7	C	7.1
07-23	2000	2.5	9D	2D	10	10D	17D	12D	C	8.6
07-23	2200	2.5	12	15	12D	20	2D	11D	C	10.3
07-24	0000	2.5	9D	12	10D	8D	7D	12	C	8.3

TABLE G-3

DATE	TIME	AGIT. WATER FLOW	JACKET WATER FLOW	JACKET W. F. TOTAL	JACKET WATER HRLY USE	STEAM RATE FLOW	METER INLET PRESS.	INLET VALVE PRESS.	OUTLET VALVE PRESS.	VALVE POSIT.
0718	1030	3.0	2.0							
0718	1136	6.0	8.0	12854	300					
0718	1236	6.0	11.0	12859	500					
0718	1330	6.0	12.0	12866	700					
0718	1430	6.0	16.0	12875	800					
0718	1530	6.0	17.0	12885	1000					
0718	1630	6.0	17.0	12996	1100					
0718	1730	6.0	18.0	12906	1000					
0718	1830	6.0	18.0	12917	1100					
0718	1930	6.0	18.0	12928	1100					
0718	2030	6.0	17.0	12938	1000					
0718	2130	6.0	18.0	12949	1100					
0718	2230	6.0	18.0	12959	1000					
0718	2330	6.0	18.0	12968	900					
0719	0030	6.0	18.0	12976	800					
0719	0130	6.0	17.0	12989	1300					
0719	0230	6.0	17.0	13000	1100					
0719	0330	6.0	14.0	13008	800					
0719	0430	6.0	15.0	13018	1000					
0719	0530	6.0	14.0	13025	700					
0719	0630	6.0	12.0	13034	900					
0719	0730	6.0	12.0	13040	600					
0719	0830	6.0	12.0	13047	700					
0719	0930	6.0	13.5	13055	800					
0719	1030	6.0	15.0	13063	800					
0719	1130	6.0	14.0	13072	900					
0719	1230	6.0	13.0	13080	600					
0719	1330	6.0	20.0	13090	1000	5	13.5	11.5	5	30
0719	1430	6.0	20.0	13101	1100	5	13.5	11.5	5	30
0719	1530	6.0	20.0	13114	1300	5.8	12.5	11.5	6.5	30
0719	1625	6.0	20.0	13132	1800		13.0	12.5		12
0719	1830	6.0	20.0	13143	1100	2.43	12.2	11.0	3.5	24
0719	1930	6.0	20.0	13154	1100	2.43	12.6	11.5	3.5	26
0719	2030	6.0	20.0	13166	1200	2.43	12.3	12.0	2.4	20
0719	2130	6.0	20.0	13178	1200	2.42	12.9	12.5	3.2	24
0719	2230	6.0	20.0	13189	1100	2.425	12.9	11.6	3.0	26
0719	2330	6.0	20.5	13201	1200					
0720	0030	6.0	21.0	13211	1000					
0720	0130	6.0	21.0	13221	1000					
0720	0230	6.0	20.0	13231	1000					
0720	0330	6.0	20.0	13242	1100					
0720	0430	6.0	24.0	13261	1900					
0720	0530	6.0	25.0	13275	1400	2.42	12.0	12.0	1.0	8.0
0720	0630	6.0	25.0	13290	1500	2.42	12.0	12.0	1.0	8.0
0720	0730	6.0	24.5	13305	1500	2.42	13.5	12.0	1.0	15.0
0720	0830	6.0	25.0	13319	1400	2.42	12.5	12.0	1.0	18.0
0720	0930	6.0	25.0	13334	1500	2.42	12.7	12.0	1.0	18.0
0720	1030	6.0	24.5	13348	1400	2.42	12.5	11.0	2.0	21.0

DATE	TIME	AGIT. WATER FLOW	JACKET WATER FLOW	JACKET W. F. TOTAL	JACKET WATER HRLY USE	STEAM RATE FLOW	METER INLET PRESS.	INLET VALVE PRESS.	OUTLET VALVE PRESS.	VALVE POSIT.
0720	1130	6.0	24.5	13363	1500	2.42	13.0	12.0	2.0	19.0
0720	1230	6.0	25.0	13377	1400	2.42	12.0	12.0	3.0	22.0
0720	1330	6.0	25.0	13392	1500	3.5	13.0	12.0	3.0	20.0
0720	1430	6.0	25.0	13408	1600	3.5	13.0	12.0	3.0	20.0
0720	1530	6.0	25.0	13423	1500	2.432	12.4	11.5	3.0	24.0
0720	1630	6.0	25.0	13437	1400	2.438	13.0	11.7	3.9	24.0
0720	1830	6.0	25.0	13468	3100	2.45	12.6	12.0	4.0	24.0
0720	1930	6.0	25.0	13484	1600	2.435	13.0	12.4	2.0	20.0
0720	2030	6.0	25.0	13498	1400	2.41	12.5	11.5	2.0	22.0
0720	2130	6.0	25.0	13512	1400	2.41	13.0	12.0	2.0	22.0
0720	2230	6.0	25.0	13526	1400	2.43	12.5	11.5	3.2	24.0
0720	2330	6.0	25.0	13542	1600	3.0	12.0	11.5	3.0	22.0
0721	0030	6.0	25.0	13556	1400	4.0	12.5	11.5	4.5	26.0
0721	0130	6.0	25.0	13570	1400	3.5	12.0	11.5	4.0	24.0
0721	0230	6.0	25.0	13587	1700	4.0	12.5	11.0	5.0	26.0
0721	0330	6.0	25.0	13604	1700	4.0	12.5	11.0	5.0	26.0
0721	0430	6.0	25.0	13618	1400	4.5	13.0	12.0	5.5	25.0
0721	0530	6.0	25.0	13636	1800	4.5	12.5	11.5	5.0	26.0
0721	0630	6.0	25.0	13646	1000	4.5	13.0	11.5	6.0	30.0
0721	0730	6.0	24.5	13660	1400	6.0	12.2	11.5	6.0	20.0
0721	0830	6.0	24.0	13672	1200	6.0	12.5	10.5	5.0	19.0
0721	0930	6.0	24.5	13688	1600	6.0	13.0	12.0	4.0	26.0
0721	1030	6.0	24.5	13702	1400	5.0	13.0	12.0	4.5	26.0
0721	1130	6.0	24.0	13717	1500	5.0	13.0	12.0	5.0	28.0
0721	1230	6.0	24.0	13730	1300	5.0	13.0	12.0	5.0	26.0
0721	1330	6.0	24.0	13744	1400	5.5	13.0	12.0	5.0	26.0
0721	1430	6.0	24.0	13759	1500	6.0	12.5	11.5	6.0	30.0
0721	1530	6.0	25.0	13773	1400	2.455	12.5	11.5	5.5	28.0
0721	1630	6.0	25.0	13788	1500	2.459	12.9	11.6	7.0	32.0
0721	1730	6.0	25.0	13803	1500	2.46	12.9	11.9	6.5	30.0
0721	1830	6.0	25.0	13817	1400	2.465	12.5	11.6	7.5	34.0
0721	1930	6.0	25.0	13831	1400	2.465	12.4	11.3	7.4	34.0
0721	2030	6.0	25.0	13846	1500	2.47	12.8	11.5	9.0	40.0
0721	2130	6.0	25.0	13861	1500	2.47	12.4	11.4	8.5	40.0
0721	2230	6.0	25.0	13875	1400	2.47	12.2	11.4	8.4	40.0
0721	2330	6.0	25.0	13889	1400	7.0	12.5	12.0	9.5	42.0
0722	0030	6.0	25.0	13905	1600	7.0	12.5	12.0	4.5	42.0
0722	0130	6.0	25.0	13919	1400	7.0	12.5	12.0	4.5	42.0
0722	0230	6.0	25.0	13933	1400	7.0	12.5	12.0	4.5	42.0
0722	0330	6.0	25.0	13948	1500	7.0	12.5	12.0	4.5	42.0
0722	0430	6.0	25.0	13963	1500	7.0	12.5	12.0	4.5	42.0
0722	0530	6.0	25.0	13978	1500	7.0	11.5	12.0	4.5	42.0
0722	0630	6.0	25.0	13994	1600	7.0	11.5	12.0	4.5	42.0
0722	0730	6.0	24.5	14006	1200	8.0	12.5	12.0	11.0	60.0
0722	0830	6.0	25.0	14021	1500	8.0	12.5	11.5	10.5	70.0
0722	0930	6.0	24.5	14035	1400	8.0	12.5	11.0	11.0	92.0
0722	1030	6.0	24.5	14050	1500	8.0	12.5	11.5	11.0	100.0
0722	1130	6.0	20.0	14062	1200	8.0	12.5	11.0	11.0	100.0
0722	1230	6.0	17.0	14072	1000	8.0	12.5	11.0	11.0	78.0
0722	1330	6.0	17.0	14082	1000	8.0	12.5	11.5	11.0	72.0

DATE	TIME	AGIT. WATER FLOW	JACKET WATER FLOW	JACKET W. F. TOTAL	JACKET WATER HRLY USE	STEAM RATE FLOW	METER INLET PRESS.	INLET VALVE PRESS.	OUTLET VALVE PRESS.	VALVE POSIT.
0722	1430	6.0	17.0	14092	1000	8.0	12.5	11.5	11.0	62.0
0722	1530	6.0	17.0	14101	900	7.0	12.2	11.44	8.9	42.0
0722	1630	6.0	17.0	14111	1000	7.0	12.5	11.5	8.1	38.0
0722	1730	6.0	17.0	14121	1000	7.0	12.5	11.6	8.4	38.0
0722	1830	6.0	17.0	14131	1000	7.0	12.9	12.0	7.9	34.0
0722	1930	6.0	17.0	14142	1100	7.0	12.4	11.5	8.2	40.0
0722	2030	6.0	17.0	14151	900	7.0	12.5	11.3	9.9	52.0
0722	2130	6.0	17.0	14161	1000	7.3	12.5	11.5	11.0	80.0
0722	2230	6.0	17.0	14171	1000	7.8	12.6	11.5	11.0	88.0
0722	2330	6.0	17.0	14181	1000	8.0	12.5	11.5	11.0	80.0
0723	0030	6.0	17.0	14191	1000	8.0	12.5	11.5	11.0	80.0
0723	0130	6.0	17.0	14201	1000	8.0	12.5	11.5	11.0	82.0
0723	0230	6.0	17.0	14212	1100	8.0	12.5	11.5	11.0	80.0
0723	0330	6.0	17.0	14222	1000	8.0	12.5	11.5	11.0	80.0
0723	0430	6.0	17.0	14231	900	8.0	12.5	11.5	11.0	80.0
0723	0530	6.0	17.0	14241	1000	8.0	12.5	11.5	11.0	75.0
0723	0630	6.0	17.0	14251	1000	8.0	12.5	11.5	11.0	77.0
0723	0730	6.0	17.0	14261	1000	8.0	11.5	11.5	11.0	79.0
0723	0830	6.0	17.0	14270	900	8.0	12.0	11.5	10.5	80.0
0723	0930	6.0	20.0	14282	1200	7.5	12.5	11.5	8.0	35.0
0723	1030	6.0	20.0	14295	1300	7.0	12.5	11.5	7.0	34.0
0723	1130	6.0	20.0	14306	1100	7.0	12.5	11.5	7.0	34.0
0723	1230	6.0	20.0	14318	1200	7.0	12.5	11.5	7.0	32.0
0723	1330	6.0	20.0	14329	1100	7.0	13.0	11.0	7.0	30.0
0723	1430	6.0	20.0	14341	1200	7.0	12.5	12.0	7.0	30.0
0723	1530	6.0	20.0	14353	1200	6.9	12.4	11.5	6.2	30.0
0723	1630	6.0	20.0	14365	1200	6.8	12.6	12.0	6.6	31.0
0723	1730	6.0	20.0	14377	1200	6.7	12.4	11.5	6.7	32.0
0723	1830	6.0	20.0	14389	1200	6.3	12.4	11.5	6.5	31.0
0723	1930	6.0	20.0	14401	1200	6.1	12.7	12.0	6.0	30.0
0723	2030	6.0	20.0	14412	1100	6.0	12.5	11.5	5.5	28.0
0723	2130	6.0	20.0	14424	1200	5.5	13.0	12.0	6.0	28.0
0723	2230	6.0	20.0	14436	1200	5.8	12.2	11.4	5.8	29.0
0723	2330	6.0	20.0	14448	1200	7.0	12.5	11.5	5.8	30.0
0724	0030	6.0	20.0	14460	1200	7.0	12.5	11.5	6.0	30.0

TABLE G-4

OPERATOR LOG 1B

DATE	TIME	AGIT. COUNT RDING	AGIT SWEEP PER HR	AGIT DRIVE SETNG	GRATE GEAR COUNTER READING	GRATE GEAR RPH	GRATE DRIVE SETNG	FLUE GAS SCRUBBER		
								PH	REAGENT PUMP SPEED	REAGENT PUMP STROKE
0718	1030			2.0				7.0	35	50
0718	1130	2	2	2.0				6.2	35	40
0718	1230	4	2	3.5				6.2	35	40
0718	1330	14	10	2.0				6.2	35	40
0718	1500	17	3	2.0				6.2	35	40
0718	1600	19	2	2.0				6.5	35	40
0718	1700	21	2	3.0				6.5	35	40
0718	1800	24	3	3.0				6.5	35	40
0718	1900	28	4	3.5				6.5	35	40
0718	2000	31	3	3.5				5.9	35	40
0718	2100	34	3	2.5				5.9	35	40
0718	2200	37	3	2.0				6.2	35	40
0718	2300	39	2	2.0				6.0	35	40
0718	2330	41	2	4.9				6.0	35	40
0719	0030	50	9	8.0				6.0	35	40
0719	0130	55	5	3.1				6.0	35	40
0719	0230	57	2	1.7				4.0	35	35
0719	0330	59	2	3.1				6.2	35	40
0719	0430	63	4	4.0				6.2	35	40
0719	0530	69	6	6.5				6.0	35	40
0719	0630	74	5	7.0	10.0		2.5	6.0	35	40
0719	0730	79	5	7.0	23.0	13	2.5	6.2	35	40
0719	0830	86	7	7.0	44.0	39	3.0	6.2	35	40
0719	0930	93	7	8.5	74.0	30	3.00	6.2	35	40
0719	1030	101	8	8.5	102.0	28	4/2.0	6.2	35	40
0719	1130	116	15	10.5	144.0	42	4/2.0	6.2	30	30
0719	1230	120	4	5.0	195.0	51	3.5	6.5	30	30
0719	1330	126	6	6.0	271.0	76	3.5	6.5	30	30
0719	1430	133	7	7.5	347.0	76	4.5	6.5	30	30
0719	1530	141	8	7.5	450.0	103	5/4.5	6.5	30	30
0719	1630	155	14	9.0	507.0	57	5/2.5	6.5	30	30
0719	1830	160	5	6.0	548.0	41	5/2.5	6.2	30	30
0719	1930	167	7	7.0	595.0	47	5/2.5	6.8	30	30
0719	2030	174	7	7.0	652.0	57	5/2.5	7.0	30	30
0719	2130	181	7	7.0	700.0	48	4/2.5	7.0	30	30
0719	2230	188	7	9.0	741.0	41	2/1.25	7.0	30	30
0719	2330	197	9	9.0	755.0	14	2/1.25	7.0	30	30
0720	0030	204	7	8.1	764.0	9	2/1.25	7.0	30	30
0720	0130	212	8	7.5	773.0	9	2/1.25	6.5	30	30
0720	0230	220	8	8.0	782.0	9	2/1.25	7.0	30	30
0720	0330	227	7	8.0	792.0	10	2/1.25	6.5	30	30
0720	0430	235	8	7.5	817.0	25	2/1.25	6.6	30	30
0720	0530	242	7	7.5	833.0	16	2/1.25	6.6	28	30
0720	0630	249	7	7.0	849.0	16	2/1.25	7.0	28	30
0720	0730	256	7	7.0	856.0	7	2/1.25	6.5	28	30
0720	0830	261	5	4.0	868.0	12	2/1.25	6.5	28	30

DATE	TIME	AGIT. COUNT RDING	AGIT SWEEP PER HR	AGIT DRIVE SETNG	GRATE GEAR COUNTER READING	GRATE GEAR RPH	GRATE DRIVE SETNG	FLUE GAS SCRUBBER		
								pH	REAGENT PUMP SPEED	REAGENT PUMP STROKE
0720	0930	266	4	5.5	884.0	16	2/1.75	6.2	28	30
0720	1030	272	6	5.5	901.0	17	2/1.35	6.2	28	30
0720	1130	277	5	5.5	915.0	14	2/1.35	6.2	28	30
0720	1230	282	5	5.5	928.0	13	2/1.35	6.5	28	30
0720	1330	288	6	5.5	942.0	14	2/1.35	6.5	28	30
0720	1430	293	5	5.5	957.0	15	2/1.35	6.5	28	30
0720	1530	298	5	4.5	970.0	13	2/1.35	6.5	28	30
0720	1630	302	4	5.0	989.0	19	2/2.20	6.5	29	30
0720	1830	307	5	5.3	1012.0	23	1/1.35	6.5	29	30
0720	1930	313	6	6.5	1026.0	14	1/1.35	6.5	29	30
0720	2030	320	7	6.5	1038.0	12	1/1.35	6.5	29	30
0720	2130	326	6	6.5	1051.0	13	1/1.35	6.5	29	30
0720	2230	331	5	5.5	1064.0	13	1/1.35	6.2	29	30
0720	2330	337	6	5.5	1079.0	15	1/1.35	6.2	29	30
0721	0030	343	6	8.0	1094.0	15	1/1.35	6.6	29	30
0720	0130	349	6	8.0	1105.0	11	1/1.35	6.4	29	30
0720	0230	358	9	8.0	1120.0	15	1/1.35	6.5	29	30
0721	0330	367	9	8.0	1135.0	15	1/1.35	6.2	29	30
0721	0430	375	8	8.5	1147.0	12	1/1.35	6.2	29	30
0721	0530	382	7	9.0	1159.0	12	1/1.35	6.2	29	30
0721	0630	391	9	10.0	1173.0	14	1/1.35	6.5	29	30
0721	0730	400	9	10.0	1185.0	12	2/1.35	5.0	29	30
0721	0830	407	7	7.5	1201.0	16	2/2.00	6.5	29	30
0721	0930	414	7	7.5	1219.0	18	2/2.00	6.5	29	30
0721	1030	421	7	7.5	1240.0	21	2/2.50	6.5	29	30
0721	1130	429	8	8.0	1265.0	25	2/2.50	6.5	29	30
0721	1230	436	7	8.0	1288.0	23	2/2.50	6.5	29	30
0721	1330	444	8	9.0	1311.0	23	2/2.50	6.5	29	30
0721	1430	453	9	10.0	1336.0	25	2/2.65	6.5	29	30
0721	1530	463	10	10.0	1362.0	26	2/2.65	6.5	29	30
0721	1630	473	10	10.0	1386.0	24	2/1.90	6.5	29	30
0721	1730	482	9	10.0	1404.0	18	2/1.90	6.5	29	30
0721	1830	492	10	10.0	1422.0	18	2/2.20	6.5	29	30
0721	1930	502	10	10.0	1443.0	21	2/2.20	6.5	29	30
0721	2030	512	10	10.0	1464.0	21	2/2.20	6.5	29	30
0721	2130	521	9	10.0	1486.0	22	2/2.20	6.5	29	30
0721	2230	531	10	10.0	1507.0	21	2/1.50	6.35	29	30
0721	2330	541	10	10.0	1524.0	17	2/1.50	6.0	29	30
0722	0030	551	10	10.0	1537.0	13	2/1.50	6.0	29	30
0722	0130	561	10	10.0	1551.0	14	2/1.50	6.0	29	30
0722	0230	574	13	14.7	1565.0	14	2/1.50	6.0	29	30
0722	0330	585	11	10.0	1579.0	14	2/1.20	6.0	29	30
0722	0430	597	12	10.0	1604.0	25	2/2.00	6.0	29	30
0722	0530	606	9	10.0	1620.0	16	2/2.00	6.0	29	30
0722	0630	618	12	11.5	1644.0	24	3/4.00	6.2	29	30
0722	0730	627	9	11.7	1693.0	49	3/4.00	5.0	29	30
0722	0830	638	11	10.0	1742.0	49	3/2.00	6.5	29	30
0722	0930	648	10	10.0	1771.0	29	3/2.00	6.5	29	30
0722	1030	658	10	10.0	1803.0	32	3/2.00	6.5	29	30
0722	1130	667	9	9.0	1832.0	29	3/2.00	6.5	29	30

DATE	TIME	AGIT. COUNT RDING	AGIT SWEEP PER HR	AGIT DRIVE SETNG	GRATE GEAR COUNTER READING	GRATE GEAR RPH	GRATE DRIVE SETNG	FLUE GAS SCRUBBER		
								PH	REAGENT PUMP SPEED	REAGENT PUMP STROKE
0722	1230	675	8	8.0	1860.0	28	3/2.00	6.5	29	30
0722	1330	683	8	8.0	1886.0	26	3/2.00	6.5	29	30
0722	1430	691	8	8.0	1918.0	32	3/2.25	6.5	29	30
0722	1530	698	7	8.0	1949.0	31	3/2.25	6.5	29	30
0722	1630	706	8	8.0	1981.0	32	3/1.65	6.5	29	30
0722	1730	714	8	8.0	2006.0	25	3/1.65	6.5	29	30
0722	1830	721	7	8.0	2031.0	25	3/1.65	6.5	29	30
0722	1930	732	11	11.5	2048.0	17	3/1.65	6.5	29	30
0722	2030	744	12	13.0	2070.0	22	3/1.65	6.5	29	30
0722	2130	756	12	9.5	2094.0	24	3/1.65	6.2	29	30
0722	2230	765	9	8.0	2118.0	24	3/2.50	6.2	29	30
0722	2330	772	7	8.0	2176.0	58	3/2.50	6.2	29	30
0723	0030	781	9	10.0	2191.0	15	3/2.50	6.2	29	30
0723	0130	790	9	12.0	2229.0	38	3/2.50	6.2	29	30
0723	0230	803	13	11.0	2273.0	44	3/3.00	6.2	29	30
0723	0330	814	11	1.0	2318.0	45	3/3.00	6.2	29	30
0723	0430	824	10	13.0	2362.0	44	3/3.50	6.2	29	30
0723	0530	838	14	14.5	2415.0	53	3/3.50	6.4	29	30
0723	0630	852	14	13.0	2463.0	48	3/3.00	6.2	29	30
0723	0730	866	14	13.0	2511.0	48	3/3.00	6.5	28	30
0723	0830	876	10	13.0	2543.0	32	3/3.25	6.5	28	30
0723	0930	889	13	13.0	2595.0	52	3/3.25	7.0	28	30
0723	1030	896	7	7.0	2646.0	51	3/2.85	6.5	28	30
0723	1130	903	7	8.5	2687.0	41	3/2.85	6.5	28	30
0723	1230	911	8	7.5	2726.0	39	3/2.85	6.2	28	30
0723	1330	919	8	7.5	2755.0	29	2/2.85	6.2	28	30
0723	1430	925	6	6.5	2785.0	30	2/2.85	6.2	28	30
0723	1530	931	6	6.5	2816.0	31	2/3.00	6.5	28	30
0723	1630	939	8	7.0	2850.0	34	2/3.00	7.0	28	30
0723	1730	945	6	7.0	2879.0	29	2/3.00	7.0	28	30
0723	1830	953	8	8.0	2910.0	31	2/2.50	7.0	28	30
0723	1930	961	8	8.0	2937.0	27	2/2.50	7.0	25	40
0723	2030	968	7	8.0	2961.0	24	2/2.30	7.0	25	40
0723	2130	976	8	8.0	2985.0	24	2/2.30	7.0	20	30
0723	2230	984	8	8.0	3010.0	25	2/2.30	5.9	30	30
0723	2330	992	8	8.0	3035.0	25	2/2.30	6.4	30	30
0724	0030	1000	8	7.9	3060.0	25	2/2.30	6.2	30	30

APPENDIX H
Gas Chromatograph Data

GAS CHROMATOGRAPH DATA

DATE TIME	H2 %	CO2 %	C2H4 %	C2H6 %	O2 %	N2 %	CH4 %	CO %	C3H6 %	C3H8 %	HHV BTU/SCF	LHV BTU/SCF	TMP %	MW	S.G. WRT AIR

7/18/1983															
14:23	19.934	7.109	0.002	0.009	0.000	47.75	1.370	21.69	0.000	0.000	148.2	136.9	97.86	23.21	0.801
14:40	19.354	7.023	0.002	0.001	0.000	47.39	1.335	21.72	0.000	0.000	146.0	135.0	96.82	23.06	0.796
14:57	19.014	7.170	0.002	0.008	0.000	47.82	1.183	21.73	0.000	0.000	143.5	132.8	96.93	23.22	0.801
15:14	18.285	6.850	0.002	0.008	0.000	48.18	1.182	22.11	0.000	0.000	142.3	132.0	96.62	23.27	0.803
15:31	17.349	7.000	0.002	0.007	0.000	48.46	1.056	22.34	0.000	0.000	138.7	129.0	96.21	23.44	0.809
15:47	17.043	7.286	0.001	0.006	0.000	49.03	0.952	22.56	0.000	0.000	137.4	127.9	96.87	23.76	0.820
16: 4	15.108	6.889	0.001	0.006	0.000	51.93	0.863	21.86	0.000	0.000	127.9	119.5	96.66	24.15	0.834
16:41	15.808	7.205	0.001	0.007	0.000	50.60	0.912	23.19	0.000	0.000	135.0	126.2	97.73	24.31	0.839
17: 5	16.143	7.583	0.002	0.007	0.000	50.25	0.991	22.46	0.000	0.000	134.5	125.5	97.44	24.19	0.835
17:34	14.775	8.033	0.001	0.004	0.000	51.53	0.553	22.69	0.000	0.000	126.4	118.4	97.59	24.72	0.853
17:51	13.633	8.050	0.001	0.002	0.000	52.25	0.290	22.49	0.000	0.000	119.3	112.2	96.72	24.81	0.856
18:29	13.245	8.187	0.058	0.091	0.000	52.09	0.678	23.15	0.036	0.026	128.1	120.5	97.57	25.13	0.867
18:46	12.933	8.221	0.066	0.102	0.000	52.02	0.726	22.80	0.051	0.036	127.4	119.8	96.95	25.04	0.864
19: 3	13.130	8.391	0.065	0.094	0.000	51.84	0.719	22.57	0.048	0.032	126.9	119.2	96.89	25.00	0.863
19:20	13.037	8.476	0.066	0.096	0.000	52.13	0.703	22.38	0.048	0.021	125.6	118.0	96.95	25.05	0.865
19:54	12.564	7.998	0.071	0.102	0.000	52.51	0.781	22.78	0.043	0.027	126.4	119.0	96.88	25.07	0.865
20:11	11.993	7.690	0.060	0.086	0.000	53.95	0.681	22.00	0.044	0.029	120.6	113.6	96.53	25.09	0.866
20:28	12.665	8.141	0.059	0.073	0.000	52.49	0.612	22.71	0.042	0.023	123.9	116.7	96.81	25.07	0.865
20:45	12.961	8.366	0.075	0.079	0.000	52.22	0.672	22.34	0.043	0.018	124.5	117.1	96.78	25.01	0.863
21: 2	12.835	8.631	0.066	0.073	0.000	52.21	0.613	21.94	0.040	0.017	121.9	114.6	96.43	24.99	0.863
22:12	11.997	8.258	0.068	0.066	0.000	53.63	0.570	21.40	0.037	0.015	116.8	110.0	96.04	25.05	0.865
22:29	12.520	8.295	0.068	0.063	0.000	52.32	0.570	22.10	0.042	0.018	120.9	113.8	96.00	24.91	0.860
22:46	12.674	8.311	0.058	0.054	0.000	52.31	0.516	22.14	0.033	0.012	120.3	113.2	96.11	24.90	0.860
23: 3	12.381	8.296	0.058	0.053	0.000	52.45	0.484	22.27	0.033	0.011	119.4	112.5	96.04	24.96	0.862
23:20	12.231	8.246	0.069	0.087	0.000	52.76	0.642	22.15	0.051	0.028	121.7	114.7	96.27	25.05	0.865
23:37	12.762	8.145	0.075	0.108	0.000	51.93	0.817	21.92	0.048	0.029	124.9	117.4	95.84	24.75	0.854
23:54	12.644	8.227	0.074	0.107	0.000	52.40	0.818	21.81	0.046	0.028	124.1	116.6	96.15	24.88	0.859
7/19/1983															
0:11	12.227	8.400	0.067	0.096	0.000	53.15	0.746	21.34	0.043	0.024	120.0	112.9	96.09	25.01	0.863
0:28	12.842	7.795	0.080	0.128	0.000	52.43	0.938	22.24	0.065	0.045	128.6	120.8	96.56	24.87	0.858
0:45	13.256	8.166	0.087	0.145	0.000	52.00	1.053	22.13	0.073	0.049	131.5	123.3	96.95	24.92	0.860
1: 2	13.407	8.349	0.092	0.149	0.000	51.94	1.055	21.82	0.061	0.042	130.7	122.5	96.92	24.89	0.859
1:20	13.032	8.585	0.077	0.085	0.000	52.70	0.720	21.82	0.050	0.025	124.1	116.5	97.09	25.11	0.867
1:37	13.041	8.536	0.070	0.065	0.000	52.73	0.612	21.88	0.043	0.018	122.4	115.0	96.99	25.08	0.866
1:54	12.714	8.277	0.074	0.064	0.000	52.68	0.604	22.17	0.045	0.017	122.2	115.0	96.64	25.03	0.864
2:11	12.493	9.024	0.064	0.052	0.000	54.19	0.483	20.63	0.040	0.014	114.8	107.9	97.00	25.32	0.874
2:28	12.549	8.829	0.048	0.031	0.000	53.82	0.329	21.38	0.028	0.008	114.8	108.0	97.02	25.30	0.873
2:45	11.924	8.652	0.041	0.027	0.000	53.94	0.272	22.08	0.025	0.006	114.1	107.8	96.97	25.42	0.877
3: 2	11.960	6.418	0.048	0.037	0.000	52.64	0.300	25.45	0.028	0.008	125.7	119.3	96.89	25.03	0.864
3:19	12.876	6.733	0.066	0.057	0.000	51.65	0.448	25.03	0.040	0.016	130.0	122.9	96.92	24.84	0.857
3:36	13.196	7.412	0.100	0.084	0.000	51.27	0.670	23.81	0.059	0.025	131.0	123.4	96.63	24.76	0.855
3:53	12.958	7.255	0.102	0.079	0.000	51.93	0.665	23.82	0.052	0.023	130.0	122.5	96.88	24.87	0.858
4:10	12.788	7.202	0.098	0.081	0.157	52.33	0.711	23.16	0.052	0.025	127.8	120.4	96.61	24.83	0.857
4:28	13.351	7.489	0.113	0.089	0.000	51.41	0.793	23.22	0.056	0.027	131.2	123.3	96.55	24.69	0.852

H-2

GAS CHROMATOGRAPH DATA

DATE TIME	H2 %	CO2 %	C2H4 %	C2H6 %	O2 %	N2 %	CH4 %	CO %	C3H6 %	C3H8 %	HHV BTU/SCF	LHV BTU/SCF	TMP %	MW	S.G. WRT AIR

7/19/1983															
4:45	13.495	7.461	0.143	0.128	0.000	51.58	1.063	22.82	0.074	0.041	135.0	126.7	96.81	24.70	0.853
5: 2	13.455	7.434	0.162	0.135	0.000	51.89	1.161	22.42	0.067	0.033	134.7	126.3	96.76	24.68	0.852
5:19	13.955	7.906	0.191	0.145	0.000	51.35	1.264	21.63	0.077	0.036	135.7	126.9	96.56	24.56	0.848
5:36	13.816	7.809	0.210	0.169	0.000	51.94	1.450	21.25	0.108	0.050	137.8	128.7	96.80	24.63	0.850
5:53	13.874	8.221	0.177	0.123	0.000	51.96	1.131	21.14	0.076	0.026	131.6	123.1	96.72	24.69	0.852
6:10	14.004	7.994	0.179	0.129	0.000	51.89	1.186	21.35	0.089	0.035	134.0	125.2	96.85	24.65	0.851
6:27	14.930	8.507	0.173	0.122	0.000	50.99	1.146	20.90	0.084	0.035	134.8	125.6	96.88	24.50	0.846
6:44	14.598	8.622	0.160	0.118	0.000	51.43	1.085	20.73	0.066	0.025	131.6	122.7	96.83	24.60	0.849
7: 1	15.047	8.872	0.142	0.107	0.000	51.04	0.974	20.70	0.071	0.029	131.6	122.6	96.98	24.58	0.848
7:18	14.886	8.792	0.176	0.125	0.000	51.09	1.144	20.65	0.082	0.035	133.9	124.8	96.98	24.59	0.849
7:36	15.093	9.271	0.163	0.120	0.000	51.10	1.069	20.04	0.078	0.034	131.4	122.3	96.97	24.62	0.850
7:53	14.532	9.199	0.196	0.154	0.000	51.44	1.298	19.84	0.096	0.046	133.1	123.9	96.81	24.68	0.852
8:10	14.016	8.612	0.219	0.158	0.405	52.54	1.422	19.45	0.096	0.046	131.9	122.8	96.96	24.77	0.855
8:27	14.302	8.470	0.256	0.154	0.000	51.66	1.503	20.33	0.091	0.035	136.6	127.3	96.81	24.60	0.849
8:45	15.015	9.034	0.276	0.149	0.000	51.26	1.555	19.50	0.090	0.033	136.9	127.2	96.91	24.53	0.847
9: 2	15.260	10.600	0.260	0.144	0.000	51.51	1.466	17.21	0.099	0.039	129.5	119.7	96.59	24.64	0.850
9:20	13.516	10.570	0.307	0.113	0.000	53.38	1.380	17.09	0.086	0.025	122.1	113.4	96.47	25.06	0.865
9:37	12.883	10.326	0.260	0.083	0.000	54.52	1.129	17.51	0.064	0.017	116.9	108.8	96.79	25.30	0.873
9:54	12.960	10.242	0.320	0.106	0.000	54.11	1.439	17.00	0.078	0.019	120.4	111.8	96.27	25.08	0.866
10:11	14.002	9.827	0.287	0.185	0.408	53.79	1.799	16.34	0.082	0.046	126.9	117.3	96.77	24.86	0.858
10:28	11.922	12.263	0.374	0.141	0.000	56.91	1.683	13.12	0.113	0.034	109.7	101.3	96.56	25.74	0.888
10:46	14.014	10.463	0.379	0.258	0.000	53.87	2.283	15.04	0.125	0.070	132.0	121.7	96.50	24.82	0.857
11: 3	13.887	11.250	0.444	0.220	0.000	54.71	2.294	13.10	0.127	0.051	125.5	115.2	96.08	24.86	0.858
11:20	15.107	10.803	0.401	0.233	0.000	53.35	2.379	14.00	0.146	0.068	133.6	122.6	96.49	24.58	0.849
11:37	15.740	10.689	0.339	0.188	0.000	52.62	2.045	14.66	0.104	0.041	130.9	120.1	96.42	24.41	0.843
11:55	15.409	11.390	0.265	0.138	0.000	53.16	1.566	14.12	0.091	0.027	120.6	110.6	96.17	24.59	0.849
12:12	13.522	11.960	0.243	0.082	0.000	55.12	1.208	13.78	0.071	0.010	107.5	99.0	95.99	25.16	0.868
12:29	13.650	10.981	0.258	0.108	0.000	54.39	1.323	15.27	0.077	0.019	114.9	106.2	96.08	24.98	0.862
12:46	14.461	11.305	0.268	0.139	0.000	53.26	1.459	14.67	0.091	0.028	118.3	108.9	95.68	24.70	0.853
13: 4	14.988	9.541	0.292	0.159	0.000	51.87	1.646	17.20	0.091	0.035	130.9	121.0	95.83	24.30	0.839
13:21	15.485	9.879	0.298	0.174	0.000	50.73	1.717	17.11	0.110	0.037	133.8	123.5	95.54	24.14	0.833
13:38	15.897	9.569	0.419	0.166	0.000	49.93	2.017	17.45	0.115	0.031	141.0	130.1	95.60	23.96	0.827
13:56	15.889	9.811	0.328	0.147	0.000	50.51	1.740	17.08	0.106	0.034	135.1	124.6	95.65	24.05	0.830
14:34	16.009	10.208	0.280	0.160	0.000	51.81	1.608	17.85	0.099	0.032	135.8	125.5	98.06	24.77	0.855
14:52	16.369	9.802	0.276	0.157	0.000	51.47	1.603	18.19	0.086	0.032	137.6	127.1	97.98	24.59	0.849
15: 9	16.977	9.317	0.280	0.159	0.000	50.98	1.687	18.97	0.095	0.035	143.3	132.4	98.50	24.49	0.845
15:26	16.990	10.124	0.278	0.173	0.000	51.71	1.762	18.00	0.091	0.038	141.2	130.2	99.17	24.80	0.856
15:44	16.866	10.795	0.292	0.171	0.000	52.08	1.797	16.68	0.081	0.037	136.8	125.9	98.80	24.83	0.857
16: 1	16.742	10.872	0.306	0.187	0.000	52.70	1.887	16.46	0.101	0.040	137.7	126.6	99.29	25.00	0.863
16:18	16.724	10.559	0.289	0.152	0.000	52.24	1.656	17.47	0.101	0.037	137.6	126.8	99.22	24.96	0.862
18: 6	16.835	10.131	0.138	0.140	0.661	52.80	1.351	17.24	0.059	0.047	130.8	120.5	99.40	24.97	0.862
18:23	15.890	10.306	0.215	0.139	0.000	52.36	1.461	18.07	0.080	0.039	133.0	123.0	98.56	24.97	0.862
18:40	15.927	10.523	0.213	0.136	0.000	52.24	1.452	17.33	0.082	0.037	130.5	120.5	97.93	24.83	0.857
18:58	15.701	10.774	0.200	0.128	0.000	52.78	1.409	17.20	0.066	0.022	127.9	118.1	98.28	25.02	0.864
19:15	16.117	10.542	0.204	0.150	0.000	52.60	1.489	17.52	0.073	0.035	132.0	121.9	98.73	25.00	0.863
19:32	16.180	10.384	0.223	0.153	0.000	52.04	1.564	17.87	0.069	0.035	134.4	124.1	98.52	24.89	0.859

H-3

GAS CHROMATOGRAPH DATA

DATE TIME	H2 %	CO2 %	C2H4 %	C2H6 %	O2 %	N2 %	CH4 %	CO %	C3H6 %	C3H8 %	HHV BTU/SCF	LHV BTU/SCF	TMP %	MW	S.G. WRT AIR

7/19/1983

19:49	15.650	10.879	0.210	0.142	0.000	53.01	1.489	16.88	0.069	0.032	128.2	118.3	98.36	25.07	0.865
20: 6	14.615	10.628	0.184	0.130	0.408	54.98	1.353	16.04	0.064	0.030	120.0	110.8	98.43	25.35	0.875
20:23	15.590	11.037	0.207	0.131	0.000	53.44	1.419	16.58	0.071	0.028	126.0	116.3	98.50	25.15	0.868
20:40	14.604	11.594	0.190	0.129	0.000	54.56	1.314	15.55	0.079	0.034	118.5	109.3	98.05	25.39	0.876
20:57	14.622	11.729	0.187	0.133	0.000	54.34	1.318	15.19	0.069	0.030	117.2	108.0	97.62	25.28	0.873
21:14	14.941	11.188	0.219	0.146	0.000	54.08	1.518	15.94	0.077	0.033	123.6	114.0	98.14	25.24	0.871
21:31	14.692	11.572	0.223	0.124	0.000	54.42	1.420	15.49	0.069	0.026	119.7	110.4	98.03	25.34	0.875
21:48	15.361	11.073	0.186	0.131	0.000	53.05	1.387	16.68	0.060	0.031	124.8	115.2	97.96	25.07	0.865
22: 5	15.342	11.169	0.184	0.138	0.000	53.70	1.413	16.49	0.061	0.034	124.5	114.9	98.52	25.25	0.871
22:22	15.006	11.621	0.185	0.143	0.000	54.28	1.444	15.50	0.056	0.035	120.6	111.2	98.27	25.33	0.874
22:39	15.609	10.824	0.181	0.161	0.000	52.69	1.503	16.92	0.067	0.040	128.4	118.5	97.99	24.97	0.862
22:56	16.451	10.093	0.177	0.153	0.000	51.56	1.450	18.46	0.066	0.038	135.2	125.0	98.45	24.76	0.855
23:13	16.050	10.170	0.184	0.151	0.000	51.63	1.439	18.30	0.068	0.037	133.4	123.4	98.02	24.76	0.855
23:30	15.537	10.744	0.191	0.152	0.000	52.68	1.470	16.93	0.068	0.038	127.8	118.0	97.81	24.92	0.860
23:47	15.287	11.308	0.197	0.149	0.000	53.44	1.490	15.75	0.069	0.036	123.4	113.7	97.72	25.05	0.865

7/20/1983

0: 4	14.909	11.620	0.193	0.145	0.000	54.20	1.465	14.79	0.078	0.041	119.1	109.6	97.44	25.13	0.867
0:21	14.494	11.921	0.200	0.140	0.000	54.99	1.471	14.23	0.077	0.039	115.9	106.6	97.56	25.31	0.874
0:39	14.378	12.360	0.185	0.141	0.000	55.67	1.412	13.58	0.077	0.041	112.7	103.5	97.84	25.50	0.880
0:56	14.226	12.303	0.170	0.138	0.000	55.88	1.350	13.64	0.062	0.034	110.9	102.0	97.80	25.52	0.881
1:13	14.491	10.940	0.159	0.130	0.000	55.71	1.297	15.10	0.065	0.039	115.8	106.8	97.92	25.28	0.873
1:31	15.143	11.252	0.172	0.127	0.000	53.99	1.298	15.94	0.056	0.030	120.4	111.0	98.01	25.18	0.869
1:48	14.927	11.140	0.182	0.125	0.000	53.99	1.302	16.17	0.052	0.029	120.5	111.2	97.91	25.19	0.870
2: 5	14.541	11.687	0.201	0.129	0.000	54.73	1.386	14.88	0.056	0.030	116.4	107.3	97.64	25.29	0.873
2:22	14.597	11.692	0.194	0.126	0.000	54.39	1.372	15.00	0.064	0.035	117.0	107.8	97.47	25.23	0.871
2:39	14.570	11.714	0.185	0.135	0.000	54.34	1.382	14.90	0.068	0.039	116.9	107.7	97.33	25.21	0.870
2:56	14.015	12.074	0.201	0.138	0.000	55.56	1.431	13.95	0.060	0.033	112.5	103.5	97.46	25.44	0.878
3:14	13.273	12.998	0.223	0.141	0.000	57.03	1.491	12.21	0.076	0.039	106.1	97.3	97.48	25.78	0.890
3:31	12.922	12.810	0.210	0.146	0.000	57.26	1.489	12.60	0.065	0.036	105.7	97.2	97.54	25.85	0.892
3:48	12.850	13.539	0.201	0.144	0.000	58.20	1.464	11.23	0.060	0.036	100.5	92.1	97.72	26.04	0.899
4:39	12.626	13.125	0.213	0.142	0.000	58.50	1.490	11.40	0.068	0.033	100.9	92.5	97.60	26.00	0.897
4:56	12.956	13.096	0.214	0.145	0.000	57.83	1.486	11.68	0.070	0.034	103.0	94.4	97.51	25.88	0.893
5:13	12.663	12.955	0.231	0.132	0.000	58.31	1.497	11.92	0.068	0.029	102.8	94.4	97.81	26.02	0.898
5:31	12.919	12.760	0.189	0.126	0.000	57.52	1.389	12.60	0.057	0.030	103.6	95.3	97.59	25.87	0.893
5:48	13.189	12.393	0.182	0.131	0.000	57.35	1.356	13.24	0.059	0.031	106.3	97.8	97.92	25.84	0.892
6: 5	12.885	11.904	0.169	0.116	0.218	57.90	1.253	13.24	0.054	0.027	103.6	95.4	97.76	25.81	0.891
6:24	13.608	12.095	0.171	0.120	0.000	56.75	1.268	14.03	0.054	0.029	108.8	100.2	98.13	25.75	0.889
6:42	13.131	12.136	0.180	0.127	0.000	57.03	1.318	13.77	0.056	0.029	107.2	98.8	97.78	25.78	0.890
6:59	12.793	12.889	0.176	0.126	0.000	57.84	1.306	12.44	0.058	0.030	101.7	93.5	97.66	25.95	0.896
7:16	12.930	12.562	0.173	0.134	0.000	57.68	1.320	13.03	0.070	0.040	104.8	96.5	97.95	25.95	0.896
7:33	12.655	12.778	0.197	0.140	0.000	58.23	1.406	12.19	0.080	0.039	102.8	94.5	97.71	25.98	0.897
7:50	12.458	12.888	0.199	0.134	0.000	58.49	1.354	12.30	0.079	0.038	101.9	93.7	97.94	26.12	0.902
8: 7	11.837	12.817	0.192	0.111	0.000	60.07	1.246	11.69	0.058	0.024	95.4	87.8	98.04	26.30	0.908
8:25	12.351	12.937	0.206	0.115	0.000	58.69	1.306	12.25	0.063	0.024	99.9	91.9	97.94	26.16	0.903

GAS CHROMATOGRAPH DATA

DATE TIME	H2 %	CO2 %	C2H4 %	C2H6 %	O2 %	N2 %	CH4 %	CO %	C3H6 %	C3H8 %	HHV BTU/SCF	LHV BTU/SCF	TMP %	MW	S.G. WRT AIR

7/20/1983															
8:42	12.405	13.119	0.200	0.121	0.000	58.80	1.335	11.77	0.066	0.025	99.0	90.9	97.84	26.14	0.902
9: 0	12.068	13.260	0.193	0.115	0.000	59.56	1.255	11.39	0.068	0.030	95.8	88.0	97.94	26.29	0.907
9:17	12.352	12.962	0.194	0.119	0.000	58.79	1.237	12.17	0.064	0.025	98.9	91.0	97.91	26.16	0.903
9:35	12.826	12.385	0.183	0.119	0.000	57.67	1.229	13.43	0.062	0.025	104.2	96.1	97.93	25.95	0.896
9:52	12.618	12.088	0.180	0.121	0.000	57.59	1.205	13.94	0.063	0.026	104.9	96.9	97.83	25.93	0.895
10: 9	13.985	11.264	0.183	0.115	0.000	55.91	1.229	15.22	0.068	0.029	113.9	105.1	98.00	25.49	0.880
10:26	14.049	11.078	0.218	0.128	0.000	55.38	1.325	15.74	0.060	0.027	117.3	108.4	98.01	25.43	0.878
10:43	14.104	11.273	0.203	0.137	0.000	55.57	1.407	15.19	0.063	0.031	116.6	107.6	97.98	25.43	0.878
11: 1	13.581	11.719	0.212	0.136	0.000	56.23	1.389	14.31	0.081	0.036	112.6	103.8	97.70	25.57	0.883
11:18	13.620	12.038	0.214	0.144	0.000	56.70	1.457	13.81	0.086	0.038	112.1	103.2	98.10	25.72	0.888
11:35	13.508	11.971	0.201	0.131	0.000	56.74	1.358	13.88	0.069	0.028	109.9	101.2	97.89	25.68	0.886
11:53	13.653	11.840	0.204	0.130	0.000	56.62	1.333	14.20	0.076	0.034	111.5	102.7	98.09	25.68	0.887
12:10	13.409	11.539	0.186	0.128	0.143	57.38	1.317	14.27	0.059	0.028	109.9	101.3	98.46	25.81	0.891
12:27	14.310	11.562	0.205	0.131	0.000	55.81	1.356	15.13	0.062	0.028	116.4	107.3	98.59	25.60	0.884
12:45	14.364	11.181	0.189	0.122	0.000	55.38	1.274	15.86	0.059	0.027	117.5	108.6	98.46	25.50	0.880
13: 2	14.539	10.990	0.201	0.123	0.000	55.17	1.280	16.08	0.062	0.027	119.2	110.1	98.48	25.43	0.878
13:19	14.301	10.883	0.207	0.131	0.000	55.07	1.359	16.27	0.057	0.030	120.0	111.0	98.31	25.42	0.877
13:36	13.600	11.323	0.213	0.132	0.000	56.05	1.371	15.38	0.064	0.030	115.3	106.5	98.16	25.63	0.885
13:54	13.411	11.332	0.253	0.158	0.131	56.92	1.595	13.89	0.074	0.038	113.7	104.7	97.80	25.56	0.882
15:38	13.607	11.466	0.221	0.114	0.000	55.89	1.274	15.13	0.073	0.028	113.5	104.9	97.81	25.56	0.882
15:55	13.671	11.595	0.229	0.124	0.000	55.85	1.339	14.87	0.065	0.025	113.5	104.8	97.77	25.54	0.882
16:13	13.668	11.699	0.226	0.117	0.000	56.22	1.325	14.56	0.066	0.024	112.3	103.6	97.91	25.60	0.884
18:27	13.163	11.831	0.209	0.098	0.000	57.35	1.148	14.21	0.066	0.025	107.1	98.9	98.11	25.83	0.892
18:44	13.787	11.415	0.239	0.120	0.000	55.78	1.320	15.07	0.082	0.032	115.0	106.2	97.85	25.52	0.881
19: 1	14.210	11.080	0.225	0.129	0.000	55.31	1.360	15.43	0.073	0.028	117.6	108.6	97.85	25.34	0.875
19:18	14.038	11.304	0.218	0.135	0.000	55.64	1.373	14.92	0.076	0.029	115.6	106.7	97.74	25.39	0.877
19:35	13.779	11.578	0.226	0.146	0.000	56.00	1.401	14.53	0.082	0.031	114.3	105.4	97.78	25.51	0.881
19:52	13.375	11.739	0.216	0.141	0.000	56.33	1.380	14.20	0.080	0.030	111.4	102.8	97.50	25.57	0.883
20: 9	12.309	11.838	0.200	0.137	0.383	59.00	1.319	12.49	0.070	0.030	101.3	93.3	97.78	25.96	0.896
20:26	13.587	11.367	0.209	0.128	0.000	55.98	1.300	14.95	0.066	0.027	113.0	104.3	97.61	25.49	0.880
20:43	13.220	11.693	0.215	0.132	0.000	56.25	1.339	14.32	0.072	0.028	110.5	101.9	97.27	25.54	0.882
21:17	13.695	11.876	0.221	0.142	0.000	56.03	1.409	13.96	0.072	0.030	111.9	103.1	97.44	25.48	0.880
21:34	14.115	11.436	0.207	0.130	0.000	55.29	1.329	14.73	0.069	0.028	114.3	105.4	97.33	25.29	0.873
21:40	13.402	11.899	0.219	0.137	0.000	56.35	1.348	14.07	0.069	0.029	110.5	101.9	97.52	25.60	0.884
21:52	13.937	11.320	0.218	0.131	0.000	55.14	1.361	15.03	0.079	0.034	115.7	106.8	97.25	25.29	0.873
22: 9	12.922	11.568	0.211	0.117	0.000	57.35	1.293	13.56	0.062	0.024	105.9	97.7	97.10	25.55	0.882
22:26	13.620	11.697	0.223	0.113	0.000	55.49	1.281	14.53	0.066	0.022	111.4	102.7	97.03	25.38	0.876
22:43	13.589	11.397	0.210	0.111	0.000	55.67	1.244	14.79	0.056	0.023	111.3	102.7	97.09	25.35	0.875
23:17	13.907	11.172	0.222	0.117	0.000	54.96	1.308	15.18	0.068	0.023	114.8	106.0	96.95	25.19	0.870
23:34	13.400	11.432	0.214	0.114	0.000	55.61	1.230	14.82	0.066	0.023	110.9	102.5	96.91	25.36	0.875
23:40	13.600	11.531	0.224	0.123	0.000	55.48	1.318	14.62	0.071	0.025	112.4	103.7	96.99	25.34	0.875
23:51	13.395	11.400	0.213	0.115	0.000	55.51	1.235	14.77	0.063	0.023	110.8	102.3	96.72	25.31	0.874

7/21/1983

0: 8	13.520	11.108	0.220	0.117	0.000	55.61	1.321	14.51	0.065	0.023	111.4	102.8	96.50	25.15	0.868
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GAS CHROMATOGRAPH DATA

DATE TIME	H2 %	CO2 %	C2H4 %	C2H6 %	O2 %	N2 %	CH4 %	CO %	C3H6 %	C3H8 %	HHV BTU/SCF	LHV BTU/SCF	TMP %	MW	S.G. WRT AIR

7/21/1983															
0:25	13.914	10.764	0.231	0.121	0.000	54.20	1.322	15.77	0.072	0.024	117.2	108.3	96.41	24.97	0.862
0:42	14.075	10.655	0.225	0.122	0.000	54.17	1.284	16.05	0.068	0.024	118.0	109.2	96.67	24.99	0.863
0:59	14.607	10.158	0.234	0.128	0.000	53.20	1.358	16.83	0.078	0.025	123.5	114.3	96.61	24.75	0.854
1:17	14.652	10.332	0.250	0.146	0.000	53.18	1.446	16.55	0.081	0.030	124.4	115.0	96.66	24.77	0.855
1:35	14.550	10.543	0.233	0.144	0.000	53.65	1.426	16.14	0.080	0.030	122.2	112.9	96.79	24.87	0.858
1:52	14.606	10.530	0.241	0.146	0.000	53.56	1.441	16.13	0.083	0.030	122.8	113.4	96.76	24.84	0.858
2:26	14.279	11.201	0.244	0.140	0.000	54.74	1.428	15.48	0.075	0.028	119.2	110.0	97.62	25.27	0.872
2:43	14.712	10.894	0.247	0.135	0.000	54.00	1.423	15.93	0.077	0.027	122.0	112.6	97.45	25.07	0.865
3: 0	14.893	10.877	0.246	0.133	0.000	53.99	1.446	15.89	0.076	0.027	122.6	113.1	97.57	25.05	0.865
3:17	15.186	10.648	0.250	0.134	0.000	53.46	1.426	16.38	0.088	0.032	125.4	115.8	97.60	24.95	0.861
3:34	15.102	10.609	0.244	0.136	0.000	53.54	1.403	16.43	0.074	0.027	124.6	115.0	97.57	24.95	0.861
3:52	14.728	10.625	0.251	0.131	0.000	53.80	1.377	16.34	0.073	0.025	122.7	113.4	97.35	25.00	0.863
4: 9	13.229	10.274	0.207	0.118	0.274	56.65	1.253	15.28	0.076	0.028	112.4	104.0	97.39	25.37	0.876
4:26	14.686	10.755	0.259	0.135	0.000	54.17	1.451	15.95	0.076	0.026	122.4	113.0	97.51	25.06	0.865
4:43	14.636	11.069	0.272	0.138	0.000	54.33	1.497	15.20	0.078	0.027	120.6	111.2	97.25	25.05	0.865
5:17	14.286	11.347	0.258	0.137	0.000	55.04	1.410	14.71	0.083	0.026	116.9	107.7	97.29	25.21	0.870
5:35	14.105	11.620	0.269	0.137	0.000	55.46	1.447	14.15	0.089	0.024	115.1	106.0	97.30	25.30	0.873
5:40	14.535	11.149	0.255	0.137	0.000	54.46	1.411	15.07	0.086	0.026	118.9	109.6	97.13	25.06	0.865
5:52	13.897	11.941	0.290	0.153	0.000	55.70	1.574	13.53	0.092	0.029	114.6	105.4	97.21	25.36	0.875
6: 9	12.838	11.952	0.269	0.144	0.000	57.78	1.503	12.73	0.089	0.028	107.2	98.7	97.33	25.68	0.886
6:26	14.626	11.626	0.301	0.160	0.000	54.61	1.666	14.19	0.109	0.038	120.9	111.1	97.32	25.15	0.868
6:43	14.761	11.073	0.303	0.155	0.000	54.16	1.653	15.07	0.106	0.036	123.9	114.1	97.32	25.02	0.864
7:17	15.299	10.856	0.291	0.160	0.000	53.35	1.650	15.59	0.092	0.032	126.7	116.7	97.32	24.85	0.858
7:35	15.299	10.679	0.274	0.154	0.000	53.35	1.607	15.90	0.088	0.031	126.8	116.9	97.38	24.84	0.857
7:40	15.130	10.977	0.278	0.166	0.000	53.51	1.646	15.48	0.108	0.042	126.3	116.3	97.34	24.92	0.860
7:52	15.421	10.415	0.241	0.134	0.000	53.07	1.461	16.51	0.075	0.027	126.4	116.6	97.35	24.77	0.855
8: 9	14.888	10.371	0.242	0.121	0.000	53.88	1.416	16.32	0.075	0.022	123.2	113.8	97.33	24.90	0.860
8:26	15.227	10.560	0.231	0.116	0.000	53.16	1.330	16.53	0.080	0.026	124.1	114.6	97.26	24.84	0.857
8:44	14.665	10.938	0.227	0.120	0.000	53.97	1.318	15.89	0.075	0.022	119.9	110.7	97.23	25.04	0.864
9: 1	14.692	10.652	0.220	0.117	0.000	53.85	1.248	16.36	0.068	0.022	120.4	111.3	97.23	24.99	0.863
9:19	14.597	10.425	0.255	0.125	0.000	53.86	1.327	16.57	0.079	0.022	122.6	113.4	97.26	24.98	0.862
9:36	14.654	10.407	0.255	0.117	0.000	53.81	1.282	16.73	0.084	0.018	122.7	113.5	97.36	24.99	0.863
9:53	14.653	9.968	0.224	0.112	0.000	53.41	1.201	17.66	0.687	0.019	138.4	128.4	97.93	25.18	0.869
10:10	13.863	9.980	0.207	0.108	0.000	55.31	1.196	16.70	0.066	0.019	117.8	109.2	97.45	25.16	0.869
10:27	14.965	9.706	0.246	0.108	0.000	52.99	1.235	18.05	0.075	0.017	126.9	117.7	97.39	24.81	0.857
10:45	14.984	9.759	0.270	0.118	0.000	53.20	1.353	17.65	0.081	0.019	127.6	118.2	97.43	24.81	0.857
11: 2	14.446	9.946	0.295	0.129	0.000	53.87	1.469	17.11	0.085	0.021	126.1	116.8	97.37	24.96	0.861
11:19	14.253	10.455	0.312	0.125	0.000	54.05	1.469	16.57	0.095	0.020	124.1	114.8	97.34	25.08	0.866
11:36	14.292	10.307	0.303	0.138	0.000	54.21	1.508	16.27	0.097	0.024	123.9	114.6	97.15	24.99	0.863
11:54	14.048	10.879	0.323	0.126	0.000	54.69	1.524	15.60	0.091	0.019	121.0	111.8	97.30	25.18	0.869
12:11	14.172	10.944	0.337	0.137	0.000	54.65	1.625	15.27	0.094	0.023	121.9	112.5	97.26	25.14	0.868
12:28	14.561	10.389	0.323	0.131	0.000	53.92	1.550	16.32	0.096	0.021	125.5	116.0	97.31	24.97	0.862
12:45	14.067	10.338	0.309	0.157	0.000	55.20	1.638	15.66	0.120	0.035	123.8	114.3	97.53	25.15	0.868
13: 3	14.630	10.290	0.321	0.137	0.000	54.30	1.562	16.18	0.092	0.023	125.4	115.8	97.53	25.00	0.863
13:20	14.188	10.727	0.309	0.127	0.000	54.21	1.456	16.09	0.095	0.020	122.2	113.0	97.22	25.11	0.867
13:37	14.088	10.824	0.303	0.134	0.000	54.42	1.477	15.80	0.097	0.022	121.3	112.1	97.17	25.13	0.868

GAS CHROMATOGRAPH DATA

DATE TIME	H2 %	CO2 %	C2H4 %	C2H6 %	O2 %	N2 %	CH4 %	CO %	C3H6 %	C3H8 %	HHV BTU/SCF	LHV BTU/SCF	TMP %	MW	S.G. WRT AIR

7/21/1983															
13:55	14.719	10.896	0.322	0.151	0.000	53.91	1.625	15.50	0.107	0.027	124.8	115.1	97.25	24.99	0.863
14:12	15.354	10.360	0.291	0.150	0.000	52.86	1.594	16.45	0.092	0.028	128.8	118.8	97.17	24.72	0.853
14:47	15.183	10.223	0.242	0.139	0.000	53.25	1.383	16.61	0.088	0.026	125.5	116.0	97.15	24.76	0.855
15: 4	15.433	10.485	0.257	0.142	0.000	53.12	1.392	16.28	0.094	0.027	125.8	116.1	97.23	24.76	0.855
15:21	15.078	10.743	0.236	0.131	0.000	53.68	1.312	15.92	0.076	0.025	121.7	112.3	97.19	24.89	0.859
15:38	14.859	10.592	0.234	0.136	0.000	54.06	1.359	15.79	0.084	0.026	121.3	111.9	97.14	24.90	0.860
15:56	15.342	10.529	0.248	0.130	0.000	53.10	1.337	16.34	0.077	0.024	124.3	114.7	97.13	24.77	0.855
18: 2	14.831	12.074	0.291	0.144	0.000	55.46	1.466	13.71	0.095	0.027	116.9	107.4	98.09	25.40	0.877
18:19	14.029	11.876	0.262	0.128	0.000	56.24	1.348	13.41	0.100	0.031	111.7	102.7	97.42	25.40	0.877
18:36	14.552	11.681	0.280	0.125	0.000	54.59	1.370	14.13	0.085	0.022	115.6	106.3	96.84	25.07	0.865
18:53	15.212	11.277	0.326	0.138	0.000	53.58	1.536	14.59	0.096	0.023	122.1	112.3	96.78	24.80	0.856
19:10	15.351	10.992	0.304	0.145	0.000	53.26	1.501	15.00	0.100	0.026	123.5	113.6	96.68	24.69	0.852
19:27	15.246	10.733	0.303	0.147	0.000	53.48	1.523	15.06	0.101	0.025	123.6	113.7	96.62	24.66	0.851
20: 2	14.992	10.507	0.299	0.135	0.000	54.79	1.451	15.42	0.093	0.023	122.6	113.0	97.71	25.00	0.863
20:19	15.267	10.363	0.342	0.138	0.000	52.85	1.509	16.20	0.108	0.021	127.7	117.8	96.79	24.65	0.851
20:36	15.485	10.689	0.327	0.138	0.000	53.29	1.527	16.17	0.104	0.022	128.1	118.1	97.75	24.91	0.860
20:53	15.399	10.834	0.348	0.152	0.000	53.34	1.611	16.02	0.110	0.025	129.0	119.0	97.84	24.97	0.862
21:10	15.483	11.016	0.356	0.149	0.000	53.24	1.639	15.64	0.121	0.031	128.9	118.7	97.67	24.93	0.860
21:27	15.593	11.224	0.313	0.143	0.000	53.31	1.525	15.49	0.101	0.025	126.2	116.1	97.73	24.96	0.862
21:44	15.559	11.183	0.292	0.144	0.000	53.38	1.471	15.52	0.100	0.024	125.2	115.3	97.68	24.95	0.861
22: 1	15.616	11.171	0.287	0.142	0.000	53.53	1.451	15.44	0.098	0.023	124.8	114.9	97.76	24.96	0.862
7/22/1983															
3:28	14.523	11.620	0.352	0.122	0.000	54.59	1.561	14.42	0.088	0.016	119.4	109.8	97.30	25.17	0.869
3:46	14.870	11.560	0.360	0.143	0.000	54.19	1.657	14.84	0.098	0.020	123.7	113.8	97.74	25.19	0.869
4: 4	14.286	11.361	0.349	0.152	0.000	55.55	1.697	13.74	0.097	0.021	118.6	109.0	97.26	25.17	0.869
4:22	15.255	11.414	0.352	0.157	0.000	53.38	1.712	15.08	0.103	0.023	126.5	116.4	97.48	24.98	0.862
4:39	15.255	11.237	0.321	0.148	0.000	53.45	1.620	15.66	0.098	0.023	126.7	116.7	97.81	25.06	0.865
4:57	15.732	10.707	0.338	0.144	0.000	52.42	1.622	17.00	0.097	0.020	132.6	122.4	98.08	24.92	0.860
5:15	15.806	10.762	0.336	0.143	0.000	52.29	1.629	16.92	0.091	0.019	132.5	122.2	98.00	24.89	0.859
5:33	15.709	10.726	0.317	0.123	0.000	52.50	1.473	16.62	0.085	0.015	128.7	118.8	97.57	24.81	0.856
5:50	16.033	10.814	0.321	0.141	0.000	54.20	1.570	14.31	0.089	0.020	123.9	113.7	97.50	24.71	0.853
6: 8	16.094	10.727	0.340	0.137	0.000	54.11	1.590	15.00	0.087	0.018	126.7	116.4	98.10	24.84	0.858
6:26	14.885	10.891	0.354	0.156	0.000	54.27	1.730	14.55	0.098	0.022	123.7	113.7	96.96	24.85	0.858
6:44	16.092	10.729	0.353	0.151	0.000	52.21	1.702	15.98	0.097	0.021	131.7	121.2	97.33	24.62	0.850
7: 1	15.258	11.486	0.360	0.150	0.000	54.12	1.692	14.07	0.103	0.020	123.0	112.9	97.26	24.93	0.861
7:37	15.244	11.389	0.348	0.149	0.835	55.30	1.665	13.56	0.099	0.020	120.7	110.7	98.61	25.34	0.875
7:55	15.364	11.699	0.321	0.151	0.000	53.96	1.588	13.63	0.098	0.022	120.2	110.2	96.84	24.84	0.857
8:12	15.510	11.331	0.302	0.135	0.000	53.33	1.537	15.03	0.085	0.019	123.7	113.8	97.28	24.87	0.858
8:30	15.395	11.259	0.313	0.132	0.000	53.20	1.529	15.28	0.099	0.017	124.5	114.6	97.23	24.87	0.859
8:48	15.573	11.237	0.333	0.145	0.000	53.11	1.626	14.52	0.098	0.020	124.2	114.0	96.66	24.65	0.851
9: 6	15.646	10.939	0.313	0.133	0.000	52.84	1.526	14.52	0.088	0.018	122.6	112.6	96.02	24.42	0.843
9:24	15.811	10.719	0.323	0.137	0.000	51.84	1.545	15.44	0.092	0.017	126.6	116.4	95.92	24.31	0.839
9:41	15.499	10.877	0.307	0.129	0.000	52.12	1.473	14.85	0.086	0.017	122.4	112.5	95.36	24.27	0.838
9:59	15.407	10.810	0.303	0.138	0.000	51.95	1.521	14.50	0.089	0.020	121.7	111.8	94.73	24.10	0.832

GAS CHROMATOGRAPH DATA

DATE H2 CO2 C2H4 C2H6 O2 N2 CH4 CO C3H6 C3H8 HHV LHV TMP MW S.G.
 TIME % % % % % % % % % % % BTU/SCF % WRT AIR

7/22/1983

10:17	15.364	11.036	0.332	0.149	0.996	54.71	1.645	14.29	0.094	0.021	122.9	112.9	98.64	25.27	0.872
10:35	15.781	10.962	0.328	0.151	0.186	52.96	1.621	14.16	0.096	0.020	123.6	113.4	96.27	24.46	0.844
10:54	16.337	10.801	0.334	0.159	0.920	53.14	1.646	15.20	0.098	0.024	129.4	118.8	98.66	24.98	0.862
11:12	16.910	10.489	0.312	0.158	0.930	52.40	1.637	14.29	0.091	0.025	127.7	116.9	97.24	24.38	0.842
11:30	16.859	10.463	0.303	0.150	0.153	51.62	1.597	13.41	0.088	0.023	123.9	113.2	94.67	23.65	0.816
11:48	16.713	10.668	0.317	0.150	0.888	52.96	1.547	13.96	0.094	0.021	125.0	114.4	97.32	24.49	0.846
12: 7	15.580	10.845	0.282	0.137	0.232	54.28	1.423	15.90	0.079	0.019	125.1	115.3	98.79	25.21	0.870
12:25	16.608	10.638	0.331	0.152	0.181	52.42	1.548	15.47	0.097	0.020	129.8	119.3	97.46	24.53	0.847
12:43	16.636	10.382	0.338	0.146	0.170	52.09	1.588	16.27	0.093	0.020	132.8	122.2	97.73	24.55	0.847
13:18	16.674	10.498	0.337	0.148	0.176	51.98	1.575	16.47	0.097	0.020	133.6	122.9	97.97	24.63	0.850
13:36	16.335	10.510	0.345	0.142	0.180	52.49	1.549	17.39	0.097	0.017	135.1	124.7	99.06	25.03	0.864
13:40	16.764	10.305	0.346	0.152	0.177	51.99	1.595	17.06	0.099	0.020	136.2	125.5	98.51	24.72	0.853
13:54	16.165	10.390	0.343	0.143	0.182	52.00	1.538	18.06	0.100	0.018	136.7	126.3	98.94	25.02	0.864
14:12	15.587	11.004	0.321	0.128	0.187	53.10	1.505	17.09	0.089	0.016	130.5	120.5	99.03	25.30	0.873
14:30	15.223	11.085	0.356	0.130	0.195	53.44	1.555	17.13	0.094	0.014	130.6	120.7	99.22	25.45	0.879
14:48	15.381	10.967	0.361	0.145	0.217	52.88	1.595	17.63	0.098	0.018	133.6	123.6	99.29	25.41	0.877
15: 6	15.316	11.125	0.380	0.151	0.198	52.89	1.672	17.02	0.106	0.019	132.9	122.7	98.88	25.33	0.874
15:24	15.287	11.054	0.379	0.152	0.188	52.73	1.664	17.73	0.106	0.019	134.9	124.8	99.31	25.44	0.878
15:42	15.541	10.554	0.351	0.145	0.197	51.85	1.554	19.25	0.096	0.019	138.7	128.7	99.56	25.38	0.876
16:18	15.471	10.434	0.342	0.145	0.265	51.85	1.494	19.51	0.096	0.020	138.6	128.7	99.63	25.41	0.877
16:40	15.719	10.431	0.336	0.145	0.210	51.68	1.538	19.40	0.094	0.020	139.4	129.2	99.57	25.32	0.874
18:34	14.528	11.224	0.486	0.124	0.000	53.78	1.965	15.56	0.098	0.013	129.4	119.4	97.78	25.19	0.870
18:52	14.269	11.202	0.361	0.071	0.000	54.41	1.460	16.04	0.047	0.004	120.7	111.6	97.86	25.33	0.874
19:10	12.736	12.252	0.515	0.140	0.000	56.49	1.997	13.47	0.112	0.014	118.4	109.1	97.73	25.81	0.891
19:28	16.035	10.924	0.488	0.149	0.000	52.26	2.094	15.77	0.109	0.015	137.1	126.1	97.85	24.76	0.855
19:47	16.263	10.568	0.490	0.191	0.000	51.37	2.177	16.53	0.135	0.027	142.8	131.5	97.75	24.61	0.850
20: 5	15.143	10.706	0.267	0.078	0.000	53.45	1.239	17.01	0.050	0.006	123.1	113.9	97.95	25.08	0.866
20:23	15.142	10.998	0.572	0.199	0.000	52.83	2.338	15.60	0.142	0.024	139.3	128.3	97.84	24.98	0.862
20:40	17.560	9.902	0.459	0.221	0.000	49.80	2.248	17.55	0.139	0.036	151.3	139.2	97.91	24.21	0.836
20:58	17.596	9.697	0.376	0.178	0.000	49.61	1.905	18.33	0.115	0.028	147.6	136.1	97.83	24.18	0.835
21:16	16.907	10.055	0.316	0.148	0.000	50.31	1.617	18.12	0.100	0.021	139.8	129.0	97.60	24.38	0.842
21:34	16.962	10.423	0.298	0.138	0.000	50.87	1.556	17.49	0.096	0.019	136.7	126.0	97.85	24.50	0.846
21:52	16.611	10.546	0.317	0.135	0.000	51.30	1.543	17.36	0.096	0.018	135.3	124.7	97.93	24.64	0.850
22:10	16.396	10.456	0.288	0.136	0.017	52.01	1.420	16.92	0.089	0.019	131.4	121.1	97.76	24.65	0.851
22:28	16.791	10.209	0.297	0.124	0.000	50.75	1.450	18.10	0.088	0.016	136.5	126.1	97.82	24.52	0.846
22:46	16.583	10.512	0.339	0.138	0.000	51.05	1.606	17.49	0.098	0.017	136.7	126.1	97.84	24.61	0.849
23: 4	16.576	10.467	0.336	0.133	0.000	50.87	1.567	17.69	0.095	0.017	136.7	126.1	97.75	24.58	0.848
23:22	16.196	10.830	0.345	0.130	0.000	51.70	1.636	16.84	0.092	0.016	133.4	123.0	97.79	24.74	0.854
23:40	15.912	11.119	0.329	0.122	0.000	52.26	1.528	16.36	0.091	0.014	129.4	119.3	97.73	24.86	0.858
23:58	16.374	10.738	0.380	0.145	0.000	51.46	1.744	16.78	0.104	0.018	136.0	125.3	97.74	24.65	0.851

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0:16	16.443	10.528	0.381	0.155	0.000	50.98	1.797	17.19	0.110	0.021	138.5	127.7	97.61	24.56	0.848
0:34	16.903	10.033	0.392	0.166	0.000	49.91	1.851	18.16	0.117	0.024	144.3	133.1	97.56	24.34	0.840
0:52	16.390	10.486	0.372	0.151	0.000	50.82	1.779	17.36	0.107	0.021	138.4	127.7	97.49	24.54	0.847

GAS CHROMATOGRAPH DATA

DATE TIME	H2 %	CO2 %	C2H4 %	C2H6 %	O2 %	N2 %	CH4 %	CO %	C3H6 %	C3H8 %	HHV BTU/SCF	LHV BTU/SCF	TMP %	MW	S.G. WRT AIR

7/23/1983															
1:10	16.753	10.354	0.351	0.167	0.000	50.37	1.782	17.50	0.112	0.026	140.3	129.3	97.41	24.40	0.842
1:28	16.961	10.234	0.349	0.175	0.000	49.90	1.783	17.80	0.111	0.028	142.1	131.0	97.35	24.31	0.839
1:46	17.268	9.884	0.328	0.170	0.000	49.46	1.728	18.43	0.105	0.029	144.0	132.8	97.41	24.20	0.835
2: 4	17.187	10.026	0.325	0.168	0.000	49.65	1.751	18.19	0.103	0.028	143.0	131.9	97.44	24.24	0.837
2:22	16.953	10.360	0.297	0.154	0.000	50.20	1.621	17.57	0.094	0.025	138.0	127.2	97.27	24.33	0.840
2:40	16.817	10.619	0.315	0.158	0.000	50.24	1.685	17.16	0.099	0.025	137.4	126.5	97.12	24.35	0.841
2:58	16.398	11.066	0.300	0.141	0.000	51.06	1.581	16.13	0.093	0.022	130.9	120.4	96.79	24.45	0.844
3:16	16.802	10.644	0.295	0.150	0.000	50.33	1.584	17.13	0.096	0.024	135.6	124.9	97.05	24.35	0.841
4:11	16.010	10.942	0.244	0.105	0.009	52.53	1.218	17.12	0.071	0.014	126.9	117.2	98.26	24.99	0.862
4:47	15.596	11.143	0.212	0.076	0.046	52.66	1.035	16.75	0.056	0.009	121.0	111.8	97.59	24.95	0.861
5: 5	17.201	10.279	0.366	0.192	0.000	49.35	1.934	17.33	0.122	0.038	143.9	132.5	96.81	24.09	0.832
5:22	17.058	10.431	0.341	0.192	0.000	49.56	1.891	17.22	0.115	0.039	142.1	130.9	96.84	24.16	0.834
5:40	17.026	10.388	0.311	0.180	0.000	49.63	1.796	17.20	0.110	0.038	140.2	129.1	96.68	24.13	0.833
5:58	17.122	10.347	0.304	0.166	0.000	49.61	1.746	17.29	0.097	0.030	139.4	128.4	96.71	24.11	0.832
6:16	17.305	10.141	0.291	0.153	0.000	49.15	1.671	17.83	0.090	0.028	140.4	129.3	96.67	24.02	0.829
6:33	16.999	10.488	0.265	0.159	0.000	49.68	1.576	17.33	0.092	0.029	136.5	125.8	96.62	24.16	0.834
6:51	16.938	10.481	0.256	0.158	0.000	49.86	1.545	17.13	0.091	0.029	135.2	124.5	96.49	24.14	0.833
7: 9	17.398	10.297	0.260	0.156	0.000	49.26	1.533	17.67	0.091	0.029	138.4	127.5	96.69	24.05	0.830
7:27	17.835	9.778	0.251	0.155	0.000	48.52	1.499	18.62	0.090	0.028	142.3	131.2	96.77	23.88	0.824
7:44	17.886	9.791	0.252	0.160	0.000	48.52	1.556	18.40	0.091	0.034	142.6	131.4	96.70	23.84	0.823
8: 2	17.653	9.653	0.241	0.157	0.004	48.77	1.479	18.42	0.091	0.030	140.7	129.8	96.50	23.83	0.823
8:20	16.897	9.019	0.250	0.158	0.000	49.50	1.502	19.10	0.091	0.030	140.9	130.3	96.55	23.94	0.826
8:38	17.379	9.507	0.246	0.167	0.003	48.65	1.495	18.78	0.093	0.032	141.5	130.7	96.35	23.84	0.823
8:56	17.234	9.582	0.240	0.172	0.000	49.01	1.609	18.30	0.092	0.034	140.7	129.8	96.27	23.85	0.823
9:21	16.683	9.334	0.236	0.163	0.000	49.71	1.530	18.81	0.082	0.034	139.3	128.8	96.58	24.05	0.830
9:38	16.281	9.463	0.240	0.138	0.000	50.07	1.468	18.43	0.076	0.026	135.5	125.3	96.19	24.07	0.831
9:56	16.119	9.455	0.225	0.116	0.000	50.40	1.321	18.46	0.068	0.020	132.6	122.7	96.18	24.12	0.833
10:14	15.577	10.054	0.266	0.133	0.000	51.28	1.442	18.03	0.085	0.023	132.1	122.2	96.89	24.55	0.847
10:32	15.443	9.855	0.268	0.113	0.000	51.37	1.310	18.70	0.080	0.015	131.8	122.2	97.16	24.64	0.851
10:50	15.424	9.786	0.283	0.129	0.000	51.38	1.368	18.68	0.088	0.019	133.1	123.4	97.16	24.63	0.850
11: 8	15.831	9.425	0.303	0.143	0.000	50.74	1.550	18.99	0.091	0.024	138.0	127.8	97.09	24.43	0.843
11:25	15.682	9.567	0.316	0.134	0.000	50.82	1.567	18.68	0.086	0.021	136.6	126.5	96.87	24.42	0.843
11:43	15.596	10.045	0.302	0.142	0.000	51.50	1.609	17.77	0.085	0.025	133.8	123.7	97.08	24.58	0.848
12: 2	15.538	10.030	0.283	0.134	0.000	51.71	1.521	17.70	0.080	0.023	131.9	121.9	97.02	24.58	0.849
12:20	15.743	9.719	0.292	0.124	0.000	51.15	1.493	18.43	0.079	0.019	134.4	124.4	97.04	24.49	0.845
12:38	15.623	9.553	0.295	0.131	0.000	50.80	1.490	18.67	0.083	0.021	135.1	125.2	96.67	24.39	0.842
12:55	15.309	9.489	0.285	0.136	0.000	50.03	1.515	18.54	0.086	0.022	134.0	124.1	95.42	24.11	0.832
13:13	15.041	9.668	0.284	0.123	0.000	49.95	1.436	18.18	0.084	0.018	130.7	121.2	94.78	24.03	0.830
13:31	14.843	9.718	0.302	0.128	0.000	50.12	1.485	17.98	0.086	0.019	130.4	120.9	94.68	24.06	0.831
13:49	14.756	9.801	0.286	0.120	0.000	50.30	1.431	17.86	0.083	0.017	128.7	119.3	94.66	24.10	0.832
15:18	14.911	9.876	0.314	0.136	0.000	51.83	1.543	17.80	0.087	0.022	131.1	121.4	96.52	24.58	0.848
15:36	14.900	9.855	0.293	0.131	0.000	51.83	1.477	17.91	0.083	0.021	130.2	120.6	96.50	24.58	0.848
15:40	14.974	9.631	0.317	0.143	0.000	50.73	1.553	17.74	0.093	0.023	131.5	121.7	95.20	24.15	0.834
15:54	15.472	9.853	0.311	0.147	0.000	51.12	1.599	17.70	0.096	0.025	133.5	123.5	96.32	24.37	0.841
16:12	15.358	10.015	0.303	0.138	0.000	51.41	1.550	17.20	0.088	0.023	130.5	120.6	96.09	24.36	0.841
16:30	15.558	9.803	0.285	0.146	0.000	50.95	1.520	18.16	0.090	0.025	133.9	124.0	96.54	24.41	0.842

6-H

GAS CHROMATOGRAPH DATA

DATE TIME	H2 %	CO2 %	C2H4 %	C2H6 %	O2 %	N2 %	CH4 %	CO %	C3H6 %	C3H8 %	HHV BTU/SCF	LHV BTU/SCF	TMP %	MW	S.G. WRT AIR
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7/23/1983

16:48	15.505	9.749	0.285	0.144	0.000	51.01	1.495	18.20	0.091	0.024	133.6	123.6	96.50	24.40	0.842
17: 5	15.556	9.644	0.300	0.144	0.000	50.83	1.515	18.30	0.093	0.024	134.5	124.6	96.40	24.34	0.840
17:23	15.473	9.637	0.308	0.132	0.000	51.01	1.489	18.33	0.088	0.020	133.8	123.9	96.49	24.39	0.842
17:41	14.739	10.223	0.343	0.137	0.000	51.91	1.555	17.27	0.095	0.020	129.5	119.9	96.29	24.61	0.850
17:59	14.870	10.118	0.354	0.140	0.000	51.80	1.652	17.45	0.095	0.021	131.7	121.9	96.50	24.61	0.849
18:17	14.913	10.222	0.357	0.130	0.000	51.84	1.629	17.15	0.091	0.018	130.4	120.6	96.35	24.57	0.848
18:35	14.539	10.369	0.325	0.133	0.000	52.36	1.528	17.00	0.091	0.020	127.3	117.8	96.36	24.71	0.853
18:53	14.927	10.078	0.311	0.143	0.000	51.73	1.538	17.50	0.096	0.023	130.4	120.7	96.35	24.56	0.848
19:11	15.052	9.889	0.285	0.144	0.000	51.81	1.452	17.71	0.091	0.024	130.1	120.5	96.46	24.54	0.847
19:29	14.980	10.039	0.281	0.139	0.000	51.86	1.462	17.46	0.085	0.023	128.8	119.2	96.32	24.54	0.847
19:48	14.980	10.200	0.259	0.141	0.000	51.95	1.417	17.23	0.085	0.024	127.4	117.8	96.28	24.56	0.848
20: 6	14.811	10.197	0.267	0.135	0.000	52.26	1.410	17.24	0.085	0.022	126.7	117.3	96.43	24.64	0.851
20:24	14.644	10.459	0.260	0.131	0.000	52.64	1.349	16.85	0.083	0.022	124.1	114.8	96.44	24.74	0.854
20:41	14.562	10.671	0.249	0.143	0.000	52.71	1.390	16.38	0.087	0.025	123.0	113.7	96.22	24.73	0.854
21:17	14.622	10.640	0.253	0.133	0.000	52.87	1.321	16.37	0.085	0.022	122.2	113.0	96.31	24.74	0.854
21:35	15.116	10.049	0.268	0.145	0.000	51.42	1.393	17.57	0.088	0.025	129.0	119.4	96.07	24.44	0.844
21:40	14.498	10.880	0.258	0.137	0.000	53.10	1.357	16.00	0.087	0.023	121.2	111.9	96.33	24.81	0.857
21:53	15.126	10.214	0.264	0.135	0.000	51.74	1.348	17.07	0.087	0.022	126.6	117.1	96.00	24.45	0.844
22:11	14.735	10.100	0.301	0.141	0.000	52.38	1.487	16.89	0.091	0.022	127.0	117.4	96.15	24.56	0.848
22:29	14.833	10.014	0.294	0.136	0.000	51.54	1.395	17.47	0.092	0.021	128.0	118.5	95.79	24.43	0.843
22:47	14.998	10.020	0.299	0.133	0.000	51.34	1.409	17.54	0.089	0.020	128.8	119.3	95.84	24.40	0.842
23: 5	14.413	10.537	0.279	0.126	0.000	52.49	1.338	16.38	0.088	0.019	122.0	112.9	95.66	24.60	0.849
23:23	14.631	10.480	0.279	0.135	0.000	52.22	1.369	16.48	0.089	0.022	123.6	114.3	95.71	24.54	0.847
23:41	14.355	10.576	0.294	0.140	0.000	52.36	1.404	16.45	0.092	0.022	123.4	114.1	95.70	24.62	0.850
23:59	14.775	10.204	0.295	0.138	0.000	51.69	1.422	16.90	0.090	0.022	126.3	116.8	95.54	24.41	0.842

7/24/1983

0:17	14.721	10.147	0.297	0.139	0.000	51.60	1.423	17.15	0.091	0.023	127.0	117.6	95.59	24.42	0.843
0:35	14.395	10.570	0.266	0.131	0.000	52.61	1.285	16.41	0.087	0.021	121.4	112.3	95.77	24.64	0.851
0:53	14.191	10.683	0.273	0.134	0.000	52.46	1.314	16.29	0.086	0.021	120.8	111.8	95.45	24.62	0.850
1:11	14.515	10.695	0.280	0.145	0.000	52.23	1.370	16.15	0.093	0.024	122.5	113.2	95.50	24.55	0.847
1:29	14.813	10.169	0.279	0.135	0.000	51.67	1.317	17.15	0.087	0.021	125.7	116.4	95.63	24.43	0.843
1:47	14.967	10.012	0.306	0.141	0.000	51.53	1.402	17.32	0.092	0.022	128.3	118.8	95.80	24.40	0.842
2: 5	15.024	9.926	0.315	0.138	0.000	51.11	1.441	17.55	0.090	0.021	129.7	120.0	95.62	24.31	0.839

APPENDIX I

Continuous Output Transducer Data

These are averages of the continuous output transducer data averaged for the time periods over which material and energy balance calculations were made.

AVERAGE FROM PERIOD:0 7/18/83 15:00 TO 7/19/83 16:00

SIGNAL	AVERAGE	UNITS	STD.DEV.
T-701	27.292	DEG C	2.965
T-702	38.042	DEG C	2.806
T-703	62.792	DEG C	1.893
T-710	21.458	DEG C	0.498
T-711	93.792	DEG C	4.301
T-712	22.545	DEG C	0.582
T-713	42.167	DEG C	6.196
T-705	530.310	DEG C	47.795
T-706	354.280	DEG C	45.695
T-707	420.880	DEG C	63.357
T-812	874.863	DEG C	97.699
T-813	—OFF—	DEG C	
T-814	690.985	DEG C	103.526
T-815	—OFF—	DEG C	
T-816	—OFF—	DEG C	
T-817	—OFF—	DEG C	
T-818	452.762	DEG C	59.823
T-819	678.308	DEG C	78.792
T-820	546.583	DEG C	53.748
T-823	71.042	DEG C	2.169
T-822	71.711	DEG C	5.600
T-806	386.627	DEG C	65.937
T-811	904.759	DEG C	110.494
F-701	985.039	SCFM	2.192
TT2-703	63.421	DEG C	1.999
P-703	11.922	IN WC	2.106
P-704	9.473	IN WC	2.195
P-705	2.449	IN WC	0.284
P-706	1.601	IN WC	0.234
F-707	0.573	SCFM	0.211
WT-720	9.162	TONS	1.004
P-707	0.291	IN WC	0.386
P-810	-0.839	IN WC	0.021
F-802	3540.625	CFM	77.497
F-803	8706.726	CFM	259.158
TT1-703	62.638	DEG C	1.847
CO	19.445	%	2.827
CO2	9.639	%	1.246
O2	-0.828	%	0.097
SIGMA	133.459	BTU/SCF	5.726
T-715	164.494	DEG C	20.511
T-821	366.591	DEG C	170.035
T-703A	80.750	DEG C	98.721
PH	—OFF—	PH	
AG VEL	5.964	SPH	2.570
GR VEL	2.889	RPD/T	1.807
P-702	—OFF—	IN WC	

AVERAGE BASE TEMPERATURE 22.161

AVERAGE FROM PERIOD:0 7/19/83 20:00 TO 7/20/83 16:00

SIGNAL	AVERAGE	UNITS	STD.DEV.
T-701	25.110	DEG C	3.457
T-702	36.350	DEG C	3.038
T-703	64.550	DEG C	0.669
T-710	22.000	DEG C	0.000
T-711	91.750	DEG C	3.064
T-712	21.500	DEG C	4.500
T-713	31.450	DEG C	7.166
T-705	529.041	DEG C	26.232
T-706	339.949	DEG C	11.131
T-707	432.422	DEG C	16.435
T-812	676.014	DEG C	58.716
T-813	—OFF—	DEG C	
T-814	488.055	DEG C	56.704
T-815	—OFF—	DEG C	
T-816	—OFF—	DEG C	
T-817	—OFF—	DEG C	
T-818	247.952	DEG C	22.614
T-819	538.702	DEG C	42.856
T-820	480.600	DEG C	33.893
T-823	68.000	DEG C	1.483
T-822	67.425	DEG C	3.247
T-806	394.942	DEG C	12.275
T-811	711.601	DEG C	73.571
F-701	913.458	SCFM	1.364
TT2-703	64.306	DEG C	0.906
P-703	6.883	IN WC	0.769
P-704	4.602	IN WC	0.789
P-705	2.281	IN WC	0.257
P-706	1.597	IN WC	0.233
F-707	0.467	SCFM	0.047
WT-720	8.686	TONS	1.456
P-707	0.631	IN WC	4.745
P-810	-0.841	IN WC	0.017
F-802	2500.000	CFM	1414.214
F-803	8972.809	CFM	175.483
TT1-703	63.394	DEG C	0.909
CO	14.307	%	1.844
CO2	12.365	%	0.914
O2	-0.785	%	0.413
SIGMA	116.436	BTU/SCF	12.552
T-715	167.561	DEG C	21.431
T-821	461.800	DEG C	33.113
T-703A	56.650	DEG C	2.725
PH	—OFF—	PH	
AG VEL	6.891	SPH	1.355
GR VEL	1.429	RPD/T	0.430
P-702	—OFF—	IN WC	

AVERAGE BASE TEMPERATURE 26.009

AVERAGE FROM PERIOD:0 7/20/83 19:00 TO 7/21/83 11:00

SIGNAL	AVERAGE	UNITS	STD.DEV.
T-701	31.250	DEG C	1.346
T-702	42.500	DEG C	1.275
T-703	64.000	DEG C	0.866
T-710	22.125	DEG C	0.331
T-711	80.500	DEG C	5.339
T-712	23.063	DEG C	0.242
T-713	34.938	DEG C	1.029
T-705	599.015	DEG C	21.601
T-706	368.728	DEG C	16.275
T-707	488.277	DEG C	18.605
T-812	733.115	DEG C	39.954
T-813	—OFF—	DEG C	
T-814	539.340	DEG C	40.842
T-815	—OFF—	DEG C	
T-816	—OFF—	DEG C	
T-817	—OFF—	DEG C	
T-818	273.590	DEG C	15.883
T-819	572.173	DEG C	28.972
T-820	501.500	DEG C	23.125
T-823	69.188	DEG C	0.950
T-822	68.100	DEG C	2.927
T-806	447.591	DEG C	16.424
T-811	770.652	DEG C	56.898
F-701	918.637	SCFM	1.350
TT2-703	63.139	DEG C	0.254
P-703	4.881	IN WC	1.165
P-704	2.417	IN WC	0.998
P-705	2.464	IN WC	0.295
P-706	1.849	IN WC	0.264
F-707	0.280	SCFM	0.098
WT-720	9.035	TONS	1.037
P-707	0.282	IN WC	0.126
P-810	-0.842	IN WC	0.017
F-802	3460.000	CFM	80.000
F-803	8885.001	CFM	168.809
TT1-703	62.534	DEG C	0.189
CO	15.405	%	0.999
CO2	11.573	%	0.550
O2	-0.874	%	0.058
SIGMA	121.115	BTU/SCF	3.795
T-715	168.175	DEG C	18.629
T-821	482.938	DEG C	21.856
T-703A	52.313	DEG C	2.256
PH	—OFF—	PH	
AG VEL	7.422	SPH	1.443
GR VEL	1.371	RPD/T	0.175
P-702	—OFF—	IN WC	

AVERAGE BASE TEMPERATURE 26.464

AVERAGE FROM PERIOD:0 7/21/83 14:00 TO 7/23/83 9:00

SIGNAL	AVERAGE	UNITS	STD.DEV.
T-701	28.408	DEG C	6.037
T-702	39.743	DEG C	5.168
T-703	66.076	DEG C	2.208
T-710	24.202	DEG C	5.549
T-711	69.224	DEG C	4.587
T-712	25.341	DEG C	4.852
T-713	39.754	DEG C	3.859
T-705	669.825	DEG C	30.903
T-706	401.613	DEG C	38.654
T-707	555.370	DEG C	18.084
T-812	784.984	DEG C	25.607
T-813	—OFF—	DEG C	
T-814	593.493	DEG C	26.911
T-815	—OFF—	DEG C	
T-816	—OFF—	DEG C	
T-817	—OFF—	DEG C	
T-818	296.748	DEG C	11.322
T-819	672.825	DEG C	519.013
T-820	-54.456	DEG C	767.616
T-823	-94.799	DEG C	108.434
T-822	66.784	DEG C	1.625
T-806	513.895	DEG C	27.487
T-811	828.180	DEG C	40.733
F-701	905.705	SCFM	6.710
TT2-703	64.982	DEG C	0.338
P-703	6.106	IN WC	1.464
P-704	3.209	IN WC	1.404
P-705	2.897	IN WC	0.343
P-706	2.462	IN WC	0.370
F-707	0.040	SCFM	0.090
WT-720	8.792	TONS	1.039
P-707	-0.110	IN WC	0.100
P-810	-0.889	IN WC	0.103
F-802	3569.231	CFM	123.317
F-803	8815.860	CFM	373.229
TT1-703	64.624	DEG C	0.295
CO	15.906	%	1.131
CO2	11.500	%	0.641
O2	-0.844	%	0.165
SIGMA	128.339	BTU/SCF	5.475
T-715	152.605	DEG C	4.222
T-821	515.595	DEG C	18.401
T-703A	49.350	DEG C	11.552
PH	—OFF—	PH	
AG VEL	10.324	SPH	1.692
GR VEL	2.175	RPD/T	0.680
P-702	—OFF—	IN WC	

AVERAGE BASE TEMPERATURE 24.714

AVERAGE FROM PERIOD:0 7/23/83 10:00 TO 7/24/83 2:00

SIGNAL	AVERAGE	UNITS	STD.DEV.
T-701	28.335	DEG C	2.562
T-702	38.875	DEG C	2.446
T-703	63.938	DEG C	0.242
T-710	22.813	DEG C	0.390
T-711	75.313	DEG C	3.703
T-712	23.563	DEG C	0.496
T-713	37.313	DEG C	1.648
T-705	663.475	DEG C	19.830
T-706	368.938	DEG C	1.298
T-707	558.563	DEG C	8.321
T-812	—OFF—	DEG C	
T-813	—OFF—	DEG C	
T-814	—OFF—	DEG C	
T-815	—OFF—	DEG C	
T-816	—OFF—	DEG C	
T-817	—OFF—	DEG C	
T-818	—OFF—	DEG C	
T-819	547.563	DEG C	38.575
T-820	491.500	DEG C	27.717
T-823	71.313	DEG C	0.982
T-822	—OFF—	DEG C	
T-806	513.188	DEG C	10.702
T-811	—OFF—	DEG C	
F-701	918.429	SCFM	4.929
TT2-703	62.604	DEG C	0.194
P-703	7.369	IN WC	1.291
P-704	4.225	IN WC	1.120
P-705	3.144	IN WC	0.474
P-706	1.944	IN WC	0.487
F-707	0.000	SCFM	0.000
WT-720	—OFF—	TONS	
P-707	—OFF—	IN WC	
P-810	—OFF—	IN WC	
F-802	3668.750	CFM	135.641
F-803	9750.000	CFM	684.653
TT1-703	62.296	DEG C	0.173
CO	18.633	%	0.921
CO2	9.900	%	0.424
O2	—OFF—	%	
SIGMA	130.789	BTU/SCF	3.766
T-715	154.000	DEG C	0.707
T-821	450.813	DEG C	25.576
T-703A	47.813	DEG C	1.590
PH	—OFF—	PH	
AG VEL	7.567	SPH	0.602
GR VEL	2.650	RPD/T	0.286
P-702	—OFF—	IN WC	

AVERAGE BASE TEMPERATURE 22.697

APPENDIX J

Stack Sampling Report

This is the report submitted by Interpoll, Inc., Circle Pines, Minnesota to the University of Minnesota Particle Technology Laboratory. The appendices to the stack sampling report have not been included here. The appendices include raw data and calculations.

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RESULTS OF THE JULY 20, 1983,
PENNSYLVANIA COAL
TEST BURN EMISSION TESTS ON THE
WELLMAN-GALUSHA GASIFIER AT THE
TWIN CITIES RESEARCH CENTER
IN MINNEAPOLIS, MINNESOTA

Submitted to:

UNIVERSITY OF MINNESOTA
Room 130 Mechanical Eng. Bldg.
111 Church Street S.E.
Minneapolis, Minnesota 55455

Attention: David Y. H. Pui, Ph.D.

Approved by:



Perry Lonnes, Ph.D.
President

Report Number 3-1582
September 14, 1983

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APPENDICES:

- A - Results of Volumetric Flow Rate Measurements
- B - Location of Test Ports and Traverse Points
- C - Method 2-5 Field Data Sheets
- D - Method 9 Field Data Sheets
- E - Laboratory Data Sheets
- F - Operating Conditions of Gasifier and Fuel Composition
- G - Procedures
- H - Calculation of the Dry F-Factor
- I - Calculation Equations
- J - Sampling Train Calibration Data

ABBREVIATIONS

ACFM	actual cubic feet per minute
cc (ml)	cubic centimeter (milliliter)
DSCFM	standard cubic foot of dry gas per minute
DSML	dry standard milliliter
DEG-F (°F)	degrees Fahrenheit
DIA.	diameter
FT/SEC	feet per second
GPM	gallons per minute
GR/ACF	grains per actual cubic foot
GR/DSCF	grains per dry standard cubic foot
g	gram
HP	horsepower
HRS	hours
IN.	inches
IN. HG.	inches of mercury
IN. WC.	inches of water
LB	pound
LB/DSCF	pounds per dry standard cubic foot
LB/HR	pounds per hour
LB/10 ⁶ BTU	pounds per million British Thermal Units heat in
LB/MMBTU	pounds per million British Thermal Units heat in
MW	megawatt
mg/DSCM	milligrams per dry standard cubic meter
microns (µm)	micrometer
MIN.	minutes
ohm-cm	ohm-centimeter
PPH	pounds per hour
PPM	parts per million
PSI	pounds per square inch
SQ. FT.	square feet
v/v	percent by volume
w/w	percent by weight

Standard conditions are defined as 68 °F (20 °C) and 29.92 IN. of mercury pressure

1 INTRODUCTION

On July 20, 1983, Interpoll Inc. personnel conducted a series of flow rate and emission tests on the pilot low BTU Gasifier at the Bureau of Mines Twin Cities Research Center, Minneapolis, Minnesota. On-site testing was performed by a two-man team under the direction of S. Olson. Coordination between testing activities and gasifier operation was provided by Dave Thimsen and Dick Pooler of Black, Sivalls and Bryson (BSB).

The unit tested is a six-foot, six-inch Wellman-Galusha, single stage, fixed-bed gasifier with an agitator. This gasifier has a nominal operating capacity of 30×10^6 BTU/HR (bituminous coal). A combustion test chamber is attached to the gasifier and it also has a nominal capacity of 30×10^6 BTU/HR. The combustion test chamber is a horizontal, cylindrical chamber, seven feet I.D. by 21 feet long, and exhausts through an impingement tray-type scrubber and an induced draft fan to a three-foot diameter stack. Most of the testing in this work was performed at the combustion test chamber outlet, however, flow determinations were performed at the forced draft fan outlet to allow assessment of the combustion air usage and in the stack to ascertain the total volumetric flow rate of the combustion products. During this test, Eastern bituminous coal from Clarion County, Pennsylvania was gasified.

Particulate and sulfur dioxide determinations were performed in accordance with EPA Methods 1-6, CFR Title 40, Part 60, Appendix A (Revised July 1, 1982). A preliminary determination of the gas velocity profile was made before the first particulate run to allow selection of the appropriate nozzle diameter required for isokinetic sample withdrawal. An Interpoll sampling train which meets or exceeds specifications in the above-cited reference was used to collect particulate samples by means of a heated stainless steel-lined probe. A single diameter traverse was used in this work due to the high cost of installing a second test port at 90 degrees to the existing port.

The back half of the EPA Method 5 particulate sampling train was used to collect sulfur dioxide samples. This is the large impinger version specified in EPA Method 6 and provides for a complete stack traverse during sample collection. Collected sulfur dioxide samples were returned to the laboratory for sulfate analysis by the standard barium/Thorin I titration technique.

Nitric oxide concentrations in the flue gas were measured by means of a Monitor Labs chemiluminescent nitric oxide analyzer. Nitric oxide concentrations were read at each traverse point in the particulate determination. The nitric oxide concentrations were determined on a dry basis using the exhaust gas stream from the EPA Method 5 sampling train.

An integrated flue gas sample was extracted simultaneously with each particulate and sulfur dioxide sample using a specially designed gas sampling system. Integrated flue gas samples were collected in 44-liter Tedlar bags. After sampling was complete, the bags were sealed and returned to the laboratory for Orsat analysis. The integrity of the sample bags was insured by reading the oxygen concentration of the bag in the field immediately after sampling and again in the laboratory immediately prior to Orsat analysis using a Teledyne Model 320P oxygen analyzer.

Testing at the combustion chamber outlet test site was conducted from one test port on the combustion chamber outlet duct (see Appendix B). Each traverse point was sampled five minutes to give a total sampling time of 60 minutes per run. Test port and traverse port locations for the flow determinations are also given in Appendix B.

The important results of the tests are summarized in Section 2. Detailed results are presented in Section 3. Results of preliminary measurements, field data and all other supporting information are presented in the appendices.

The important results of the particulate determinations performed at the combustor outlet are summarized in Table 1. As will be noted, the particulate concentration ranged from .019 to .023 GR/ACF and the corresponding mass rate from 2.6 to 3.3 LB/HR. The particulate emission factor, the parameter used by most pollution control agencies to regulate emissions from boilers and combustors, ranged from .15 to .18 LB/10⁶BTU (EPA methods specify that the emission factor be calculated from oxygen concentrations in the flue gas derived from Orsat analysis). The heat input to the combustion test chamber was estimated to be approximately 16 10⁶BTU/HR using the F-factor calculated from the low BTU gas composition together with the particulate emission factor and the particulate mass rates. These heat input rates were verified by the SO₂ emission factors and rates.

The results of the SO₂ determinations are given in Table 2. As will be noted, the SO₂ concentrations ranged from 368 to 425 ppm. The SO₂ emission rate was approximately 70 LB/HR and the SO₂ emission factor 4.36 LB/10⁶BTU. This is about 15% higher than would be expected based on the heating value and the sulfur content of the fuel. This discrepancy may be due to sampling bias in the collection of the fuel sample. Nitric oxide concentrations ranged from 149 to 231 ppm (dry). Plume opacity was estimated to be about 0%.

Volumetric flow rate determinations were performed at three different locations. The results of the flow rate determinations performed at the combustor outlet are given in Table 1 and ranged from 16,000 to 16,500 DSCFM. The flow rate at the combustion fan inlet duct was estimated at 6810 DSCFM. The flow rate at the stack test site was 14,100 DSCFM.

Table 1. Summary of the Results of the July 20, 1983 Particulate Emission Test on the Combustor Outlet at the Bureau of Mines Coal Gasifier Plant Located in Minneapolis, Minnesota

ITEM	RUN 1	RUN 2	RUN 3
Time of test (HRS)	0852/0952	1030/1130	1220/1320
Estimated gas burning rate (DSCFM)	2285	2249	2375
Estimated heat input (MMBTU)	15.4	16.5	16.0
Estimated percent of rated capacity	51.3	55.0	53.3
Volumetric flow			
ACTUAL (ACFM)	43900	44800	47600
STANDARD (DSCFM)	16300	16500	16000
Gas temperature (DEG-F)	850	855	964
Moisture content (% v/v)	5.59	6.14	6.71
Gas composition (% v/v dry)			
carbon dioxide	3.60	4.26	4.05
oxygen	16.45	16.20	16.20
nitrogen	79.95	79.54	79.75
Oxygen analyzer (% v/v, dry)	16.66	15.90	16.19
Isokinetic variation (%)	100.2	98.1	98.5
Particulate concentration			
ACTUAL (GR/ACF)	.0070	.0085	.0070
STANDARD (GR/DSCF)	.019	.023	.021
Particulate mass rate (LB/HR)	2.6	3.3	2.8
Particulate emission factor (LB/MMBTU)			
F-factor method (Orsat)	.17	.20	.18

Table 2. Summary of the Results of the July 20, 1983 Sulfur Dioxide Emission Test on the Combustor Outlet at the Bureau of Mines Coal Gasifier in Minneapolis, Minnesota.

ITEM	Run 1	Run 2	Run 3
Time of test (HRS)	852- 952	1030-1130	1220-1320
SO2 concentration (PPM/dry)	390	453	454
(PPM/wet)	368	425	424
SO2 mass rate (LB/HR)	63	74	73
SO2 emission factor (LB/MMBTU) F-factor method	4.1	4.5	4.5

No difficulties were encountered in the field or in the laboratory evaluation of the flyash and sulfur dioxide samples. On the basis of this fact and a complete review of the entire data and results, it is our opinion that the particulate, sulfur dioxide, and oxides of nitrogen concentration emission rates and emission factors reported herein are accurate and closely reflect the actual values which existed at the time the tests were performed.

3 RESULTS

The results of all field and laboratory evaluations are presented in this section. Gas composition (Orsat and moisture) are presented first, followed by the computer printout of particulate, visible emission data and results of NO concentrations. Preliminary measurements including traverse point description are given in Appendices A and B.

The results have been calculated on a DEC PDP-11 Computer using standard Fortran programs. EPA-published equations have been used as the basis of the calculation techniques in these programs. It should be noted in interpreting these results that the particulate emission rates have been calculated by both the "concentration x flow" and the "ratio of areas" methods and the average reported. The average is the best estimate of the true value, since the bias introduced by anisokinetic sampling is approximately equal but of opposite sign in the two calculation techniques and thus cancels in the average.

Test No. 1
 Combustor Outlet

Results of Orsat & Moisture Analysis -- Methods 3 & 4 (% v/v)

	Run 1	Run 2	Run 3
Date of run	07/20/83	07/20/83	07/20/83
Dry basis (orsat)			
carbon dioxide	3.40	4.26	4.05
oxygen	16.45	16.20	16.20
carbon monoxide	.00	.00	.00
nitrogen	79.95	79.54	79.75
Wet basis (orsat)			
carbon dioxide	3.40	4.00	3.78
oxygen	15.53	15.21	15.11
carbon monoxide	.00	.00	.00
nitrogen	75.48	74.66	74.40
Moisture content	5.59	6.14	6.71
Dry molecular weight	29.23	29.33	29.30
Wet molecular weight	28.61	28.63	28.54
Specific gravity (relative to air)	.9881	.9891	.9858
Teledyne oxygen analyzer (velocity & time weighted avg.)	16.66	15.90	16.19

Test No. 1
Combustor Air Inlet Duct

Results of Orsat & Moisture Analysis -- Methods 3 & 4 (% v/v)

Run 1

Date of run 07/20/83

Dry basis (orsat)*

carbon dioxide	.03
oxygen	20.90
carbon monoxide	.00
nitrogen	79.07

Wet basis (orsat)*

carbon dioxide	.03
oxygen	20.34
carbon monoxide	.00
nitrogen	76.93

Moisture content 2.70

Dry molecular weight 28.84

Wet molecular weight 28.55

Specific gravity
(relative to air) .9861

J - 13

* Ambient air; sample not measured.

Test No. 1
Scrubber Stack

Results of Orsat & Moisture Analysis -- Methods 3 & 4 (% v/v)

	Run 1
Date of run	07/20/83
Dry basis (orsat)	
carbon dioxide	2.65
oxygen	16.53
carbon monoxide	.00
nitrogen	80.82
Wet basis (orsat)	
carbon dioxide	2.02
oxygen	12.61
carbon monoxide	.00
nitrogen	61.64
Moisture content	23.73
Dry molecular weight	29.09
Wet molecular weight	26.45
Specific gravity (relative to air)	.9138

Test No. 1
 Combustor Outlet

3.2 Results of Particulate Loadings Determinations -- method 5

	Run 1	Run 2	Run 3
Date of run	07/20/83	07/20/83	07/20/83
Time run start/end (HRS)	0852/0952	1030/1130	1220/1320
Pitot tube coefficient	.856	.856	.856
Water in sample			
condensate (ml)	31.0	38.0	39.0
silica gel (grams)	11.0	8.0	10.5
Total particulate material collected (grams) *	.0406	.0497	.0432
Meter correction coefficient	1.0047	1.0045	1.0047
Volume through gas meter			
at meter conditions... (CF)	35.08	35.33	34.59
standard conditions... (SCF)	33.43	33.12	32.42
Total sampling time (min)	60.0	60.0	60.0
Nozzle diameter (IN)	.374	.374	.374
Average stack gas temperature during determination (DEG-F)	850	855	964
Volumetric flow			
actual..... (CFM)	43883	44812	47574
standard..... (DSCFM)	16277	16456	16042
Isokinetic variation (%)	100.2	98.1	98.5
Particle concentration			
actual..... (GR/ACF)	.0070	.0085	.0070
dry standard..... (GR/DSCF)	.0187	.0232	.0206
Particle mass flow (LB/HR)	2.62	3.24	2.81
Emission factor (LB/MMBTU)			
by F factor (320-P)	.178	.186	.176
by F factor (corst)	.169	.198	.176

* Dry Catch Plus Inorganic Wet Catch
 F factor: Run 1 =13465.0 Run 2 =13465.0 Run 3 =13465.0
 mAmCR/2

Test No. 1
 Combustor Outlet

3.3 Results of Sulfur Dioxide Determinations -- Method 6

	Run 1	Run 2	Run 3
Date of run	7/20/83	7/20/83	7/20/83
Time run start/end (HRS)	852/ 952	1030/1130	1220/1320
Average stack gas temperature during determination (DEG-F)	850	855	964
Barometric Pressure (IN.HG.)	29.25	29.25	29.25
Meter Temperature (DEG-F)	85.3	94.4	94.6
Meter correction coefficient	1.0050	1.0050	1.0050
Volume through gas meter			
at meter conditions... (CF)	35.08	35.33	34.57
standard conditions... (SCF)	33.45	33.13	32.43
Total sampling time (MIN)	60	60	60
Moisture content (% v/v)	5.57	6.14	6.71
Oxygen content (% v/v dry)	16.45	16.20	16.20
Milliequivalents of SO ₂ in gas sample	30.6661	35.2693	34.6665
Sulfur dioxide concentration			
(GR/DSCF)	.4531	.5261	.5282
(MG/DSCM)	1037	1204	1209
(PPM-dry)	390	453	454
(PPM-wet)	368	425	424
Dry standard volumetric flow (DSCFM)	16277	16456	16042
Sulfur dioxide mass rate (LB/HR)	63.22	74.20	72.63
Sulfur dioxide emission factor (LB/MMBTU)			
F-factor method*	4.094	4.500	4.518

Test No. 1
 Combustor Outlet

3.4 Results of Opacity Observations - EPA Method 9

Percent Opacity	Optical Density	Relative Frequency (%)
0	.0000	100.00
5	.0223	.00
10	.0458	.00
15	.0706	.00
20	.0969	.00
25	.1249	.00
30	.1549	.00
35	.1871	.00
40	.2219	.00
45	.2596	.00
50	.3010	.00
55	.3468	.00
60	.3979	.00
65	.4559	.00
70	.5229	.00
75	.6021	.00
80	.6990	.00
85	.8239	.00
90	1.0000	.00
95	1.3010	.00
99	2.0000	.00

.00	.00000	Time Average

Observer: J. Stock
 Cert. Date: 6/01/83
 Date of Observation: 7/20/83
 Time of Observation: 0900-0908

Test No. 1
Combuster Outlet

3.5 Results of NO Measurement--Monitor Labs Cheminescent NO Analyzer

NO Concentration (PPM-DRY)

Run 1	Run 2	Run 3
149	201	219
161	202	208
159	215	217
170	211	220
175	220	221
181	219	219
185	231	221
188	214	220
178	215	226
188	230	219
181	228	218
182	230	226
<hr/>		
Average: 174.5	218.0	219.5

APPENDIX K

Retort Particle Sampling Data

K-1. Dust Loading Data

K-2. Cummulative Dust Sizing Data

Reference: Thimsen et al (1984)

TABLE K-1

DUST LOADING DATA

Grand Average Gas/Air Ratio 1.64 Estimated Offtake Elbow Area/ Sampler Inlet Area 8319 Retort Area Less Draft Shroud Area 28.75 square feet

K-12

RUN #	DATE TIME	TEST LENGTH (min)	MASS PARTICLES (millgram)	COAL FEED RATE (lb/hr)	T- 705 (deg. K)	P-705 ("hg abs)	F-701 (scfm)	GAS FLOW RATE (acfm)	DUST RT/ COAL RT (%)	PROBE DEPTH (inch)	AGITATOR ANGLE (deg)	AGITATOR RATE (sw/hr)	FREE-BOARD (inch)
1	22-JUL-83 09:07	7	124.0	1180	963	29.43	912	4954	1.50	34	--	--	31
2	22-JUL-83 12:44	4	83.9	1160	918	29.43	905	4686	1.80	34	--	--	30

HOUR TEMP RELATIVE BAROMET RAIN
HUMIDITY PRESS SNOW

Date: July 24, 1983

0100	70	68	29.120	
0200	69	70	29.120	
0300	68	70	29.125	

End of BOM/FGT 006

TABLE K-2

CUMULATIVE DUST SIZING DATA

SIEVING			Sample # 006-1
ASTM SIEVE NUM.	SIEVE SIZE (um)	SHIFT SIZE (um)	Percent Less Than Stated Size (%<)
14	1400	1891.9	100.0
20	841	1136.5	91.3
30	595	804.1	78.6
40	420	567.5	59.2
60	250	337.8	34.4
100	149	201.4	15.9
200	74	100.0	3.27
270	53	71.6	2.30

MICROSCOPY

PARTICLE DIAMETER (um)	Percent Less Than Stated Size (%<)
100.0	2.30
56.0	1.45
32.0	0.609
17.8	0.349
10.0	0.144
5.60	0.0466
3.20	0.0131