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FIXED-BED GASIFICATION RESEARCH USING U.S. COALS, VOLUME 10 GASIFICATION OF BENTON LIGNITE

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Black, Sivalls, and Bryson, Incorporated

**BUREAU OF MINES
UNITED STATES DEPARTMENT OF THE INTERIOR**

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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 Benton lignite gasified during this test was donated by GCO Minerals, Inc., Houston, Texas. ANR Technology, Inc. provided monitoring assistance during this test.

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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 tenth 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-009, gasification of Benton Lignite. The time period covered is November 1 - 8, 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

Benton Lignite is a low-swelling, low-sulfur, moderate ash fusion temperature lignite from Arkansas that is currently not mined. The lignite for this test was obtained from a test pit. Testing of this lignite involved gasification in a Wellman-Galusha fixed-bed gas producer and combustion of the hot, raw gas in a combustion chamber. The products of combustion were water-quenched, cleaned of sulfur oxides and particles and exhausted.

The lignite gasified well during the test. Gas quality was steady and very high throughputs were achieved. Both 3 x 3/4 inch and 3 x 1/4 inch sizings were successfully gasified. Table 1-1 gives design point data for gasification of this fuel at a throughput of 2.6 tons/hour and a blast saturation temperature of 158 F (70.0 C). Very little blast steam was generated in the water jacket around the retort due to low operating temperatures, and thus maximum throughput was limited by the import steam delivery capacity to maintain blast saturation temperature (steam/air ratio) control. Product gas temperatures were very low (100 - 150 C) during the test resulting in accumulation of condensed tar and dust in the cyclone bottom cone.

Due to high throughputs achievable and high gas quality observed during this test, the lignite is recommended as a single-stage, fixed-bed gasifier feedstock. Due consideration should be given, however, to gas cleanup as the product gas temperatures were low enough to condense the tars in the retort.

Table 1-1

Design Point Characteristics for Gasification
of Benton Lignite

Coal Throughput - 2.6 tons/hour (157 lb/hr/sq ft grate)		
Air/Coal	1.067	lb/lb
Steam/Coal	.302	lb/lb
Blast Saturation Temperature	158	deg F
Gas Offtake Temperature	292	deg F
Wet Gas/Coal	38.4	scf/lb
Gas Dewpoint	160	deg F
Tar Yield	11.2	lb/100lb coal
Tar Analysis		
HHV (dry)	18953	Btu/lb
Pourpoint	90	deg F
Viscosity (210 F)	49.5	SUS
Specific Gravity (60/60 F)	1.0461	
Dry Gas Composition (mol%)		
Hydrogen	21.4	
Carbon Monoxide	23.0	
Methane	1.76	
Ethane	.112	
Ethylene	.219	
Propane	.086	
Propylene	.072	
Carbon Dioxide	10.6	
Nitrogen	42.5	
Water	21.8	lb/1000 dscf
Dry Gas HHV	172	Btu/dscf
Dry Gas LHV	158	Btu/dscf
Thermal Efficiencies		
Hot, Raw	99	%
Cold, with Tar	89	%
Cold, without Tar	54	%

SECTION 2

TEST OBJECTIVES

2.1 Selection of Coal for Testing

Benton Lignite was selected for testing in this gasification program to expand the data base to low rank fuels. No lignite had been gasified during the period of the BS&B/UMPTL contract.

GCO Minerals, Inc. donated the lignite to the program.

2.2 Test Objectives

- A. Determine gasifier performance (including throughput and conversion efficiency) gasifying this lignite.
- B. Investigate the influence of bottomsize on maximum throughput and thermal efficiency.
- C. Identify operational requirements for gasifying lignite.

2.3 Test Plan

The proposed test plan is given in Figure 2-1. Several load levels are shown along with various blast saturation temperatures. An evaluation of gasifier response to step changes in air flow is included. Agitator rate and vertical position are left to the facility manager's judgement based on observations during the operations as are establishment of maximum throughput and minimum blast saturation temperature.

The grate spacings were set at 6 inches and 6 1/2 inches between the top and middle and the middle and bottom grates respectively.

Figure 2-1

Proposed Test Plan, BOM/FGT-009

SECTION 3

DESCRIPTION OF FUEL TESTED

The Benton Lignite gasified during BOM/FGT-009 is a gulf coast lignite located in Saline County, Arkansas. There is no active mine currently producing this lignite. The lignite gasified during this test was mined from a test pit opened during September 1983 by GCO Minerals, Inc. The test pit is 8 miles southeast of Benton, Arkansas. Figure 3-1 shows the location of the test pit. The lignite is found in a seam 6-7 feet thick with 11-20 feet of overburden. The GCO Minerals reserve base of this lignite is 56,000,000 tons.

For this test the lignite was mined with bulldozers and loaded on trucks with a backhoe. This run of mine lignite was transported by truck about 35 miles to the Port of Little Rock. The lignite sat in uncovered storage on the dock for 2-3 weeks. It was loaded onto a covered barge on September 28, 1983. The barge arrived in St. Paul on October 29, and was unloaded and trucked 3 miles to the screening site.

The run of mine lignite was passed over a 3/4 inch screen. Approximately 60% of the shipment went through the screen. The fraction of material that passed over the screen contained substantial amounts of lignite larger than 3 inches. These pieces would have introduced difficulties in feeding the gasifier evenly. Consequently, the +3/4 inch fraction of the shipment was passed through a 3 inch screen. The oversize material was crushed by the tires of the loader and fed to the screen again. This guaranteed that all lignite delivered to the test site, except the first three truck loads (October 31 and November 1) which were 4 inch x 3/4 inch, was less than 3 inches, but it also allowed some -3/4 inch material to be included in the delivery. The crushed, double-screened lignite was hauled 7 miles to the test site November 2-4.

Table 3-1 gives the analysis of the lignite gasified during BOM/FGT-009. Table 3-2 shows how the fuel fits into the coal test objective matrix. Benton Lignite is a low-ash, high-moisture, medium ash fusion temperature, low-swelling fuel.

Figure 3-1

Location of the Benton Lignite Test Pit

Table 3-1
Analysis of Benton Lignite

Proximate Analysis (%)		
Volatile Matter		34.87
Fixed Carbon		25.93
Ash		6.43
Moisture		32.77
Sulfur		0.56
Heating Value (Btu/lb)		8081
Ultimate Analysis (%)		
Carbon		44.79
Hydrogen		3.74
Nitrogen		0.62
Sulfur		0.56
Oxygen		11.09
Ash		6.43
Moisture		32.77
Ash Fusion Temperatures (deg F):		
	Oxidizing	Reducing
Initial deformation	2320	2350
Softening	2365	2395
Hemispherical	2410	2410
Fluid	2465	2430
Free Swelling Index:	1/2	

Table 3-2

Characteristics of Benton Lignite with Regard to
the Coal Test Objective Matrix.

COAL TEST OBJECTIVE MATRIX									
PHYSICAL CHARACTERISTICS		COAL RANK							
TYPE	RANGE	BITUMINOUS	SUB-BITUMINOUS			LIGNITE	PEAT/BIOMASS	PETROLEUM COKE	BRIQUETTES
			A	B	C				
ASH CONTENT	H + 20%								
	M 10 - 20%								
	L - 10%					009			
ASH FUSION	H + 2700 F								
	M 2300-2700 F					009			
	L - 2300 F								
FREE SWELLING INDEX	H 3 +								
	M 1 - 3								
	L 0 - 1					009			
MOISTURE CONTENT	H + 15%					009			
	M 5 - 15%								
	L - 5%								
FRIABILITY (GRINDABILITY)	H								
	M					009			
	L								

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 and a tar scrubber which were 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 water-cooled agitator, 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 controlled with 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 MM BTU/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 condensation. The hot producer gas is quenched rapidly upon

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

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 nondispersive 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.

Sulfur species concentrations in the gas are determined with a HP 5793 gas chromatograph by manual injection of grab samples. The principal features of the HP 5793 are given in Table 4-2.

Table 4-1

Operating Configuration and Conditions,
Hewlett-Packard Model 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 Sieve 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

Table 4-2

Operating Configuration and Conditions,
Hewlett-Packard Model 5793 Gas Chromatograph

1. Flame photometric detector
2. Single column - 1-18" x 1/8" Teflon Supelpak-S (Porapak QS)
3. Ten port valve for sample injection and column backflush
4. Integrator with limited control capabilities
5. Nitrogen carrier gas: Carrier Flowrate = 32 ml/min
6. Sample loop size = 125 ul
7. Temperature program
 - Initial temperature 30 C
 - Initial time 1.5 min
 - Program rate 35 C min
 - Final temperature 170 C
 - Final time 5.0 min
8. Analysis cycle time 25 min.

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, Sivalls & Bryson, Incorporated (BS&B) and consisted of three shift lead operators and additional helpers as required. The gasifier was staffed with a lead operator and two helpers, three shifts each day. Backup for lead operators was provided by BS&B supervisory personnel.

The gasifier operations team was responsible for overall operation of the gasifier and associated process equipment and coordination of the three test teams. This includes: gasifier start up, coal 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 water 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
- 5) safety evaluation personnel

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 chromatograph 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, had a two-man team on site on November 8. They sampled for exhaust emissions from the gas combustor.

5.1.4 Industrial Cooperators

ANR Technology, Inc. had representatives on site during the test to observe operations and collect data. Some of the transient period data shown in Section 7.1.1 were collected by this group. GCO Minerals, Inc. also had observers on site for the test.

5.2 Gasifier Sampling and Data Acquisition Procedures

5.2.1 Continuous Data

An Analog Devices, Incorporated MACSYM 350 data acquisition system was used for this test. 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. During observation of transients the sample time is reduced to 6 seconds with one-minute averages written to disc.

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.

The HP 5793 gas chromatograph is calibrated before and after the test. Calibrations with varying levels of hydrogen sulfide in nitrogen have confirmed the square root response of the flame photometric detector to gas sulfur concentrations. The hydrogen sulfide FPD calibration factor is used for determination of carbonyl sulfide and mercaptan concentrations.

5.2.3 Tar and Oil Data

The condensed tar, oil, and water are removed from the accumulation reservoirs 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. Moisture content of each daily tar sample is determined by distillation.

5.2.4 Coal Data

Coal samples are taken by the operations team during coal addition to the lock hopper four times each shift. These four samples are stored in one bucket and submitted as a composite shift sample. 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 ash is discharged, and stored in a sealed container. For each ash sample the bulk density, particle size distributions, 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 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 daily from the dust accumulation bin. A single composite of all daily samples is submitted for analysis.

5.2.7 Exhaust Gas Sampling

The gas phase combustion 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 gasifier offtake for particles is performed periodically as operating conditions permit.

5.2.9 Retort Temperature and Pressure Probing

Vertical temperature and pressure profiles are measured periodically. The measurements are usually taken at the end of a period of steady state operation, just before operational changes are made.

SECTION 6

TEST CONDUCT

BOM/FGT-009, gasification of Benton Lignite, began 1:30 pm, November 1, 1983. The test operating history is shown in Figure 6-1.

The gasifier was charged with 9.55 tons of coke and the modified start-up procedure described in Volume 1 of this series (Thimsen, Maurer et al, 1984) was used. The gasifier was lit at 1:30 pm, and gas was sent to the combustor at 2:30 pm. The coke was gasified until 1:30 am, November 2 when the lignite reached the retort. The lignite fully occupied the retort by about 4:30 am. The 3/4 inch bottomsize screen was in use at this time.

For the first part of the test the blast air flow was maintained at 600 scfm. The resulting lignite consumption was about 1.2 tons/hr. During the transition from coke to lignite the blast saturation temperature was 61-62 C. As the lignite char entered the combustion zone, the ash layer became very hard. Clearly there was clinkering of the lignite ash at these low blast saturation temperatures (BST). The BST was raised to 70 C during the day of November 2. By the evening of November 2 these measures had nearly eliminated the clinkering.

Some difficulty was encountered during the day of November 2 in feeding the lignite through one leg of the weigh bin. This resulted in uneven feed of lignite to the retort, and subsequent uneven gas flow. The offtake temperature during this initial period was around 75 C.

The blast air flow was increased to 800 and then 1000 cfm on November 3. The BST was reduced to 68 C as a result of fire tests showing a cool fire. Operation at blast air flow of 1000 cfm lasted for 16 hours with an average lignite consumption of 2.2 tons/hr.

The final load level gasifying +3/4 inch lignite was reached on the afternoon of November 4. A blast air flow of 1600 cfm was achieved. The limitation to further increases in blast air flow was the ability to meter steam into the blast for saturation temperature control. With the low offtake temperatures experienced, almost all of the steam for blast saturation had to be supplied from the boiler.

Lignite consumption at this high load was approximately 3 tons/hr. The BST was held at 68 C during this period. These conditions were held for 24 hours. During this period the offtake temperature reached 200 C. There was some indication of gas channeling at this offtake temperature, probably caused by the presence of fine material added to the gasifier when the screen was plugged. The gas channeling did not affect operation

Figure 6-1
Test History, BOM/FGT-009

in an adverse way.

On November 5 the first of two transient behavior tests was undertaken. The blast air flow was reduced from 1600 cfm to 800 cfm in a step change at 2:20 pm, increased to 1600 cfm at 3:20 pm, and reduced to 800 cfm again at 4:20 pm. The gasifier responded well during all of these changes.

The 3/4 inch undersize screen was replaced with a 1/4 inch screen for the remainder of the test. The 1/4 inch bottomsize lignite entered the retort just after midnight November 6.

The blast air flow was brought up to an indication of 1400 scfm during November 6. There was evidence that the air flow was not accurately indicated at this point, and the actual air flow may have been as high as 1500-1600 scfm. Further increases in air flow were limited by the saturation steam delivery limitations described earlier. Lignite consumptions of 2.8 tons/hr were noted during this period. These conditions were maintained for 13 hours at which time the load had to be reduced because the conveyor belt feeding the screen was inoperative. Attempts to repair the belt were not successful, and the gasifier had to be banked at 6:10 am, November 7 for 6 hours while other repair parts were obtained.

The gasifier was warm started at 11:30 am on November 7, and gas sent to the combustor at noon. The blast air flow was brought up to 1400 cfm and held for 24 hours. Emissions measurements were performed on the combustor exhaust during this period.

The second transient behavior test was initiated on November 8. The blast air flow was reduced to 800 cfm at 2:05 pm, brought back to 1400 cfm at 3:05 pm, and reduced again to 800 cfm at 4:05 pm. The gasifier responded well to all of these changes. The blast air flow was maintained at 800 cfm until the inventory of delivered lignite was depleted, and BOM/FGT-010, gasification of peat pellets could begin (Volume 11, Thimsen, Maurer et al, 1985).

Some difficulty was experienced throughout the test getting the lignite to feed evenly through the gasifier. The lignite would bridge and hang up often. The problems were not serious, and were more of an annoying nature. Contributory to this problem may be the fact that the top size of the lignite was 3 inches where a top size of 2 inches is recommended for this gasifier.

With the exception of the first day of the test, the ash produced by the lignite was dry and granular, and brown in color. The clinkered ash produced during the first day of the test exerted a large torque on the grate. The variable frequency power supply powering the grate drive shut down under overload. For the bulk of the test the grate speed was then controlled only by varying the number of drive gear teeth engaged. The motor was directly connected to the electrical power and operated at

constant speed.

With the exception of the first day the fire tests were good and the ash layer free of clinker. The fire was, for the most part, cool. There were occasional multiple zones during fire tests, but these did not present operating difficulties.

Moderate amounts of dust were removed from the cyclone. The dust sank primarily, but some yellowish float dust was collected. Draining the cyclone after the bank took an excessively long time indicating accumulation of material in the bottom of the cyclone.

After the test the cyclone was opened and a large amount of tar/dust was observed in the bottom. The tar level was close to the bottom of the the vortex finder and was estimated to be approximately 5000 lb. This tar/dust had accumulated during the test due to the fact that the offtake temperatures were low enough to condense the tar in the gasifier. The tar/dust then collected in the bottom of the cyclone. The tar in the cyclone was ignited and allowed to burn the cyclone clean after the test was over. Tar yield data collected from the gas sampling and conditioning system downstream of the cyclone (Section 7.1.4) indicate lower tar loadings at this location during the beginning of the test and higher tar loadings at the end of the test suggesting that much of this material was collected during the beginning of the test.

Large accumulations of aqueous condensate and smaller amounts of tar condensate were collected periodically at a vertical to horizontal right angle bend in the gas duct. The aqueous condensate was yellow to green in color.

SECTION 7

TEST RESULTS

7.1 Data Summary

7.1.1 Continuous Output Transducer Data

The data acquisition system operated smoothly during the entire test. The only problem encountered was signal clipping when the NDIR carbon dioxide concentrations exceeded 10%.

Figure 7-1 shows the offtake temperature, fire loss pressure and dry gas heating value along with the operating parameters observed during the test period. The steady state offtake temperature was under 100 C. During the first two days the offtake temperature was higher while the ash zone was being cleared of clinker. The offtake temperature also rose somewhat on November 5 which is associated with some gas channeling and incomplete gasification as indicated by a reduction in gas heating value during this period. Otherwise, gas heating value was very stable at 170 - 175 BTU/dscf. Fire loss pressure was directly dependent on blast air flow. Fire loss pressure rose somewhat during the November 5 period identified above.

On November 5, 7, and 8 rapid changes in blast air flow were made to observe the transient response of the gasifier. Figures 7-2a to 7-2c show the data collected and averaged over 1 minute intervals during the transient periods. Oscillations in blast saturation temperature are the result of a faulty steam regulator in the import steam line. The carbon dioxide concentrations tended to rise on a drop in blast air flow and drop on a rise in blast air flow. Carbon monoxide concentrations and offtake temperature tended to rise and fall with blast air flow. In all, these transient effects were very minor, and barely noticeable.

7.1.2 Coal, Ash, and Dust Data

A complete list of the tests performed on the bulk lignite, ash, and cyclone dust samples collected during BOM/FGT-009, together with the number of samples analysed is given in Table 7-1.

7.1.2.1 Lignite Data

The mass fraction of lignite less than each of five indicated mesh sizes and the mean lignite particle size are presented in Figures 7-3 and 7-4 respectively. The bottom size screen change on November 5 from 3/4 to 1/4 inch is noticeable in both of these figures. Geometrical mean lignite size varied through the test which is a reflection of the fact that no systematic sizing was done during coal preparation at the mine site. The average lignite size distribution is shown in Figure 7-5.

Figure 7-1

Physical Characteristics of the Gasifier Operation

BOM/FGT-009

Figure 7-2a

Gasifier Response to Step Changes in Blast Air Flow

Figure 7-2b

Gasifier Response to Step Changes in Blast Air Flow

BOM/FGT-009

Figure 7-2c

Gasifier Response to Step Changes in Blast Air Flow

Table 7-1

Summary of Lignite, Ash and Cyclone Dust Analysis Performed

Material Type of Analysis		Samples Collected	Composite Samples Analyzed
Lignite	Particle size distribution	21	-
	Proximate analysis	-	1
	Ultimate analysis	-	1
	Ash fusion temperature	-	1
	Free swelling index	-	1
Ash	Particle size distribution	48	-
	Bulk density	48	-
	Moisture content	48	-
	Carbon content	48	1
	Sulfur content	48	1
	Chemical analysis	-	1
*Cyclone dust	Proximate analysis	-	1
	Ultimate analysis	-	1

* Composite of 5 cyclone dust samples.

Figure 7-3

Feed Coal Size Distribution Analysis

Figure 7-4

Geometrical Mean Coal Particle Size

Figure 7-5

Average Particle Size Distribution of Feed Coal

The results of the physical and chemical analyses of a single lignite sample composited over the entire test is given in Table 7-2.

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 shown in Figures 7-6 and 7-7 respectively. The mean ash particle size was somewhat larger after the initial clinkering period and the gas channeling noted on November 5. The rise in ash particle size on November 8 is unexplained. Geometrical ash particle size was 0.5 to 0.6 inches for most of the test.

Figure 7-8 shows the physical and chemical characteristics of the ash along with operational parameters. Ash carbon content was somewhat higher during periods of clinkering and after the bank on November 7. The other ash characteristics were unremarkable.

Table 7-3 gives the elemental analysis of a single sample of ash composited over the entire test period.

7.1.2.3 Cyclone Dust Data

The chemical analysis of one cyclone dust sample composited over the entire test period is shown in Table 7-2. The cyclone dust has a volatile matter/fixed carbon ratio only 56% that of the feed lignite. This is consistent with partial devolatilization of the dust in the higher temperatures of the upper retort and offtake duct. This partial devolatilization is not adequate to explain the increase in ash content, however. The ash to fixed carbon ratio of the dust is 2.6 times that of the feed lignite. High ash materials are, apparently, preferentially blown over. These materials may come from the lower regions of the retort where fixed carbon has been lost to the solid phase during gasification.

7.1.3 Gas Analysis Data

The NDIR gas analyzers and the gas chromatographs operated well during the entire test. The SIGMA calorimeter showed a calibration drift of about 1%/day, probably due to malfunctions of the barometric compensator.

The concentrations of the various species measured by the HP 5880A are shown in Figures 7-9 and 7-10. The major gas species along with operating parameters are shown in Figure 7-11. Gas composition was very stable throughout the test with the exception of the initial clinkering period and the gas channeling noted on November 5. Hydrogen and carbon dioxide concentrations tended to rise and fall with blast saturation temperature. This is consistent with the rapid achievement of

Table 7-2

Physical and Chemical Properties of Lignite and Dust

Material	Lignite	Cyclone Dust (dry basis)
<u>Type of Analysis</u>		
Proximate Analysis, wt %:		
Moisture	32.77	---
Volatile Matter	34.87	31.43
Ash	6.43	26.97
Fixed Carbon	25.93	41.61
Sulfur	0.56	1.54
Ultimate Analysis, wt %:		
Hydrogen	3.74	3.84
Carbon	44.79	63.63
Nitrogen	0.62	0.67
Sulfur	0.56	1.54
Oxygen	11.09	3.36
Ash	6.43	26.97
Moisture	32.77	---
Heating Value, btu/lb.:		
As Received	8081	-
Moisture Free	12020	11097
Ash Fusion Temp., deg F:		
(Oxidizing Atmosphere)		
Initial Def., IT	2300	-
Softening, ST	2365	-
Softening, HT	2410	-
Fluid, FT	2465	-
(Reducing Atmosphere)		
Initial Def., IT	2350	-
Softening, ST	2365	-
Softening, HT	2410	-
Fluid, FT	2430	-
Free Swelling Index	1/2	

Figure 7-6

Ash Size Distribution Analysis

Figure 7-7
Geometrical Mean Ash Particle Size

Figure 7-8

Ash Characteristics and Operating Conditions

Table 7-3
Elemental Analysis of Moisture-Free Ash

Element	Mass Fraction % (*)
Fe	12.5
Fe ₂ ⁺	3.4
Si	24.7
Al	5.4
C	5.7
Ca	3.9
Mg	0.44
K	0.12
P	0.58
Na	0.54
S	0.34
Ti	1.2

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

Figure 7-9

Major Gas Species Measured by the Gas Chromatograph.

Figure 7-10

Minor Gas Species Measured by the Gas Chromatograph.

Figure 7-11

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

equilibrium for the water - gas shift reaction in the gasification zone of the retort.

Ethylene and propylene concentrations tended to increase with an increase in offtake temperature, but not necessarily at the expense of ethane and propane. This behavior has been noted before (Volume 9, Thimsen, Maurer et al, 1985).

The HP 5793 gas chromatograph was used to measure sulfur species from hand-injected, syringe gas samples. The results of these analyses are shown in Figure 7-12. As these samples were injected by hand, the total quantity of gas varied from sample to sample. Thus the normalized composition is reported here. Gas sulfur composition was normalized so that hydrogen sulfide, carbonyl sulfide, methyl mercaptan and ethyl mercaptan concentrations all add to 100%. Generally, hydrogen sulfide was about 75%, carbonyl sulfide 10%, methyl mercaptan 3%, and ethyl mercaptan 12% of the total gas sulfur species.

7.1.4 Tar and water Yield Data

The gas sampling and conditioning system was shut down for service 7 times during the test. Table 7-4 shows the times and duration of these service periods. Clean gas was unavailable to the gas analyzers for only 6.5 hours during the 8-day test.

All condensate samples contained an emulsion of tar and water. This emulsion had to be removed by heating prior to compositing for analysis. A single composite condensate sample was prepared from samples collected throughout the test period. Table 7-5 shows the results of the analysis of this sample.

The tar and water yields along with operating parameters are shown in Figure 7-13. The tar yield measured at the gas sampling point is not representative of the tar content of the gas as it leaves the retort. As discussed in Section 6 considerable amounts of tar were removed in the cyclone upstream of the gas sampling point. The estimated overall gas tar content (including that collected in the cyclone) is 3.8 lb/1000 dscf.

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 balances around the gasifier include process temperatures, pressures and flows, material ultimate analyses, gas compositions, and dust carryover measurements (Section 7.6). For this test only the tar/oil loadings in the gas were set at 3.8 lb/1000 dscf for the first four time periods over which the material and energy balances were calculated (Tables 7-6 to 7-9). During these time periods

Figure 7-12

Sulfur Species Measured by the Gas Chromatograph

Table 7-4

Operation Summary for the Gas Sampling System

11/1	1630 - 1700	Replaced ESP high voltage power supply leads
11/2	1610 - 1905	Line between condenser and ESP plugged; Steam clean to remove clog
11/2	2015 - 2305	Line between condensor and ESP plugged; increase condensor exit temperature to 100 F
11/4	1500 - 1515	Observed oxygen in gas analysis instrument; tightened sampling line fittings by the gas meter to stop leak
11/7	1515 - 1545	Steam cleaned and rod cleaned condensor and main ball valve
11/7	1645 - 1650	Steam cleaned line between condensor and ESP
11/9	0030 - 0100	Observed low line pressure; tightened diaphragm pump bolts

Table 7-5
Condensed Material Analysis

11/1 - 11/9

Water

Total organics, % 0.16

	As Received	Dry Basis
--	----------------	--------------

Tar

Heating value, Btu/lb	17189	18953
-----------------------	-------	-------

Flash point, F	215	
Water by distillation, %	9.31	
Specific gravity, 60/60 F	1.0461	
Pour point, F	90	
Cold (solid) point, F	-	

Viscosity at:

122 F Saybolt Furol, s	42.7	
122 F Kinematic, centistokes	86.83	
210 F Saybolt Universal, s	49.5	
210 F Kinematic, centistokes	7.13	

Ultimate Analysis, WT%

Hydrogen	9.23	10.18
Carbon	77.22	85.15
Nitrogen	0.43	0.47
Oxygen (by difference)	3.20	3.53
Sulfur	0.59	0.65
Moisture, Total	9.31	
Ash	0.02	0.02

Figure 7-13

Tar/Oil Yield and Water Yield with Operating Conditions

BOM/FGT-009

Table 7-6

Material Balance and Thermal Efficiency Calculation
1.43 tn/hr, 159 F, +3/4 inch

Input Data

Time period: 11/02/83 15:00 - 11/03/83 6:00 (15.0 hours)

Gasifier Operation:

Coal feed, Ton/hour = 1.43
Blast air flow (dry) , Scfm = 725.
Saturated air temperature, F= 159.
Steam/Air Ratio (lb./lb.) = 0.29
Ambient air temperature, F = 45.
Off-take temperature, F = 291.

Coal Data:

Type = Benton Lignite (3/4 inch)
Mass Fraction Carbon % = 44.8
Mass Fraction Fixed Carbon = 25.93
Mass Fraction Moisture % = 32.77
Mass Fraction nitrogen % = 0.62
Mass Percent sulfur = 0.56
Heating value, Btu/lb = 8081

Tar and Water Yield (dry basis):

Water yield, lb./1000 SCF = 22.64
Tar yield, lb/1000 SCF = 3.80
Carbon in Tar (percent) = 85.1
Sulfur in Tar (percent) = 0.65
Tar HHV, thou. Btu/lb = 18.95

Ash and Dust Data:(dry basis)

Ash discharge ,lb/hour = 474.
Ash carbon ,percent = 13.2
Ash sulfur ,percent = 0.38
Ash moisture (wet),percent = 6.4
Cyclone dust,lb/hour(est.) = 25.

Gas Composition (Dry): (normalized to 99.90)

H2 % = 21.6	CH4 % = 1.81	H2S (est ppm)= 1320
CO % = 22.5	C2H4 % = 0.208	COS (est ppm)= 182
CO2 % = 10.70	C2H6 % = 0.144	CH3SH (est ppm)= 267
N2 % = 42.0	C3H6 % = 0.106	C2H5SH (est ppm)= 27
O2 % = 0.00	C3H8 % = 0.061	HHV, Btu/SCF = 172
Molec. Weight= 23.78	Argon(est. %)= 0.500	LHV, Btu/SCF = 158

Calculation Results (based on nitrogen and carbon balance)

Material Balance (Percent unaccounted for: -5.86)

Input,	lb/hr	% Total	Output,	lb/hr	% Total
Coal	= 2857.	39.2	Dry gas	= 5270.	68.2
Steam (total)	= 1001.	13.7	Water in gas	= 1903.	24.6
Air (calc,dry)	= 3437.	47.1	Oil and tar	= 319.	4.1
			Ash(calc,dry)	= 205.	2.7
			Dust	= 25.	0.3
Total	= 7294.		Total	= 7722.	

Energy Balance (Percent unaccounted for: -0.73)

Input,	MM BTU/hr	Output,	MM Btu/hr	% Total
Coal	= 23.1	Dry coal gas	= 14.4	59.9
Air	= -0.012	Oil and tar	= 6.05	25.1
Steam(import)	= 0.958	Sensible	= 0.59	2.5
Cooling water	= -0.084	Latent	= 2.043	8.5
		Ash	= 0.387	1.6
		Dust	= 0.277	1.1
		Cooling water	= 0.302	1.3
Total	= 23.9	Total	= 24.1	

Performance Data

Cold gas efficiency, percent = 60.4
Cold gas with tar efficiency, percent = 85.7
Hot gas without tar efficiency percent = 71.0
Hot gas with tar efficiency, percent = 96.6
Air/Coal (lb./lb.) = 1.203
Steam/Coal (lb./lb.) = 0.350
Air/Fixed Carbon (lb./lb.) = 4.640
Coal/Gasifier Area (lb./hr./sqft) = 86.1
Fixed Carbon/Area (lb./hr./sqft) = 22.3
Producer Gas/Coal (SCF/lb.) = 43.6
Producer Gas/Fixed Carbon (SCF/lb.) = 168.2
Tar Yield (lb./lb. coal) = 0.112

Table 7-7

Material Balance and Thermal Efficiency Calculation
1.81 tn/hr, 156 F, +3/4 inch

Input Data

Time period: 11/03/83 7:00 - 11/03/83 18:00 (11.0 hours)

Gasifier Operation:		Coal Data:	
Coal feed, Ton/hour	= 1.81	Type = Benton Lignite (3/4 inch)	
Blast air flow (dry) , Scfm	= 893.	Mass Fraction Carbon %	= 44.8
Saturated air temperature, F	= 156.	Mass Fraction Fixed Carbon	= 25.93
Steam/Air Ratio (lb./lb.)	= 0.27	Mass Fraction Moisture %	= 32.77
Ambient air temperature, F	= 36.	Mass Fraction nitrogen %	= 0.62
Off-take temperature, F	= 158.	Mass Percent sulfur	= 0.56
		Heating value, Btu/lb	= 8081

Tar and Water Yield (dry basis):		Ash and Dust Data:(dry basis)	
Water yield, lb./1000 SCF	= 17.93	Ash discharge ,lb/hour	= 152.
Tar yield, lb/1000 SCF	= 3.80	Ash carbon ,percent	= 9.9
Carbon in Tar (percent)	= 85.1	Ash sulfur ,percent	= 0.34
Sulfur in Tar (percent)	= 0.65	Ash moisture (wet),percent	= 35.4
Tar HHV, thou. Btu/lb	= 18.95	Cyclone dust,lb/hour(est.)	= 30.

Gas Composition (Dry): (normalized to 99.90)

H2 %	= 21.4	CH4 %	= 1.91	H2S (est ppm)	= 1447
CO %	= 23.6	C2H4 %	= 0.184	COS (est ppm)	= 172
CO2 %	= 9.96	C2H6 %	= 0.154	CH3SH (est ppm)	= 136
N2 %	= 42.0	C3H6 %	= 0.011	C2H5SH (est ppm)	= 50
O2 %	= 0.00	C3H8 %	= 0.069	HHV, Btu/SCF	= 173
Molec. Weight	= 23.70	Argon(est. %)	= 0.499	LHV, Btu/SCF	= 160

Calculation Results (based on nitrogen and carbon balance)

Material Balance (Percent unaccounted for: -1.56)

Input,	lb/hr	% Total	Output,	lb/hr	% Total
Coal	= 3613.	39.6	Dry gas	= 6667.	72.0
Steam (total)	= 1155.	12.7	Water in gas	= 1913.	20.7
Air(calc,dry)	= 4354.	47.7	Oil and tar	= 405.	4.4
			Ash(calc,dry)	= 248.	2.7
			Dust	= 30.	0.3
Total	= 9121.		Total	= 9264.	

Energy Balance (Percent unaccounted for: 2.58)

Input,	MM BTU/hr	Output,	MM Btu/hr	% Total
Coal	= 29.2	Dry coal gas	= 18.5	62.6
Air	= -0.023	Oil and tar	= 7.68	26.0
Steam(import)	= 1.248	Sensible	= 0.29	1.0
Cooling water	= -0.088	Latent	= 2.062	7.0
		Ash	= 0.353	1.2
		Dust	= 0.337	1.1
		Cooling water	= 0.302	1.0
Total	= 30.3	Total	= 29.5	

Performance Data

Cold gas efficiency,	percent	= 61.0
Cold gas with tar efficiency,	percent	= 86.4
Hot gas without tar efficiency	percent	= 68.6
Hot gas with tar efficiency,	percent	= 94.0
Air/Coal	(lb./lb.)	= 1.205
Steam/Coal	(lb./lb.)	= 0.320
Air/Fixed Carbon	(lb./lb.)	= 4.647
Coal/Gasifier Area	(lb./hr./sqft)	= 108.9
Fixed Carbon/Area	(lb./hr./sqft)	= 28.2
Producer Gas/Coal	(SCF/lb.)	= 40.9
Producer Gas/Fixed Carbon	(SCF/lb.)	= 157.5
Tar Yield	(lb./lb. coal)	= 0.112

Table 7-8

Material Balance and Thermal Efficiency Calculation
2.18 tn/hr, 153 F, +3/4 inch

Input Data

Time period: 11/03/83 18:00 - 11/04/83 9:00 (15.0 hours)

Gasifier Operation:

Coal feed, Ton/hour = 2.18
Blast air flow (dry) , Scfm = 1034.
Saturated air temperature, F = 153.
Steam/Air Ratio (lb./lb.) = 0.24
Ambient air temperature, F = 33.
Off-take temperature, F = 199.

Coal Data:

Type = Benton Lignite (3/4 inch)
Mass Fraction Carbon % = 44.8
Mass Fraction Fixed Carbon = 25.93
Mass Fraction Moisture % = 32.77
Mass Fraction nitrogen % = 0.62
Mass Percent sulfur = 0.56
Heating value, Btu/lb = 8081

Tar and Water Yield (dry basis):

Water yield, lb./1000 SCF = 17.87
Tar yield, lb/1000 SCF = 3.80
Carbon in Tar (percent) = 85.1
Sulfur in Tar (percent) = 0.65
Tar HHV, thou. Btu/lb = 18.95

Ash and Dust Data:(dry basis)

Ash discharge ,lb/hour = 206.
Ash carbon ,percent = 6.9
Ash sulfur ,percent = 0.26
Ash moisture (wet),percent = 16.7
Cyclone dust,lb/hour(est.) = 50.

Gas Composition (Dry): (normalized to 99.90)

H2 % = 20.6	CH4 % = 1.85	H2S (est ppm) = 1344
CO % = 25.1	C2H4 % = 0.187	COS (est ppm) = 197
CO2 % = 8.91	C2H6 % = 0.153	CH3SH (est ppm) = 218
N2 % = 42.2	C3H6 % = 0.111	C2H5SH (est ppm) = 86
O2 % = 0.00	C3H8 % = 0.068	HHV, Btu/SCF = 177
Molec. Weight = 23.77	Argon(est. %) = 0.502	LHV, Btu/SCF = 165

Calculation Results (based on nitrogen and carbon balance)

Material Balance (Percent unaccounted for: -2.13)

Input,	lb/hr	% Total	Output,	lb/hr	% Total
Coal	= 4354.	40.4	Dry gas	= 7936.	72.0
Steam (total)	= 1233.	11.4	Water in gas	= 2264.	20.5
Air(calc,dry)	= 5201.	48.2	Oil and tar	= 481.	4.4
			Ash(calc,dry)	= 287.	2.6
			Dust	= 50.	0.5
Total	= 10788.		Total	= 11018.	

Energy Balance (Percent unaccounted for: 1.58)

Input,	MM BTU/hr	Output,	MM Btu/hr	% Total
Coal	= 35.2	Dry coal gas	= 22.5	63.0
Air	= -0.032	Oil and tar	= 9.12	25.6
Steam(import)	= 1.182	Sensible	= 0.50	1.4
Cooling water	= -0.063	Latent	= 2.439	6.8
		Ash	= 0.287	0.8
		Dust	= 0.551	1.5
		Cooling water	= 0.276	0.8
Total	= 36.2	Total	= 35.7	

Performance Data

Cold gas efficiency, percent = 62.1
Cold gas with tar efficiency, percent = 87.2
Hot gas without tar efficiency percent = 69.9
Hot gas with tar efficiency, percent = 95.2
Air/Coal (lb./lb.) = 1.195
Steam/Coal (lb./lb.) = 0.283
Air/Fixed Carbon (lb./lb.) = 4.607
Coal/Gasifier Area (lb./hr./sqft) = 131.2
Fixed Carbon/Area (lb./hr./sqft) = 34.0
Producer Gas/Coal (SCF/lb.) = 40.2
Producer Gas/Fixed Carbon (SCF/lb.) = 155.0
Tar Yield (lb./lb. coal) = 0.111

Table 7-9

Material Balance and Thermal Efficiency Calculation
2.97 tn/hr, 154 F, +3/4 inch

Input Data

Time period: 11/04/83 14:00 - 11/05/83 14:00 (24.0 hours)

Gasifier Operation:

Coal feed, Ton/hour	= 2.97	Coal Data:	Type = Benton Lignite (3/4 inch)
Blast air flow (dry) , Scfm	= 1487.	Mass Fraction Carbon	% = 44.8
Saturated air temperature, F	= 154.	Mass Fraction Fixed Carbon	= 25.93
Steam/Air Ratio (lb./lb.)	= 0.25	Mass Fraction Moisture	% = 32.77
Ambient air temperature, F	= 39.	Mass Fraction nitrogen	% = 0.62
Off-take temperature, F	= 319.	Mass Percent sulfur	= 0.56
		Heating value, Btu/lb	= 8081

Tar and Water Yield (dry basis):

Water yield, lb./1000 SCF	= 20.09	Ash and Dust Data:(dry basis)	Ash discharge ,lb/hour = 259.
Tar yield, lb/1000 SCF	= 3.80	Ash carbon ,percent	= 3.3
Carbon in Tar (percent)	= 85.1	Ash sulfur ,percent	= 0.17
Sulfur in Tar (percent)	= 0.65	Ash moisture (wet),percent	= 15.7
Tar HHV, thou. Btu/lb	= 18.95	Cyclone dust,lb/hour(est.)	= 134.

Gas Composition (Dry): (normalized to 99.90)

H2	% = 20.2	CH4	% = 1.71	H2S	(est ppm) = 1394
CO	% = 23.0	C2H4	% = 0.299	COS	(est ppm) = 175
CO2	% = 10.08	C2H6	% = 0.140	CH3SH	(est ppm) = 170
N2	% = 43.6	C3H6	% = 0.133	C2H5SH	(est ppm) = 47
O2	% = 0.00	C3H8	% = 0.057	HHV,	Btu/SCF = 170
Molec. Weight	= 24.06	Argon(est. %)	= 0.518	LHV,	Btu/SCF = 157

Calculation Results (based on nitrogen and carbon balance)

Material Balance (Percent unaccounted for: -3.62)

Input,	lb/hr	% Total	Output,	lb/hr	% Total
Coal	= 5945.	39.2	Dry gas	= 11060.	70.4
Steam (total)	= 1835.	12.1	Water in gas	= 3504.	22.3
Air(calc,dry)	= 7389.	48.7	Oil and tar	= 663.	4.2
			Ash(calc,dry)	= 358.	2.3
			Dust	= 134.	0.9
Total	= 15168.		Total	= 15717.	

Energy Balance (Percent unaccounted for: 0.63)

Input,	MM BTU/hr	Output,	MM Btu/hr	% Total
Coal	= 48.0	Dry coal gas	= 29.6	60.2
Air	= -0.036	Oil and tar	= 12.56	25.5
Steam(import)	= 1.613	Sensible	= 1.35	2.7
Cooling water	= -0.063	Latent	= 3.769	7.7
		Ash	= 0.177	0.4
		Dust	= 1.484	3.0
		Cooling water	= 0.251	0.5
Total	= 49.5	Total	= 49.2	

Performance Data

Cold gas efficiency,	percent = 59.8
Cold gas with tar efficiency,	percent = 85.1
Hot gas without tar efficiency	percent = 69.7
Hot gas with tar efficiency,	percent = 95.3
Air/Coal	(lb./lb.) = 1.243
Steam/Coal	(lb./lb.) = 0.309
Air/Fixed Carbon	(lb./lb.) = 4.793
Coal/Gasifier Area	(lb./hr./sqft) = 179.1
Fixed Carbon/Area	(lb./hr./sqft) = 46.5
Producer Gas/Coal	(SCF/lb.) = 41.9
Producer Gas/Fixed Carbon	(SCF/lb.) = 161.6
Tar Yield	(lb./lb. coal) = 0.111

the measured tar loadings were approximately half of this level, but probably do not accurately represent the tar loadings leaving the retort as discussed in Section 6 and Section 7.1.4. For the last four periods over which the material and energy balance calculations were made (Tables 7-10 to 7-13) actual measured tar loadings were used. Tar/oil yield is discussed further in Section 7.4.

While relative measurements of gas sulfur species are made, the total sulfur loading in the gas is calculated assuming that all the sulfur in the lignite not reporting to the tar, ash, or dust ends up in the gas stream. Individual sulfur species concentrations are obtained by recalculating the normalized GC data to the total gas sulfur loadings calculated above. In addition, the total gas composition has been normalized to 99.9% accounted for in the material and energy balance calculations.

The balances are calculated over various time periods representing relatively stable operation. Each time period is characterized by a coal rate, blast saturation temperature, and bottom screen sizing. Tables 7-6 to 7-13 show the results of the calculations. Table 7-14 shows the results of the calculation over the entire test period.

The material and energy balance calculations indicate a systematic excess of material leaving the gasifier control volume. Evaluation of hydrogen and oxygen atomic balances indicates that the excess material contains these atoms in approximately the same ratio as in water. This indicates an error in measurement of water entering or leaving the gasifier. There are two possible sources of this error: 1) The lignite may have dried prior to analysis. (This is unlikely as the measured moisture content of the lignite would have to increase by about 40% to account for the excess water.) or 2) There may have been liquid water in the steam used for establishing blast steam/air ratio. The water associated with a blast saturation temperature increase of about 4 degrees C would be required to account for the excess water leaving the retort. This is the most likely explanation as large quantities of import steam were used during this test.

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. Figure 7-14 shows the experimental data from the test and the theoretical prediction. While the data points generally fall near the predictions, the theory tends to underpredict the ash removal rates for this test.

Table 7-10

Material Balance and Thermal Efficiency Calculation
1.48 tn/hr, 155 F, +1/4 inch

 Input Data

Time period: 11/05/83 16:00 - 11/06/83 3:00 (11.0 hours)

Gasifier Operation:

Coal feed, Ton/hour	= 1.48	Coal Data:	
Blast air flow (dry) , Scfm	= 993.	Type = Benton Lignite (1/4 inch).	
Saturated air temperature, F	= 155.	Mass Fraction Carbon %	= 44.8
Steam/Air Ratio (lb./lb.)	= 0.26	Mass Fraction Fixed Carbon	= 25.93
Ambient air temperature, F	= 44.	Mass Fraction Moisture %	= 32.77
Off-take temperature, F	= 289.	Mass Fraction nitrogen %	= 0.62
		Mass Percent sulfur	= 0.56
		Heating value, Btu/lb	= 8081

Tar and Water Yield (dry basis):

Water yield, lb./1000 SCF	= 20.18	Ash and Dust Data:(dry basis)	
Tar yield, lb/1000 SCF	= 3.78	Ash discharge ,lb/hour	= 230.
Carbon in Tar (percent)	= 85.1	Ash carbon ,percent	= 5.4
Sulfur in Tar (percent)	= 0.65	Ash sulfur ,percent	= 0.25
Tar HHV, thou. Btu/lb	= 18.95	Ash moisture (wet),percent	= 10.5
		Cyclone dust,lb/hour(est.)	= 26.

Gas Composition (Dry): (normalized to 99.90)

H2 %	= 21.3	CH4 %	= 1.83	H2S (est ppm)	= 1426
CO %	= 23.5	C2H4 %	= 0.219	COS (est ppm)	= 166
CO2 %	= 10.02	C2H6 %	= 0.146	CH3SH (est ppm)	= 185
N2 %	= 42.0	C3H6 %	= 0.118	C2H5SH (est ppm)	= 52
O2 %	= 0.00	C3H8 %	= 0.064	HHV, Btu/SCF	= 175
Molec. Weight	= 23.76	Argon(est. %)	= 0.499	LHV, Btu/SCF	= 162

 Calculation Results (based on nitrogen and carbon balance)

Material Balance (Percent unaccounted for: -4.63)

Input,	lb/hr	% Total	Output,	lb/hr	% Total
Coal	= 2950.	39.7	Dry gas	= 5465.	70.3
Steam (total)	= 920.	12.4	Water in gas	= 1761.	22.7
Air(calc,dry)	= 3561.	47.9	Oil and tar	= 330.	4.2
			Ash(calc,dry)	= 194.	2.5
			Dust	= 26.	0.3
Total	= 7432.		Total	= 7776.	

Energy Balance (Percent unaccounted for: -0.14)

Input,	MM BTU/hr	Output,	MM Btu/hr	% Total
Coal	= 23.8	Dry coal gas	= 15.3	61.7
Air	= -0.013	Oil and tar	= 6.25	25.2
Steam(import)	= 0.984	Sensible	= 0.59	2.4
Cooling water	= -0.087	Latent	= 1.894	7.7
		Ash	= 0.153	0.6
		Dust	= 0.290	1.2
		Cooling water	= 0.298	1.2
Total	= 24.7	Total	= 24.7	

Performance Data

Cold gas efficiency,	percent	= 61.8
Cold gas with tar efficiency,	percent	= 87.1
Hot gas without tar efficiency	percent	= 71.5
Hot gas with tar efficiency,	percent	= 97.0
Air/Coal	(lb./lb.)	= 1.207
Steam/Coal	(lb./lb.)	= 0.312
Air/Fixed Carbon	(lb./lb.)	= 4.656
Coal/Gasifier Area	(lb./hr./sqft)	= 88.9
Fixed Carbon/Area	(lb./hr./sqft)	= 23.1
Producer Gas/Coal	(SCF/lb.)	= 42.3
Producer Gas/Fixed Carbon	(SCF/lb.)	= 163.2
Tar Yield	(lb./lb. coal)	= 0.112

Table 7-11

Material Balance and Thermal Efficiency Calculation
2.02 tn/hr, 156 F, +1/4 inch

Input Data

Time period: 11/06/83 4:00 - 11/06/83 9:00 (5.0 hours)

Gasifier Operation:

Coal feed, Ton/hour = 2.02
Blast air flow (dry) , Scfm = 1033.
Saturated air temperature, F = 156.
Steam/Air Ratio (lb./lb.) = 0.26
Ambient air temperature, F = 43.
Off-take temperature, F = 223.

Coal Data:

Type = Benton Lignite (1/4 inch)
Mass Fraction Carbon % = 44.8
Mass Fraction Fixed Carbon = 25.93
Mass Fraction Moisture % = 32.77
Mass Fraction nitrogen % = 0.62
Mass Percent sulfur = 0.56
Heating value, Btu/lb = 8081

Tar and Water Yield (dry basis):

Water yield, lb./1000 SCF = 20.25
Tar yield, lb/1000 SCF = 3.78
Carbon in Tar (percent) = 85.1
Sulfur in Tar (percent) = 0.65
Tar HHV, thou. Btu/lb = 18.95

Ash and Dust Data:(dry basis)

Ash discharge ,lb/hour = 151.
Ash carbon ,percent = 1.9
Ash sulfur ,percent = 0.23
Ash moisture (wet),percent = 15.4
Cyclone dust,lb/hour(est.) = 47.

Gas Composition (Dry): (normalized to 99.90)

H2 % = 21.4	CH4 % = 1.72	H2S (est ppm) = 1383
CO % = 24.9	C2H4 % = 0.177	COS (est ppm) = 171
CO2 % = 9.19	C2H6 % = 0.139	CH3SH (est ppm) = 226
N2 % = 41.5	C3H6 % = 0.105	C2H5SH (est ppm) = 52
O2 % = 0.00	C3H8 % = 0.065	HHV, Btu/SCF = 177
Molec. Weight = 23.62	Argon(est. %) = 0.494	LHV, Btu/SCF = 164

Calculation Results (based on nitrogen and carbon balance)

Material Balance (Percent unaccounted for: -4.52)

Input,	lb/hr	% Total	Output,	lb/hr	% Total
Coal	= 4042.	40.0	Dry gas	= 7405.	70.1
Steam (total)	= 1262.	12.5	Water in gas	= 2408.	22.8
Air(calc,dry)	= 4801.	47.5	Oil and tar	= 449.	4.3
			Ash(calc,dry)	= 252.	2.4
			Dust	= 47.	0.4
Total	= 10105.		Total	= 10562.	

Energy Balance (Percent unaccounted for: -0.02)

Input,	MM BTU/hr	Output,	MM Btu/hr	% Total
Coal	= 32.7	Dry coal gas	= 21.1	62.8
Air	= -0.018	Oil and tar	= 8.51	25.3
Steam(import)	= 1.059	Sensible	= 0.57	1.7
Cooling water	= -0.083	Latent	= 2.590	7.7
		Ash	= 0.075	0.2
		Dust	= 0.526	1.6
		Cooling water	= 0.226	0.7
Total	= 33.6	Total	= 33.6	

Performance Data

Cold gas efficiency, percent = 62.8
Cold gas with tar efficiency, percent = 88.1
Hot gas without tar efficiency percent = 71.9
Hot gas with tar efficiency, percent = 97.4
Air/Coal (lb./lb.) = 1.188
Steam/Coal (lb./lb.) = 0.312
Air/Fixed Carbon (lb./lb.) = 4.581
Coal/Gasifier Area (lb./hr./sqft) = 121.8
Fixed Carbon/Area (lb./hr./sqft) = 31.6
Producer Gas/Coal (SCF/lb.) = 42.1
Producer Gas/Fixed Carbon (SCF/lb.) = 162.5
Tar Yield (lb./lb. coal) = 0.111

Table 7-12

Material Balance and Thermal Efficiency Calculation
2.37 tn/hr, 157 F, +1/4 inch

Input Data

Time period: 11/06/83 10:00 11/06/83 24:00 (14.0 hours)

Gasifier Operation:		Coal Data:	
Coal feed, Ton/hour	= 2.37	Type = Benton Lignite (1/4 inch)	
Blast air flow (dry) , Scfm	= 1323.	Mass Fraction Carbon %	= 44.8
Saturated air temperature, F	= 157.	Mass Fraction Fixed Carbon	= 25.93
Steam/Air Ratio (lb./lb.)	= 0.28	Mass Fraction Moisture %	= 32.77
Ambient air temperature, F	= 43.	Mass Fraction nitrogen %	= 0.62
Off-take temperature, F	= 256.	Mass Percent sulfur	= 0.56
		Heating value, Btu/lb	= 8081

Tar and Water Yield (dry basis):		Ash and Dust Data:(dry basis)	
Water yield, lb./1000 SCF	= 20.67	Ash discharge ,lb/hour	= 385.
Tar yield, lb/1000 SCF	= 5.03	Ash carbon ,percent	= 0.8
Carbon in Tar (percent)	= 85.1	Ash sulfur ,percent	= 0.13
Sulfur in Tar (percent)	= 0.65	Ash moisture (wet),percent	= 13.4
Tar HHV, thou. Btu/lb	= 18.95	Cyclone dust,lb/hour (est.)	= 68.

Gas Composition (Dry): (normalized to 99.90)

H2 %	= 21.4	CH4 %	= 1.76	H2S (est ppm)	= 1427
CO %	= 22.8	C2H4 %	= 0.229	COS (est ppm)	= 163
CO2 %	= 10.63	C2H6 %	= 0.138	CH3SH (est ppm)	= 207
N2 %	= 42.1	C3H6 %	= 0.018	C2H5SH (est ppm)	= 69
O2 %	= 0.00	C3H8 %	= 0.065	HHV, Btu/SCF	= 170
Molec. Weight	= 23.82	Argon(est. %)	= 0.501	LHV, Btu/SCF	= 157

Calculation Results (based on nitrogen and carbon balance)

Material Balance (Percent unaccounted for: -3.20)

Input,	lb/hr	% Total	Output,	lb/hr	% Total
Coal	= 4731.	40.7	Dry gas	= 8269.	68.9
Steam (total)	= 1512.	13.0	Water in gas	= 2722.	22.7
Air(calc,dry)	= 5393.	46.3	Oil and tar	= 662.	5.5
			Ash(calc,dry)	= 289.	2.4
			Dust	= 68.	0.6
Total	= 11636.		Total	= 12009.	

Energy Balance (Percent unaccounted for: -0.20)

Input,	MM BTU/hr	Output,	MM Btu/hr	% Total
Coal	= 38.2	Dry coal gas	= 22.4	56.5
Air	= -0.021	Oil and tar	= 12.54	31.6
Steam(import)	= 1.444	Sensible	= 0.79	2.0
Cooling water	= -0.049	Latent	= 2.941	7.4
		Ash	= 0.041	0.1
		Dust	= 0.752	1.9
		Cooling water	= 0.187	0.5
Total	= 39.6	Total	= 39.7	

Performance Data

Cold gas efficiency,	percent	= 56.6
Cold gas with tar efficiency,	percent	= 88.3
Hot gas without tar efficiency	percent	= 65.6
Hot gas with tar efficiency,	percent	= 97.6
Air/Coal	(lb./lb.)	= 1.140
Steam/Coal	(lb./lb.)	= 0.320
Air/Fixed Carbon	(lb./lb.)	= 4.395
Coal/Gasifier Area	(lb./hr./sqft)	= 142.6
Fixed Carbon/Area	(lb./hr./sqft)	= 37.0
Producer Gas/Coal	(SCF/lb.)	= 40.2
Producer Gas/Fixed Carbon	(SCF/lb.)	= 154.9
Tar Yield	(lb./lb. coal)	= 0.140

Table 7-13

Material Balance and Thermal Efficiency Calculation
2.57 tn/hr, 158 F, +1/4 inch

Input Data

Time period: 11/07/83 15:00 - 11/08/83 14:00 (23.0 hours)

Gasifier Operation:

Coal feed, Ton/hour = 2.57
Blast air flow (dry) , Scfm = 1333.
Saturated air temperature, F = 158.
Steam/Air Ratio (lb./lb.) = 0.28
Ambient air temperature, F = 46.
Off-take temperature, F = 292.

Coal Data:

Type = Benton Lignite (1/4 inch)
Mass Fraction Carbon % = 44.8
Mass Fraction Fixed Carbon = 25.93
Mass Fraction Moisture % = 32.77
Mass Fraction nitrogen % = 0.62
Mass Percent sulfur = 0.56
Heating value, Btu/lb = 8081

Tar and Water Yield (dry basis):

Water yield, lb./1000 SCF = 21.81
Tar yield, lb/1000 SCF = 5.99
Carbon in Tar (percent) = 85.1
Sulfur in Tar (percent) = 0.65
Tar HHV, thou. Btu/lb = 18.95

Ash and Dust Data:(dry basis)

Ash discharge ,lb/hour = 250.
Ash carbon ,percent = 3.6
Ash sulfur ,percent = 0.11
Ash moisture (wet),percent = 13.1
Cyclone dust,lb/hour(est.) = 83.

Gas Composition (Dry): (normalized to 99.90)

H2 % = 21.4	CH4 % = 1.76	H2S (est ppm)= 1568
CO % = 23.0	C2H4 % = 0.219	COS (est ppm)= 164
CO2 % = 10.59	C2H6 % = 0.112	CH3SH (est ppm)= 149
N2 % = 42.0	C3H6 % = 0.072	C2H5SH (est ppm)= 50
O2 % = 0.00	C3H8 % = 0.086	HHV, Btu/SCF = 172
Molec. Weight= 23.84	Argon(est. %) = 0.499	LHV, Btu/SCF = 158

Calculation Results (based on nitrogen and carbon balance)

Material Balance (Percent unaccounted for: -3.33)

Input,	lb/hr	% Total	Output,	lb/hr	% Total
Coal	= 5146.	42.2	Dry gas	= 8454.	67.1
Steam (total)	= 1553.	12.7	Water in gas	= 2934.	23.3
Air(calc,dry)	= 5491.	45.0	Oil and tar	= 806.	6.4
			Ash(calc,dry)	= 320.	2.5
			Dust	= 83.	0.7
Total	= 12190.		Total	= 12596.	

Energy Balance (Percent unaccounted for: -1.95)

Input,	MM BTU/hr	Output,	MM Btu/hr	% Total
Coal	= 41.6	Dry coal gas	= 23.1	52.6
Air	= -0.017	Oil and tar	= 15.27	34.8
Steam(import)	= 1.580	Sensible	= 1.00	2.3
Cooling water	= -0.060	Latent	= 3.177	7.2
		Ash	= 0.171	0.4
		Dust	= 0.920	2.1
		Cooling water	= 0.261	0.6
Total	= 43.1	Total	= 43.9	

Performance Data

Cold gas efficiency, percent = 53.6
Cold gas with tar efficiency, percent = 89.1
Hot gas without tar efficiency percent = 62.8
Hot gas with tar efficiency, percent = 98.6
Air/Coal (lb./lb.) = 1.067
Steam/Coal (lb./lb.) = 0.302
Air/Fixed Carbon (lb./lb.) = 4.115
Coal/Gasifier Area (lb./hr./sqft) = 155.1
Fixed Carbon/Area (lb./hr./sqft) = 40.2
Producer Gas/Coal (SCF/lb.) = 38.4
Producer Gas/Fixed Carbon (SCF/lb.) = 148.0
Tar Yield (lb./lb. coal) = 0.157

Table 7-14

Material Balance and Thermal Efficiency Calculation
Benton Lignite Overall Average

Input Data

Time period: Overall Average (118.0 hours)

Gasifier Operation:

Coal feed, Ton/hour = 2.24
Blast air flow (dry) , Scfm = 1162.
Saturated air temperature, F = 156.
Steam/Air Ratio (lb./lb.) = 0.26
Ambient air temperature, F = 41.
Off-take temperature, F = 271.

Coal Data:

Type = Benton Lignite (1/4 inch)
Mass Fraction Carbon % = 44.8
Mass Fraction Fixed Carbon = 25.93
Mass Fraction Moisture % = 32.77
Mass Fraction nitrogen % = 0.62
Mass Percent sulfur = 0.56
Heating value, Btu/lb = 8081

Tar and Water Yield (dry basis):

Water yield, lb./1000 SCF = 20.36
Tar yield, lb/1000 SCF = 4.45
Carbon in Tar (percent) = 85.1
Sulfur in Tar (percent) = 0.65
Tar HHV, thou. Btu/lb = 18.95

Ash and Dust Data:(dry basis)

Ash discharge ,lb/hour = 274.
Ash carbon ,percent = 5.9
Ash sulfur ,percent = 0.22
Ash moisture (wet),percent = 14.7
Cyclone dust,lb/hour (est.) = 62.

Gas Composition (Dry): (normalized to 99.90)

H2 % = 21.0	CH4 % = 1.78	H2S (est ppm) = 1432
CO % = 23.3	C2H4 % = 0.232	COS (est ppm) = 173
CO2 % = 10.14	C2H6 % = 0.137	CH3SH (est ppm) = 184
N2 % = 42.4	C3H6 % = 0.088	C2H5SH (est ppm) = 54
O2 % = 0.00	C3H8 % = 0.068	HHV, Btu/SCF = 172
Molec. Weight = 23.86	Argon(est. %) = 0.505	HHV, Btu/SCF = 159

Calculation Results (based on nitrogen and carbon balance)

Material Balance (Percent unaccounted for: -3.51)

Input,	lb/hr	% Total	Output,	lb/hr	% Total
Coal	= 4473.	40.3	Dry gas	= 7983.	69.5
Steam (total)	= 1384.	12.5	Water in gas	= 2585.	22.5
Air (calc,dry)	= 5237.	47.2	Oil and tar	= 565.	4.9
			Ash (calc,dry)	= 288.	2.5
			Dust	= 62.	0.5
Total	= 11094.		Total	= 11483.	

Energy Balance (Percent unaccounted for: -0.02)

Input,	MM BTU/hr	Output,	MM Btu/hr	% Total
Coal	= 36.1	Dry coal gas	= 21.9	58.5
Air	= -0.022	Oil and tar	= 10.71	28.7
Steam(import)	= 1.339	Sensible	= 0.81	2.2
Cooling water	= -0.069	Latent	= 2.787	7.5
		Ash	= 0.246	0.7
		Dust	= 0.689	1.8
		Cooling water	= 0.265	0.7
Total	= 37.4	Total	= 37.4	

Performance Data

Cold gas efficiency, percent = 58.5
Cold gas with tar efficiency, percent = 87.2
Hot gas without tar efficiency percent = 67.7
Hot gas with tar efficiency, percent = 96.7
Air/Coal (lb./lb.) = 1.171
Steam/Coal (lb./lb.) = 0.309
Air/Fixed Carbon (lb./lb.) = 4.515
Coal/Gasifier Area (lb./hr./sqft) = 134.8
Fixed Carbon/Area (lb./hr./sqft) = 35.0
Producer Gas/Coal (SCF/lb.) = 40.7
Producer Gas/Fixed Carbon (SCF/lb.) = 157.1
Tar Yield (lb./lb. coal) = 0.126

Figure 7-14

Comparison of the Geometrical Grate Performance Model
with Ash Removal Rates.

7.4 Tar Yield Correlations

The tar sampling problem described in Section 7.1.4 did not allow quantitative measurements of tar/oil yield leaving the retort during part of the test. The material and energy balances shown in Tables 7-10 to 7-13 show actual measured tar loadings at the gas sampling and conditioning system and resulting tar yields. The measured tar yields vary from 11.2 to 15.7 lb/100 lb coal.

These yields can be compared to a Fischer-Schrader assay yield of 11.2 lb/100 lb lignite reported by Selvig and Ode (1957) for an Arkansas lignite with a similar proximate and ultimate analysis. The Fischer-Schrader Assay tar/oil yield correlations proposed by Ode and Selvig (1944) and Gomez et al (1958) and shown in Figures 7-15 and 7-16 predict tar/oil yields of 12.2 and 11.2 lb/100 lb lignite respectively. The measured yields reported here are well within the scatter of the correlations.

7.5 Combustion Emissions Monitoring

Emissions from the gas combustion chamber were monitored on November 8. The sampling report is included as Appendix K. Three particulate samples were taken, but two of these contained large pieces of sample probe liner which sloughed off at the high flue gas temperatures encountered. As the bulk of the flame produced particles are very much smaller, laboratory techniques (see Appendix K) were used to estimate the actual flame particle production for these two samples.

Particle loadings of .012 gr/acf were observed. This corresponds to a mass loading of 8.6 lb/hr and a particulate emission factor of 0.19 lb/million BTU input. If the assumption is made that the particulate is ash, this corresponds to 2.6% of the ash entering the retort during this period. Corresponding dust flow rates leaving the cyclone would be 0.6% of the lignite entering the gasifier.

Sulfur dioxide concentrations averaging 451 ppm (dry) were measured. This corresponds to a mass flow rate of 70 lb/hr and a sulfur dioxide emission factor of 1.58 lb/million BTU. If all sulfur in the lignite were converted to sulfur dioxide in the combustor exhaust, the sulfur dioxide mass flow rate would be 58 lb/hr. This indicates essentially complete conversion of fuel sulfur to gaseous sulfur as confirmed by the low sulfur flows out the ashpit and cyclone.

Nitric oxide concentrations averaged 122 ppm (dry).

7.6 Retort Particle Sampling

A total of 9 product gas particulate samplings were made resulting in 4 sets of valid data. The particulate size

Figure 7-15

Tar/Oil Yield Correlation with Volatile Matter-Oxygen

(Ode and Selvig, 1944)

Figure 7-16

Tar/Oil Yield Correlation with Volatile Btu

(Gomez et al, 1958)

distribution was measured on one of the samples. Measurement of the size distribution and solid particle mass loadings was hampered by the collection of substantial tar particulate along with the solid dust. The particulate reported here is the toluene insoluble portion of the total particulate sampled. The particle data and distributions are included in Appendix G.

The total particulate loading data is shown in Figure 7-17 graphed against total gas flow. The correlation line in this graph was used to calculate dust flows for the material and energy balance calculations in Section 7.2. The mass median particle size of the single sample analyzed was 50 μm . Modal analysis of the particle size distribution indicated that a unimodal size distribution is adequate to fit the data. The mode of the volume (mass) distribution is at 42 μm .

Figure 7-17

Dust Carryover vs. Gas Face Velocity

SECTION 8

CONCLUSIONS

1. The maximum throughput observed was 3 tn/hr for a period of 24 hours. Throughput was limited by the delivery of import steam for control of blast saturation temperature.
2. A lignite throughput of 2.6 ton/hour (157 lb/hour/square foot grate) is recommended for design purposes. Based on this throughput and a blast saturation temperature of 158 F (70.0 C) the following material and energy flows can be expected:

Material in (lb/lb coal)		Energy In (million Btu/hr)	
Air	1.067	Lignite	42.0
Steam	.302	Steam (import)	1.6
Material out (lb/lb coal)		Energy Out (million Btu/hr)	
Dry Gas	1.64	Dry Coal Gas	25.4
Tar/Oil	.11	Tar/Oil	12.9
Water	.57	Sensible, Latent Heat	4.2
Dust	.02	Dust	0.93
Ash	.06	Ash	0.17
		Cooling Water	0.26

3. Blast saturation temperatures between 154 F and 159 F (68 C and 71 C) were used successfully. Lower blast saturation temperatures resulted in excessive ash clinkering.
4. Gasification of the +1/4 inch lignite was very comparable to gasification of the +3/4 inch material. No adverse effects were attributable to the smaller bottomsized material.
5. Particle emissions from the gas flame were 0.19 lb/million Btu input. Sulfur dioxide emissions were 1.58 lb/million Btu input; essentially all of the sulfur in the coal.
6. The low offtake temperatures (due to high fuel moisture content) result in condensation of the tar in the retort. This tar fog can cause severe problems in downstream gas handling equipment and must be considered in any industrial application using this fuel.
7. Based on this test, the Benton Lignite is recommended as a fixed-bed gasifier fuel. High throughputs are possible and gas quality is good. Careful consideration must be given, however, to handling the relatively low temperature overhead product laden heavily with dust and nucleated tar.

REFERENCES

- Gomez, M., J. B. Goodman, V. F. Parry. General Properties of Low Temperature Tar. USBM Bulletin 569. 1958
- Ode, W.H., W. A. Selvig. Low Temperature Distillation Yields of Primary Tar and Light Oil from Coals of Various Ranks and Types. USBM R.I. 3748. March 1944
- Selvig, W. A., W. H. Ode. Low Temperature Carbonization Assays of North American Coals. USBM Bulletin 571. 1957
- Thimsen, D., R. E. Maurer, A. R. Pooler, D. Y. H. Pui, B. Y. H. Liu, D. B. Kittelson. Fixed-Bed Gasification Research Using U. S. Coals, Volume 1 - Program and Facility Description. BuMines Contract HO222001 Final Report. October 1984
- Thimsen, D., R. E. Maurer, A. R. Pooler, D. Y. H. Pui, B. Y. H. Liu, D. B. Kittelson. Fixed-Bed Gasification Research Using U. S. Coals, Volume 9 - Gasification of Elkhorn Bituminous Coal. BuMines Contract HO222001 Final Report. May 1985

OTHER PUBLICATIONS UNDER BUMINES CONTRACT HO222001

- Thimsen, D., R. E. Maurer, A. R. Pooler, D. Y. H. Pui, B. Y. H. Liu, D. B. Kittelson. Fixed-Bed Gasification Research Using U. S. Coals, Volume 2 - Gasification of Jetson Bituminous Coal. BuMines Contract HO222001 Final Report. March 1985
- Thimsen, D., R. E. Maurer, A. R. Pooler, D. Y. H. Pui, B. Y. H. Liu, D. B. Kittelson. Fixed-Bed Gasification Research Using U. S. Coals, Volume 3 - Gasification of Rosebud Subbituminous Coal. BuMines Contract HO222001 Final Report. March 1985
- Thimsen, D., R. E. Maurer, A. R. Pooler, D. Y. H. Pui, B. Y. H. Liu, D. B. Kittelson. Fixed-Bed Gasification Research Using U. S. Coals, Volume 4 - Gasification of Leucite Hills Subbituminous Coal. BuMines Contract HO222001 Final Report. March 1985
- Thimsen, D., R. E. Maurer, A. R. Pooler, D. Y. H. Pui, B. Y. H. Liu, D. B. Kittelson. Fixed-Bed Gasification Research Using U. S. Coals, Volume 5 - Gasification of Stahlman Stoker Bituminous Coal. BuMines Contract HO222001 Final Report. March 1985
- Thimsen, D., R. E. Maurer, A. R. Pooler, D. Y. H. Pui, B. Y. H. Liu, D. B. Kittelson. Fixed-Bed Gasification Research Using U. S. Coals, Volume 6 - Gasification of Delayed Petroleum Coke. BuMines Contract HO222001 Final Report. May 1985

Thimsen, D., R. E. Maurer, A. R. Pooler, D. Y. H. Pui, B. Y. H. Liu, D. B. Kittelson. Fixed-Bed Gasification Research Using U. S. Coals, Volume 7 - Gasification of Piney Tipple Bituminous Coal. BuMines Contract HO222001 Final Report. May 1985

Thimsen, D., R. E. Maurer, A. R. Pooler, D. Y. H. Pui, B. Y. H. Liu, D. B. Kittelson. Fixed-Bed Gasification Research Using U. S. Coals, Volume 8 - Gasification of River King Illinois #6 Bituminous Coal. BuMines Contract HO222001 Final Report. May 1985

Thimsen, D., R. E. Maurer, A. R. Pooler, D. Y. H. Pui, B. Y. H. Liu, D. B. Kittelson. Fixed-Bed Gasification Research Using U. S. Coals, Volume 11 - Gasification of Minnesota Peat. BuMines Contract HO222001 Final Report. May 1985

Thimsen, D., R. E. Maurer, A. R. Pooler, D. Y. H. Pui, B. Y. H. Liu, D. B. Kittelson. Fixed-Bed Gasification Research Using U. S. Coals, Volume 12 - Gasification of Absaloka Subbituminous Coal. BuMines Contract HO222001 Final Report. May 1985

Thimsen, D., R. E. Maurer, A. R. Pooler, D. Y. H. Pui, B. Y. H. Liu, D. B. Kittelson. Fixed-Bed Gasification Research Using U. S. Coals, Volume 13 - Gasification of Blind Canyon Bituminous Coal. BuMines Contract HO222001 Final Report. May 1985

Thimsen, D., R. E. Maurer, A. R. Pooler, D. Y. H. Pui, B. Y. H. Liu, D. B. Kittelson. Fixed-Bed Gasification Research Using U. S. Coals, Volume 14 - Gasification of Kemmerer Subbituminous Coal. BuMines Contract HO222001 Final Report. May 1985

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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 009 BENTON LIGNITE

November 1, 1983

- 1332 Lit the gasifier.
- 1345 Started the caustic pump at 20/30.
- 1415 Lit the vent burner. Start loading Benton Lignite into the weigh bin.
- 1435 Started the induced draft fan and combustor.
- 1450 Gas is going downstream.
- 1505 Opened the steam valve to the header and the gasifier. Saturation temperature is 58 degrees C.
- 1530 Pulled every other port on the combustor chamber to get slightly positive top gas and gas supply pressures. Continued loading coal into the weigh bin. The agitator and grate are still off.
- 1600 Fire test ash average is 6.0 inches. The grate will remain off until we show at least 14 inches of ash. The bars were left in for 3 minutes.
- 1700 Jacket water flow is 11 gpm in attempt to maintain the jacket water outlet temperature of 90 degrees C and allow steam control of the saturation temperature. The valve is approximately 15% open.
- 1745 Finally finished loading the lignite into the weigh bin at 10.07 tons. This procedure with this fuel will be very time consuming as the lignite contains 50-60% fines. It took 2 hours to load 4 tons.
- 1800 Fire test ash average is 5.0 inches. There is a very hard crust developing about 6 inches above the grate. Had to use a sledge to break through.
- 1900 Offtake temperature is 150 degrees C.
- 1915 Increased the saturation temperature to 60 degrees C to loosen the crust.
- 2000 Fire test ash average is 7.6 inches. The bottom crust continues to be a problem. Increased the saturation temperature to 61 degrees C.
- 2030 Cyclone continues to be free of particulate. Freeboard average is 40.5 inches. Offtake temperature is

242 degrees C. Ash pit pressure is 4.0 inches wg.

2110 Offtake temperature is 275 degrees C. Ash pit pressure is 4.3 inches wg.

2137 Offtake temperature is 300 degrees C. Increased the jacket water flow to 12 gpm. Jacket water outlet temperature is 97 degrees C.

2150 Replaced all but 3 of the combustor port holes as we now have top gas and gas supply pressures of 1.5 inches wg. With all port holes in we dropped to 0 inches wg!

2200 Fire test ash average is 6.0 inches. The bottom crust is still very hard. Increasing the saturation temperature has helped very little. We are still not running the grate as we have relatively little ash.

2248 Offtake temperature is 350 degrees C.

November 2, 1983

0005 Fire test ash average is 12.5 inches. We could only get two bars pounded through the crust.

0010 Started the grate at 1/1.07 hoping this would loosen the crust.

0030 Cycled the coal valves.

0031 Increased the saturation temperature to 62 degrees C. Still trying to loosen the ash.

0130 The north coal leg is empty. Loaded 2.7 tons of lignite.

0200 Fire test ash average is 13.5 inches. The bed is showing some signs of loosening.

0300 Dumped ash.

0400 Fire test ash average is 16.7 inches.

0430 Pounded the poke rods through the crust.

0500 Dumped ash.

0530 Pounded the poke rods through the crust.

0600 Fire test ash average is 14.0 inches. Pounded the poke rods through the crust. It still feels like concrete.

0730 Freeboard average is 43.5 inches.

0740 No particulate is evident in the cyclone.

0800 Fire test ash average is 17.4 inches.

0810 Increased the saturation temperature to 64 degrees C. We are still trying to soften the bed. Changed the grate to 3 teeth. Variable speed control of the grate malfunctioned, so we wired it direct. This way we could lower the ash level.

0900 Dumped 590 pounds of ash. The ash size varied from fine particles to clinkers the size of basketballs. The clinkers had a reddish tinge to them. There appeared to be a few stones in the ash also.

0930 Noticed, while getting a coal sample, that the north side bin is empty.

1000 Fire test ash average is 11.7 inches. Lost the last 24 inches of the poke rod put in the number 4 hole and had to use a chain hoist to remove it.

1015 Increased the saturation temperature to 66 degrees. Still trying to soften the bed. Shoveling coal from the south to the north coal leg.

1045 Started the secondary combustion fan with the valve at 35% open. Put the remaining combustion ports in.

1100 Dumped 678 pounds of ash. There were some clinkers 3 inches in size, but it was mostly fine, heavy ash.

1115 The top of the coal bed is pitch black.

1200 Fire test ash average is 17.4 inches. The bars are going in a little better. We still have to use the sledge.

1215 Increased the grate speed to 4 teeth. Saturation temperature is 67 degrees C.

1300 Dumped 870 pounds of ash. The hopper is 20% full. The ash has many clinkers varying in size from 13 inches. Flushed the ash cone with the upper nozzles.

1315 The third load of lignite has arrived. This appears to be of better size with less fines than the first two loads.

1320 Offtake temperature is 411 degrees C. The north coal leg is empty. Started the agitator. Will make 2 sweeps and then stop it. Started loading lignite into the upper bin.

- 1330 Dropped in .91 ton of lignite into the gasifier.
- 1400 Dropped 1.34 tons of lignite into the gasifier. Fire test ash average is 16.6 inches. Bars are going in easier, but we must still use the sledge.
- 1415 Increased the saturation temperature to 79 degrees C. Had to increase the regulated steam valve manually. Increased the induced draft fan to -1.6 inches wg.
- 1430 The north slide gate is empty, but it is showing a weight of 2.07 tons.
- 1500 Dropped 1.03 tons of coal into the gasifier. The gas supply valve is 100% open. Dumped ash.
- 1520 Increased the furnace pressure to -2.0 inches wg to reduce the top gas and gas supply pressures from 4.0 inches wg to 3.2 inches wg.
- 1550 Offtake temperature peaks again. This time it is at 612 degrees C. The north coal leg is empty. Rectified the situation by vibration and pounding, as well as cycling the valves a couple times. Offtake temperature responded by reducing to 240 degrees C. The north coal leg is choked full again.
- 1600 Fire test ash average is 15.4 inches. Saturation temperature is 70 degrees C. There is still a hard crust 2.5-3 inches up. Leaving the grate at 4 teeth.
- 1615 Got the first load of double screened 3/4" x 3" lignite. Continued filling the weigh bin.
- 1630 Feeding 1.3 tons of coal per hour over the last 2 hours.
- 1655 The conveyor belt broke down with only 6.34 tons of lignite in the weigh bin. The belt tore straight across with the laces intact on either side of the spline.
- 1730 The north coal leg continues to run empty. Freeboard average is 48.5 inches. Continued work on the conveyor belt repair.
- 1800 Fire test ash average is 15.7 inches.
- 1830 Dumped 1400 pounds of ash. The north coal leg is still hanging up. Offtake temperature is 640 degrees C.
- 1930 Continued working on the conveyor. Have only 2.71 tons in the weigh bin. Have managed to keep control of the offtake temperature and have managed to cover

the hot spots on the bed during the last hour. It appears that we will not have to use the agitator as a coal distributor.

2000 Fire test ash average is 18.6 inches. Increasing the grate speed to 5 teeth.

2030 Conveyor belt is now functioning. Had to disconnect the hopper from the conveyor to allow free travel. The belt will still bind if we are not careful when dumping from the front end loader. Must dump it very gently. Had a low coal feed this time (0.74 ton). This seems to be typical when the weigh bin falls below 3.5 tons.

2045 Dumped 1300 pounds of ash. Normal size distribution with a few clinkers 8-9 inches.

2130 Coal feed was 2.51 tons. This averages the last two hours at 1.63 tons/hour. We are still loading lignite into the weigh bin.

2200 Fire test ash average is 15.4 inches. Slowed the grate to 4 teeth.

2230 Dumped 1200 pounds of ash. The saturation temperature is running between 74 & 78 degrees C. The cyclone outlet is showing a similar drop (87-91 degrees C).

2250 Continue filling the upper bin. The conveyor belt is holding together. More uniformly sized 3/4" X 3" coal is now in the retort. Noticed an immediate drop in the weigh bin readout. Dropped 1.43 tons with little hang up.

October 3, 1983

0005 Fire test ash average is 20.4 inches.

0100 Dumped ash.

0130 Finished loading coal for the second shift.

0200 Fire test ash average is 20.4 inches. The bars are going in with a little difficulty.

0300 Dumped ash.

0330 Dumped the cyclone and found very little particulate.

0400 Fire test ash average is 17.7 inches. The bars are going in a little more easily.

0500 Dumped ash and started loading coal.

0530 We are increasing the saturation air flow to 800 cfm from 600 cfm in 50 cfm increments every half hour starting now. Saturation air flow is now 650 cfm.

0600 Increased the saturation air flow to 700 cfm. Fire test ash average is 12.6 inches.

0630 Increased the saturation air flow to 750 cfm.

0730 Caustic pump is pumping 45/50 instead of the 20/30 earlier presumed.

0755 Changed the saturation temperature to 68 degrees C from 70 degrees C to heat up the ash bed.

0800 Fire test ash average is 11.6 inches.

0815 Opened the downcomer and a yellowish water came out followed by a small amount of tar. Cleaned the combustion burner.

1000 Fire test ash average is 7.4 inches.

1010 Saturation temperature is up to 69 degrees C. The grate is now down to 3 teeth to build up a little higher ash level.

1015 Dumped 1320 pounds of ash. The ash was mostly clinkers 1.5-2.0 inches in diameter, with a few 7 inches in diameter.

1035 Taking a pressure and temperature bed probe.

1110 Stopped loading coal at 10.88 tons.

1200 Fire test ash average is 9.9 inches.

1230 Changing the conveyor belt.

1315 Lowered the saturation temperature to 68 degrees C. Opened the steam valve to the stack so the boiler will continuously fire.

1400 Fire test ash average is 7.0 inches.

1410 Started loading coal into the upper bin. Dumped 895 pounds of ash. This time the ash was mostly fine with a few 1-3 inch clinkers. The cyclone has a yellow scum 2 inches thick floating on top of the water, but the bottom is still clean.

1435 Slowed the grate to 2 teeth to build up the ash level.

- 1445 While taking the freeboard test, it was noticed that the north coal leg was plugged. We then freed it up.
- 1600 Fire test ash average is 11.1 inches. There were still 3 cold bars after 7 minutes! Leaving the grate at 2 teeth.
- 1620 Stopped loading coal into the weigh bin at 10.99 tons. Coaling up is going much smoother with the new belt and more uniformly sized coal.
- 1630 Dumped the cyclone and found no floating silt only about 2 inches of mustard colored sludge on the bottom.
- 1640 Dumped 600 pounds of ash. The size ranged from 3 inch clinkers down to fine granules.
- 1645 Lowered the saturation temperature to 67 degrees C. Increasing the saturation air flow to 850 cfm and will continue to increase it by 50 cfm increments every half hour.
- 1730 Saturation air flow is now 1000 cfm. We are dropping 2 tons/hour at this saturation air flow. Decreasing the jacket water to 10 gpm to aid in maintaining a 67 degrees C saturation temperature.
- 1755 Top gas and gas supply pressures have steadily climbed with the load increases. Put all blowers at 100% to reduce these pressures.
- 1800 Fire test ash average is 11.9 inches. Leaving the grate at 2 teeth. Noticed that gas is being pushed past the steam through the poke holes during a fire test at this higher load. Top gas and gas supply pressures are running between 9 & 9.4 inches.
- 1805 Decreased the jacket water flow to 8 gpm to aid in maintaining the saturation temperature at 67 degrees C.
- 1830 Again we dropped 2 tons of lignite into the retort.
- 1900 Steam control has stopped oscillating. The chart shows a much straighter line.
- 1918 Offtake temperature is 100 degrees C.
- 1935 Started filing the weigh bin at 3.33 tons.
- 2000 Fire test ash average is 11.6 inches. Leaving the grate speed at 2 teeth.

2030 Still feeding 2 tons/hour at this saturation air flow and temperature.

2035 Reduced the saturation temperature to 66 degrees C.

2110 Dumped 800 pounds of dry granular ash.

2130 Dropped 2.6 tons into the retort. Gas quality appears to be very good.

2200 Fire test ash average is 13.3 inches. Leaving the grate at 2 teeth. The bars are going in easily. Some bars had to be left in 13 minutes to get a reading.

2225 Stopped loading lignite into the weigh bin at 11.52 tons.

October 4, 1983

0005 Fire test ash average is 12.1 inches. The bars are going in with ease and no clinkers are evident. There is also no burning through. The bars were in for 10 minutes.

0030 Dropped 2.14 tons of lignite.

0100 Dumped ash.

0130 Dropped 2.04 tons of lignite.

0200 Fire test ash average is 14.7 inches.

0300 Started loading lignite into the weigh bin. Dumped ash.

0310 Coal conveyor has broken down again. The alligator lacings ripped out.

0350 Got the coal conveyor repaired. Started loading coal again.

0400 Fire test ash average is 17.4 inches.

0500 Dumped ash.

0530 Still loading coal into the upper bin.

0600 Fire test ash average is 12.3 inches.

0730 Offtake temperature is 130 degrees C. Ran the vibrator and the coal leg is empty. Dropped 2.32 tons of coal. Dumped the cyclone and found 4 rakesful of black particulate on the bottom and a small amount of

- yellow silt floating on top of the water.
- 0800 Fire test ash average is 9.4 inches.
- 0815 Started the pressure and temperature bed probe.
- 0820 Cleaned the combustion burner. The gas was so thick that we could not see the flame from the inlet port. From the exhaust port we could see heavy flame burning down with small flames coming straight out.
- 0830 Dumped 3.62 tons of lignite. The north slide valve hung up.
- 0900 Dumped 975 pounds of ash.
- 0905 Cleaned the down comer and a large amount of yellow water (10 gallons) and a little tar came out.
- 0915 Increased the saturation air flow to 1050 cfm.
- 0930 Increased the saturation air flow to 1100 cfm.
- 0945 Increased the saturation air flow to 1150 cfm.
- 1000 Fire test ash average is 9.3 inches. We could only put 2 bars in at a time due to the high cyclone outlet pressure (12.7 inches wg). Closed the cyclone valve.
- 1020 Leaving the cyclone valve closed as the pressure is still 12.7 inches wg.
- 1045 Increased the saturation air flow to 1200 cfm. The pH reading at the induced draft fan is +4.0, the bleed off line at the stack is 4.4 and the scrubber tank shows 7.0.
- 1100 Checked the pressure safety valve. It showed 11 inches wg. Found that the gas supply valve had hung up at 90% closed. We freed it up and readjusted the linkage. The cyclone pressure is now down to 0.3 inches wg.
- 1125 Offtake temperature is 173 degrees C. Cycled the coal valve to fill the coal chute. Induced draft fan is settling down to -0.2 inches wg.
- 1130 Increased the saturation air flow to 1250 cfm.
- 1145 Increased the saturation air flow to 1300 cfm.
- 1200 Fire test ash average is 9.0 inches. Turned on the vibrator as the coal had hung up.

- 1215 Increased the saturation air flow to 1350 cfm. Saturation steam temperature is 63 degrees C. Increased the steam flow.
- 1245 Increased the saturation air flow to 1400 cfm.
- 1255 Dumped 1100 pounds of ash.
- 1300 Increased the saturation air flow to 1450 cfm.
- 1315 Increased the saturation air flow to 1500 cfm.
- 1330 Increased the saturation air flow to 1550 cfm. Dropped 2.81 tons of lignite. The gas quality is steadily improving.
- 1340 University of Minnesota was getting oxygen in the samples, so we increased the cyclone outlet pressure to 1.3 with the induced draft fan at +0.6 inches wg.
- 1345 Increased the saturation air flow to 1600 cfm. Increased the regulator steam flow.
- 1400 Increased the saturation temperature to 68 degrees C and increased the grate to 3 teeth. Fire test ash average is 13.9 inches.
- 1500 Dumped 600 pounds of ash. We have started coaling up every half hour. The coal legs are running empty in 45 minutes.
- 1510 Increased the induced draft fan to 0.6 inches wg. Gas is blowing out the combustor inlet. Cyclone pressure was 1.7 inches wg and this lowered it to 1.0 inch wg.
- 1600 Fire test ash average is 18.9 inches.
- 1615 Increased the grate to 4 teeth to grind out more ash.
- 1635 Flushed the cyclone and cleaned it with the water being green in color and 10 rakesful on the bottom.
- 1700 Dumped 840 pounds of ash. The clinkers ranged from 1-6 inches in size.
- 1800 Fire test ash average is 6.0 inches, which is 12.9 inches lower than the last fire test. Changed the grate from 4 to 2 teeth to allow the ash to build back up.
- 1820 Noticing some noise from the grate. Investigation that the shaft keeper key on the grate gear box had worked out and was chewing through the shaft. Stopped the grate and reseated the key. The shaft had

been eaten 1/4 of the way through.

1900 Dumped 800 pounds of ash. Granular ash had clinkers 2-3 inches in size.

2000 Fire test ash average is 13.6 inches. Slowed the grate to 3 teeth.

2100 Dumped 600 pounds of ash. The pH is 7.0 at the scrubber with a 4.0 reading at the induced draft fan.

2200 Fire test ash average is 9.1 inches. Slowed the grate to 2 teeth to regain the 12-14 inch ash level.

2240 Upper bearings on the elevator were dry so we greased them thoroughly.

October 5, 1983

0005 Fire test ash average is 18.6 inches. The bars are going in easily.

0030 We are getting a large amount of particulate from the cyclone.

0100 Dumped ash.

0130 Finished loading lignite into the weigh bin.

0200 Fire test ash average is 12.9 inches.

0245 Started loading lignite into the weigh bin.

0310 Conveyor is out of commission again.

0317 Dumped ash.

0400 Fire test ash average is 13.4 inches.

0418 Got the conveyor going again.

0430 Dumped the cyclone and a large amount of yellow particulate resulted.

0500 Dumped ash.

0730 Offtake temperature is 208 degrees C.

0745 Combustion burner has a bright orange flame covering the entire burner end and up 1/4 of the way in the combustor. Increased the induced draft fan to -0.4 inches wg. Flushed and cleaned the cyclone. The tank under the cyclone is 2/3 full of particulate. The screen in the shaker is completely filled. The

coal weigh bin must include a lot of fines.

- 0800 Fire test ash average is 10.0 inches.
- 0835 Checked the coal below the slide gate and noticed 25% fines. The south coal leg is leaking gas with the offtake pressure at 0.9 inches wg.
- 0840 Offtake temperature is 234 degrees C. The steam valve for the number 3 retort acces port was on.
- 0845 Offtake temperature is 243 degrees C. Started the vibrator and the agitator. Will let the agitator run for 1 revolution.
- 0915 Dumped 1120 pounds of wet ash. The ash is 50% clinkers varying in size from 1/4 to 3 inches in size.
- 0920 Opened the downcomer and approximately 1 gallon of water and 1 quart of black, sticky tar came out.
- 0945 Offtake temperature is 254 degrees C. Number 3 hole shows channeling against the outside wall. Noticed bright orange sparklers flying up. Started the agitator and let it run for 1 revolution. Flushed and cleaned the cyclone. The tank was half full of black particulate and a small amooant of floating material.
- 1000 Fire test ash average is 12.4 inches.
- 1015 Started the pressure and temperature bed probe.
- 1130 Flushed and cleaned the cyclone. Again there was a large amount of particulate in the bottom of the tank. The bottom of the tank was 2/3 full.
- 1135 There is still evidence of channeling through in the region of the number 3 hole.
- 1145 Power blip. Combustor alarm sounded and everything else is o.k. The burners are out in the combustor.
- 1205 Turned the interlocks off and started the combustion burner. Fire test ash average is 17.4 inches.
- 1220 Increased the grate. Flushed the cyclone and found the tank to be 2/3 full.
- 1240 Fire loss pressure is coming down. It is now 18.8 inches wg.
- 1300 Dumped 1070 pounds of ash.
- 1400 Fire test ash average is 11.6 inches. The bed is uneven. Slowed the grate to 2 teeth.

- 1420 Starting the load swing test. We will go to 800 cfm and hold it there for 1 hour. During this time we will switch to the 1/4 inch screen. Increasing the jacket water flow to 11 gpm. The steam control valve is 22% open. Cut the furnace pressure to +0.2 inches wg. We are trying to maintain 0.5 inch wg on the top gas and gas supply pressures.
- 1435 Started topping off the weigh bin before going to the smaller screen.
- 1450 This is the final coal up on the 3/4" X 3" lignite at 11.03 tons. Started changing the screen.
- 1515 Dumped 760 pounds of ash.
- 1520 Swinging the saturation air flow back to 1600 cfm and holding there for 1 hour. Cut the jacket water flow to 6 gpm. This should allow the steam control valve to control the saturation temperature at 68 degrees C. Increased the furnace pressure to -0.4 inches wg. Noticed that the fire loss pressure is 15 inches wg.
- 1550 The 1/4 inch screen is in place.
- 1600 Fire test ash average is 9.9 inches. Slowed the grate to 2 teeth to maintain the ash level of 12-14 inches.
- 1620 Making the final swing from 1600 cfm to 800 cfm. The furnace pressure is +0.2 inches wg. Jacket water flow is back to 11 gpm. The steam control valve is 22% open.
- 1630 Noticed that the oscillations of the steam controller have straightened out.
- 1800 Fire test ash average is 12.4 inches. Slowing the grate to 1 tooth.
- 1900 Continuing to run the weigh bin empty. Higher heating value is 173 Btu/ft³. Dropping 1.5 tons/hour at 800 cfm saturation air flow.
- 2000 Fire test ash average is 13.3 inches. Leaving the grate at 1 tooth.
- 2020 Dumped 960 pounds of ash.
- 2030 There is still 0.74 tons of lignite in the weigh bin (all on the south side). We will have one final drop at 2100 and then start loading the 1/4" X 3" lignite.
- 2100 The upper bin is empty at 0.53 tons. Started loading

the 1/4" X 3" lignite into the weigh bin. Will continue to cycle the coal valve every half hour until the lower bin is empty. The coal is getting damp as it is misting outside.

2200 Fire test ash average is 16.9 inches. The bed is quite uneven. Increasing the grate to 2 teeth to reduce the ash level.

2210 Stopped filling the weigh bin at 12.12 tons. The screen did not blind over appreciably. There appear to be very few fines.

2230 Continued cycling from the lower bin to the retort. The offtake temperature is running from 150 to 160 degrees C. The induced draft fan has started making a high pitched sound. The bearings are not hot. Flushed the cyclone and got 5-10 rakesful off the bottom.

2300 The coal pipes are still choked full and cool to the touch. We will continue cycling the coal valve.

October 6, 1983

0005 We finally dropped the 1/4 X 3 inch lignite into the gasifier (3.29 tons).

0010 Fire test ash average is 26.6 inches. The bars are going in easily with no clinkering.

0030 Coal up.

0100 Dumped ash.

0200 Fire test ash average is 20.3 inches. The bed is soft with no burning through.

0230 The saturation air flow is 850 cfm and increasing by 50 cfm every half hour until we reach 1000 cfm.

0300 Increasing the saturation air flow to 900 cfm.

0330 Increasing the saturation air flow to 950 cfm. Coal is hanging up in the upper bin. We had to persuade it with a hammer.

0400 Increased the saturation air flow to 1000 cfm. Fire test ash average is 31.6 inches.

0410 Increased the grate to 4 teeth.

0500 Dumped ash.

0600 Fire test ash average is 26.3 inches. The bed is

soft and the bars are going in easily.

0730 The grate speed is at 3 teeth. Freeboard average is 43.5 inches.

0800 Fire test ash average is 18.6 inches. Increased the grate speed to 4 teeth. Flushed and cleaned the cyclone. There was some floating, yellow particulate and 1.5 rakesfull of black silt on the bottom.

0820 Started the pressure and temperature bed probe.

0840 Number 1 scrubber blow down line is plugged. The combustor port is having a positive effect on the gas. Increased the induced draft fan to +0.2 inches wg. The induced draft fan sounds good and the bearings are running cool. Fire loss pressure has increased to 10.9 inches wg.

0900 We will increase the saturation air flow by 50 cfm everfy half hour until we reach 1500 cfm.

0915 Cycled the vent valve and it appears to be working well. The offtake pressure dropped with the vent open. Increased the saturation air flow to 1100 cfm.

0930 Increased the saturation air flow to 1150 cfm.

0945 Increased the saturation air flow to 1200 cfm. Saturation steam control valve is 30% open.

1000 Increased the saturation air flow to 1250 cfm.

1015 Increased the saturation air flow to 1300 cfm. Fire test ash average is 13.0 inches. There is a crust just above the fire zone. Grate speed is set at 3 teeth. Saturation temperature is 69 degrees C. Fire loss presure dropped after the fire test.

1030 Saturation steam control valve is 70% open. Slowed the jacket water flow down to 6 gpm.

1045 Slowed the jacket water to 4 gpm. Dumped 1350 pounds of ash. Saturation steam control valve is 100% open. Increased the saturation air flow to 140 cfm.

1100 Holding the saturation air flow at 1400 as we are out of steam!

1135 Offtake temperature is 130 degrees C. Ash pit pressure is 18.7 inches wg. Fire loss pressure is 17.0 inches wg. Gas offtake pressure is 1.6 inches wg.

1200 Offtake temperature is 109 degrees C. Dropped 1.48 tons of lignite. Fire test ash average is 20.3

inches. There is still a crust above the fire zone. Increasing the grate to 4 teeth to lower the ash level to 12-14 inches.

- 1230 Repairing the roller for the conveyor top end.
- 1330 Dumped 1020 pounds of ash.
- 1350 Higher heating value is 171 Btu/ft³. Lower heating value is 158 Btu/ft³. CO is 23% and CO₂ is 9.8%.
- 1410 Power blip. Combustor and blowers are down. Flooded the cyclone. Vented the gas through the roof flare.
- 1425 Saturation air flow shows 125 cfm.
- 1430 Started the induced draft fan and combustor fans. Lit the combustor. Opened the 3 inch bypass valve to drain the water from the cyclone.
- 1435 Gas is going downstream again. Saturation air flow is back to 1400 cfm.
- 1600 Fire test ash average is 13.7 inches. The bed is evening out somewhat. Leaving the grate at 4 teeth.
- 1635 Dumped 1050 pounds of ash.
- 1650 Started filling the upper bin at 5.29 tons.
- 1725 Stopped filling the upper bin at 10.28 tons. Dust is the main problem now for coaling-up. Flushed the downcomer and the results were lots of water and heavy oils.
- 1800 Fire test ash average is 12.9 inches. The bed is slightly more inclined. Leaving the grate at 4 teeth.
- 1920 Dumped 1200 pounds of ash. This ash weight built up over a period of 2.5 hours. The grate rph have increased while maintaining 4 teeth.
- 1935 Started filling the weigh bin at 3.26 tons.
- 1955 Conveyor belt has torn again at the lacings. We have 8.2 tons of lignite in the upper bin. This should give us time to repair it well enough to get by.
- 2000 Troubleshooting the conveyor. Starting at 2030, we will be dropping the lignite every hour.
- 2030 There has been a 3 inch wg increase in both the ash pit and fire loss pressures.

- 2125 Fire loss and ash pit pressures have returned to previous levels of 17.5 inches wg and 16.5 inches wg respectively. Steam control continues to fluctuate between 20% & 50% open.
- 2130 Down to 3.96 tons in the weigh bin. We are still working on the conveyor and the drive motor wire. The hopper is 3/4 full and must be run out before attempting to move it back into place.
- 2200 Fire test ash average is 9.6 inches. Slowed the grate to 3 teeth to maintain ash level of 12-14 inches.
- 2220 Dumped 1200 pounds of ash.
- 2230 Work continues on the conveyor. 2.33 tons of lignite are remaining in the weigh bin. This time we only fed 0.35 tons into the lower bin. The north coal leg is slightly warm.
- 2300 Continued working on the conveyor motor. This time we only dropped 0.03 tons of lignite from the weigh bin. The south side of the weigh bin is empty, but the north coal leg is getting warm. Will cycle the valves periodically. Offtake temperature is 167 degrees C. The conveyor motor is still not cooperating. We will dump the lignite directly into the shaker to get some into the weigh bin.
- 2355 We are rolling once again. Hopefully, the belt will hold up. Offtake temperature peaks at 300 degrees C. It did fall off, however once the lignite hit the bed.

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- 0010 Reduced the saturation air flow to 800 as the conveyor is not holding up. We have 3.98 tons of lignite in the weigh bin. This will only last until the weigh bin reads 2.3 tons. Increased the jacket water to 11 gpm and dropped the furnace pressure to +0.2 inches wg. This will allow us to maintain a +0.3 inch wg gas supply pressure.
- 0035 Developing a crust on the bed again. Steam is not controlling the saturation temperature very well. It is oscillating between 66 and 75 degrees C. The steam control valve is working at between 8% and 32% open.
- 0043 Fire test ash average is 9.1 inches. Slowed the grate to 2 teeth to recover the desired ash level of 12-14 inches.

0100 Dropped 1.34 tons of lignite from the weigh bin. This drop emptied the weigh bin to 0.12 tons. Started loading lignite directly into the shaker with the front end loader.

0115 Dumped 1100 pounds of ash.

0120 Increased the jacket water to 15 gpm and put the steam control on manual to stop the saturation temperature and fire loss pressure oscillation.

0142 Decreased the jacket water flow to 12 gpm to aid in maintaining a desired 69 degree C saturation temperature. The saturation steam valve is 20% open and on manual control.

0230 Respliced the conveyor. Offtake temperature has been staying in the region of 83-87 degrees C. Will resume a saturation air flow of 1400 cfm once the conveyor and hopper are realigned and functioning.

0250 Dumped 1100 pounds of ash.

0330 Finally got the conveyor going!! Starting to load lignite into the upper bin.

0335 Raised the saturation air flow to 1400 cfm. The ash pit pressure is high (28.5 inches wg) at this time, due to the coal previously loaded directly onto the shaker.

0400 Fire test ash average is 9.0 inches.

0415 The conveyor belt has, again, ripped with 6.0 tons in the weigh bin. Reduced the saturation air flow to 800 cfm. Will go down and try to breath life into that belt once more.

0450 Got the belt back on line. Starting to load lignite.

0500 Dumped ash.

0538 The belt ripped again!!! There are no more belt lacings available. We were advised to bank the gasifier until the belt can be replaced in the morning.

0610 Shut down. Turned off the saturation blower and flooded the cyclone.

0630 The bearings on the conveyor are frozen with coal dust. It is causing quite a drag on the belt and the drive roller. The front roller is broken and grabs the lacing.

1137 Started the saturation air flow at 500 cfm.

- 1150 Started the induced draft fan and combustor. Saturation temperature is 65 degrees C.
- 1204 Lit the combustor. Gas is going down stream.
- 1210 Adjusted the grate speed to 2 teeth. The saturation temperature is 69 degrees C.
- 1215 Saturation air flow is now 1000 cfm.
- 1235 Repairing the shaker. Drive belts are off. Put the saturation steam control on manual.
- 1310 Increased the saturation air flow to 1200 cfm. Dumped 1864 pounds of ash and water (mostly water). Fire test ash average is 10.7 inches.
- 1320 The cyclone must be partially plugged as it took 15 minutes to drain for start up with the valve 100% open.
- 1335 Increased the induced draft fan to -0.2 inches wg.
- 1350 Started loading lignite into the weigh bin at 3.6 tons. Offtake temperature is 141 degrees C. Fire loss pressure is now down to 16.8 inches wg from 19.2 inches wg.
- 1400 Fire test ash average is 8.6 inches. Hitting a crust 2 feet above the grate.
- 1415 Had some trouble with the coal going up the belt, so we applied some contact glue to the belt with a brush every 3 feet. It appears to be working well now.
- 1445 Increased the saturation air flow to 1400 cfm. Increased the jacket water flow to 6 gpm. Outlet temperature is 94 degrees C. The induced draft fan is up to -0.3 inches wg. We are trying to hold the cyclone outlet pressure below 0.5 inches wg.
- 1500 Coal-up weight was 1.08 tons. The offtake temperature is steadily increasing and is now at 146 degrees C.
- 1600 Fire test ash average is 8.1 inches wg. Leaving the grate at 2 teeth.
- 1700 Dumped the cyclone and sampled the downcomer. Dumped ash. Offtake temperature is running in the region of 140-150 degrees C. Coal feed is averaging 2.45 tons/hour.
- 1745 Started filling the upper bin at 4.95 tons. The new belt is working fine.

- 1800 The fire test shows an ash level of 8.9 inches. The bed is fairly even. Noticed no glowing on top. We will leave the grate at 2 teeth.
- 1815 Stopped filling the weigh bin at 11.14 tons.
- 2000 Fire test shows a 9.1 inch ash average. Leaving the grate at 2 teeth.
- 2005 Ash pit and fire loss pressures have jumped to 20.6 inches wg and 19.2 inches wg respectively. Have noticed that the saturation temperature has been fluctuating for the last three hours (possibly due to the oscillations of the steam valve).
- 2030 Ash pit and fire loss pressures are down to 18.4 inches wg and 16.9 inches wg, respectively.
- 2035 Started loading lignite into the weigh bin at 3.71 tons.
- 2055 Conveyor is down again. Operator slipped with the front end loader and pushed the hopper against the conveyor, knocking the belt framework off its' support arms.
- 2135 Realigned the conveyor and repositioned the hopper. Coal-up is resuming at 2.82 tons. The upper belt drum is a mass of twisted metal. The drum still rolls, however, the possibility exists that a piece of the metal will cut the belt. More importantly, the mangled condition of the upper drum makes it impossible to get the proper tension on the belt. We can only drop smaller amounts of lignite through the hopper, as too much weight or compacting will stop the belt.
- 2150 Both the ash pit and fire loss pressures have dropped 4 inches wg over the last 2 hours.
- 2200 Fire test ash average is 9.9 inches. Leaving the grate at 2 teeth.
- 2215 Dumped 1100 pounds of ash.
- 2225 Conveyor is down again! Tightened the tension 10 turns on each side. Found the support pieces for the upper drum under the conveyor. We no longer have a cylindrically shaped drum. Two braces have fallen off due to metal fatigue and the remainder are twisted.
- 2230 Dropped 2.95 tons from the weigh bin over the last hour. There was no coal-up at 2200 as we need to leave as much on top as possible incase the upper

drum collapses completely.

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- 0005 Fire test ash average is 15.1 inches. The bars are going in easily.
- 0100 Dumped ash.
- 0130 Started loading lignite into the upper bin.
- 0200 Fire test ash average is 13.9 inches.
- 0300 Dumped ash.
- 0400 Fire test ash average is 11.4 inches.
- 0438 Interpoll, Incorporated arrived on site to do some sampling.
- 0500 Dumped ash.
- 0600 Fire test ash average is 17.1 inches.
- 0630 Interpoll just started a 60 minute test run.
- 0805 Interpoll just started their second 60 minute test run. Fire test ash average is 12.9 inches.
- 0815 Flushed and cleaned the cyclone. The tank was half full of particulate on the bottom with no floating matter.
- 0820 Opened the downcomer and got quite a bit of particulate with a little water and tar.
- 0835 Started loading lignite into the weigh bin. The top roller for the conveyor is missing 6 flat iron strap.
- 0840 Slowed the jacket water flow to 5 gpm.
- 1100 Top pulley on the conveyor fell apart. The operators are dismantling and fabricating a new pulley. The lignite in the weigh bin shows 2.11 tons. The repair should be completed by noon.
- 1200 Fire test ash average is 14.9 inches. KSTP television crew are on site taping for the news.
- 1215 Increased the induced draft fan to -0.6 inches wg. to lower the cyclone outlet pressure.
- 1320 Started the pressure and temperature bed probe.

- 1405 Reduced the saturation air flow to 800 cfm. Fire test ash average is 14.6 inches.
- 1410 Lowered the induced draft fan to +0.2 inches wg. to give a cyclone pressure of .5 inches wg. Closed the primary air flow to 3500 cfm.
- 1435 Loaded the last of the Benton lignite into the weigh bin at 11.60 tons.
- 1445 The offtake temperature has been steadily dropping from 142 degrees C to the current 133 degrees C. The ash pit pressure is 9.4 inches wg, fire los pressure is 8.7 inches wg and the gas offtake pressure is 0.7 inches wg.
- 1505 Increased the saturation air flow to 1400 cfm.
- 1600 Fire test ash average is 17.7 inches. Increasing the grate to 3 teeth for 1 hour and then returning to 2 teeth as the plan calls for a dropping the saturation air flow to 800 cfm.
- 1605 Lowered the saturation air flow to 800 cfm. We will keep it at this level unless the peat pellets for BOM/FGT 010 are late in arriving. Increased the jacket water flow to 10 gpm. Steam valve is 20% open. Dropped the furnace pressure to +0.1 inch wg. We are trying to keep the cyclone outlet presure at 0.5 inches wg.
- 1655 Dumped 100 pounds of ash.
- 1700 Reduced the grate speed to 2 teeth. The first hour after dropping the saturation air flow to 800 cfm 1.79 tons of lignite was used. Gas quality is basically unchanged and the offtake temperature has only lowered 4 degrees C. Saturation temperature is 69 degrees C. Fire loss pressure has remained between 8.0 & 8.4 inches wg.
- 1730 Opened the downcomer and found 20-25 gallons of tiny, black, granular particulate - no liquid. Flushed and cleaned the cyclone. There was no particulate on the bottom or floating on top of the tank.
- 1800 Fire test ash average is 16.1 inches. Leaving the grate at 2 teeth.
- 1815 The weather is cold and wet. We will cover the peat pellets after they arrive. If the peat does not arrive by 1830 we will reduce the saturation air flow to 600 cfm.
- 1830 Reduced the saturation air flow to 600 cfm. There

are 4.17 tons of lignite in the weigh bin. Increasing the jacket water flow to 14 gpm. Reducing the furnace pressure to +0.2 inches wg. Cut the primary air to 58%.

- 1905 Cleaned the top gas pressure sensing port.
- 2000 Fire test ash average is 23.7 inches. The bed is totally upset. Increased the grate to 3 teeth. The peat has not arrived yet. The weigh bin shows 2.44 tons. In spite of the rain, the coal storage area is ready for the peat shipment.
- 2015 Put the steam control on manual as it was fluctuating too much. Offtake temperature is 100 degrees C.
- 2030 Dumped 1050 pounds of ash. 1.64 tons remain in the weigh bin.
- 2100 Having difficulty closing the north coal leg slide gate valve. Down to 0.91 tons on top and still no peat!
- 2110 North coal leg valve indicates open. No gas on top, so the valve must be closed and seated.
- 2120 Cannot get the north coal leg valve to register closed. As banking is imminent without the peat, we are checking the pipe one last time.
- 2130 Fire test ash average is 11.7 inches. The bed has evened out. 0.48 tons left in the weigh bin.
- 2135 Started the banking procedure. Flooded the cyclone. Shut off the grate. Dropped the furnace pressure and burners.
- 2150 23 tons of peat pellets just arrived. Three minutes after we started the banking procedure, the driver walked in the door. It has been offloaded and covered.
- 2238 Started filling the weigh bin with peat pellets.
- 2250 Stopped loading peat at 12.84 tons. It is piled to the chute.
- 2307 Drained the cyclone. Getting 0.6 inches wg gas supply pressure. Grate is at 1 tooth. Saturation blower is on. Combustor has been relit. We are making gas again. Will run the Benton lignite out of the lower bin before dropping the peat pellets.

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0030 Cycled the coal valves.

0100 Dumped ash. Ash cone is filled with water.

0115 Coal leg temperature is starting to go up. Offtake
temperature is climbing.

END OF BOM/FGT 009 BENTON LIGNITE

DATE: November 1, 1983

HOUR	TEMP	RELATIVE HUMIDITY	BAROMET PRESS	RAIN SNOW
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0100	50	89	29.230	
0200	50	93	29.220	T
0300	50	96	29.205	T
0400	50	96	29.190	T
0500	51	96	29.185	.01
0600	51	96	29.180	.01
0700	52	93	29.180	T
0800	53	93	29.180	
0900	54	93	29.180	
1000	55	94	29.180	
1100	57	93	29.180	
1200	58	90	29.170	
1300	59	90	29.170	
1400	60	87	29.150	
1500	60	89	29.140	
1600	59	93	29.150	
1700	59	93	29.150	
1800	58	96	29.160	
1900	58	96	29.160	
2000	58	96	29.160	T
2100	58	100	29.170	T
2200	58	100	29.180	T
2300	58	100	29.180	T
2354	58	96	29.180	T

General Conditions: Foggy sunrise and cloudy sunset. No sunshine. Maximum wind speed is 12 mph.

DATE: November 2, 1983

HOUR	TEMP	RELATIVE HUMIDITY	BAROMET PRESS	RAIN SNOW
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0100	57	96	29.190	
0200	56	100	29.190	
0300	56	97	29.200	
0400	55	100	29.200	
0500	55	100	29.220	
0600	55	97	29.230	T
0700	54	93	29.250	
0800	53	90	29.260	
0900	55	83	29.270	
1000	56	80	29.280	
1100	58	75	29.280	
1200	59	72	29.280	
1300	59	72	29.270	
1400	59	72	29.280	
1500	58	72	29.290	
1600	56	72	29.320	
1700	55	72	29.330	
1800	55	74	29.335	
1900	55	72	29.345	
2000	55	74	29.355	
2100	55	69	29.365	
2200	54	69	29.395	
2300	49	74	29.425	
2353	45	76	29.445	

General Conditions: Cloudy sunrise and sunset. 346 minutes of sunshine (57%). Maximum wind speed is 24 mph.

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 Farenheit

Relative Humidity in %

Barometric Pressure in inches mercury

Precipitation in inches

DATE: November 5, 1983

HOURL	TEMP	RELATIVE HUMIDITY	BAROMET PRESS	RAIN SNOW
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0100	34	72	29.310	
0200	34	75	29.300	
0300	36	73	29.280	
0400	33	78	29.270	
0500	33	82	29.270	
0600	33	85	29.255	
0700	34	85	29.230	
0800	36	82	29.230	
0900	39	76	29.220	
1000	42	72	29.210	
1100	44	68	29.180	
1200	44	73	29.180	
1300	45	70	29.140	
1400	46	71	29.115	
1500	47	71	29.115	
1600	47	71	29.115	
1700	46	80	29.115	
1800	46	83	29.115	
1900	45	89	29.100	
2000	45	93	29.095	T
2100	44	96	29.095	T
2200	45	96	29.095	T
2300	45	100	29.080	T
2355	46	93	29.065	T

General Conditions: Cloudy sunrise and sunset. 18 minutes of sunshine (3%). Maximum wind speed is 16 mph.

DATE: November 6, 1983

HOURL	TEMP	RELATIVE HUMIDITY	BAROMET PRESS	RAIN SNOW
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0100	46	93	29.065	
0200	46	93	29.075	
0300	46	96	29.065	
0400	46	100	29.075	
0500	46	96	29.075	
0600	46	96	29.095	
0700	47	93	29.095	
0800	47	93	29.105	
0900	47	93	29.115	
1000	48	89	29.150	
1100	49	82	29.140	
1200	49	80	29.130	
1300	50	74	29.125	
1400	50	74	29.115	
1500	50	74	29.115	
1600	49	74	29.105	
1700	46	79	29.095	
1800	45	82	29.100	
1900	43	86	29.095	
2000	44	86	29.100	
2100	41	89	29.105	
2200	40	93	29.110	
2300	41	89	29.098	
2350	39	92	29.090	

General Conditions: Cloudy sunrise and sunset. No sunshine. Maximum wind speed is 9 mph.

DATE: November 3, 1983

HOUR	TEMP	RELATIVE HUMIDITY	BAROMET PRESS	RAIN SNOW
0100	44	76	29.445	
0200	42	76	29.460	
0300	41	76	29.465	
0400	40	76	29.475	
0500	39	79	29.485	
0600	38	70	29.495	
0700	37	73	29.505	
0800	37	73	29.515	
0900	38	85	29.540	
1000	40	62	29.515	
1100	41	57	29.505	
1200	42	49	29.485	
1300	44	51	29.445	
1400	45	43	29.445	
1500	46	42	29.445	
1600	44	45	29.465	
1700	43	43	29.475	
1800	42	45	29.495	
1900	41	46	29.515	
2000	41	48	29.515	
2100	38	57	29.540	
2200	39	55	29.530	
2300	38	57	29.530	
2355	38	52	29.525	

General Conditions Clear sunrise and cloudy sunset. 472 minutes of sunshine (78%). Maximum wind speed is 24 mph.

DATE: November 4, 1983

HOUR	TEMP	RELATIVE HUMIDITY	BAROMET PRESS	RAIN SNOW
0100	37	54	29.530	
0200	36	59	29.540	
0300	35	59	29.525	
0400	33	64	29.525	
0500	31	69	29.530	
0600	30	72	29.540	
0700	29	75	29.560	
0800	29	78	29.550	
0900	33	69	29.560	
1000	37	64	29.550	
1100	39	59	29.525	
1200	40	52	29.505	
1300	43	53	29.475	
1400	45	47	29.445	
1500	46	45	29.435	
1600	46	47	29.425	
1700	41	55	29.400	
1800	39	57	29.395	
1900	38	67	29.375	
2000	38	64	29.345	
2100	39	57	29.335	
2200	38	59	29.320	
2300	36	67	29.325	
2355	33	69	29.315	

General Conditions: Cloudy sunrise and clear sunset. 509 Minutes of sunshine (84%). Maximum wind speed is 14 mph.

DATE: November 7, 1983

HOUR	TEMP	RELATIVE HUMIDITY	BAROMET PRESS	RAIN SNOW
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0100	38	92	29.065	
0200	38	92	29.085	
0300	39	92	29.075	
0400	38	96	29.045	
0500	38	92	29.045	
0600	38	89	29.035	
0700	38	96	29.015	
0800	41	96	28.985	
0900	43	100	28.995	
1000	47	89	28.985	
1100	51	74	28.975	
1200	52	71	28.935	
1300	53	69	28.890	
1400	55	64	28.870	
1500	56	64	28.870	
1600	52	64	28.860	
1700	55	72	28.850	
1800	55	72	28.865	
1900	54	80	28.865	
2000	54	80	28.880	
2100	59	80	28.890	
2200	49	93	28.900	
2300	49	93	28.905	
2350	50	89	28.940	

General Conditions: Cloudy sunrise and sunset. 312 minutes of sunshine (21%). Maximum wind speed is 21 mph.

DATE: November 8, 1983

HOUR	TEMP	RELATIVE HUMIDITY	BAROMET PRESS	RAIN SNOW
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0100	48	73	28.955	
0200	47	76	28.925	
0300	47	73	28.995	
0400	46	70	29.000	
0500	46	70	29.035	
0600	45	68	29.025	
0700	44	62	29.055	
0800	43	70	29.075	
0900	45	65	29.105	
1000	45	68	29.105	
1100	45	65	29.115	
1200	45	65	29.130	
1300	44	68	29.115	
1400	44	68	29.115	
1500	42	70	29.125	T
1600	41	79	29.150	T
1700	39	89	29.145	T
1800	39	89	29.135	.01
1900	38	92	29.155	.02
2000	38	89	29.160	.09
2100	37	92	29.150	.07
2200	37	96	29.140	.07
2300	37	92	29.130	.07
2355	36	92	29.135	.15

General Conditions: Cloudy sunrise and sunset. 12 minutes of sunshine (2%). Maximum wind speed is 18 mph.

APPENDIX C
Lignite Sizing Data

Feed Coal Size Distribution

Sample Number	Date	Shift Start Time	Screen Mesh Size inch	Cumulative Mass Fraction, % less than stated mesh size, inch				
				1/4	1/2	3/4	1	1 1/2
1	11/ 2/84	0: 0	+3/4	0.4	1.2	6.1	32.8	66.4
2	11/ 2/84	8: 0	+3/4	0.8	1.5	5.8	34.7	65.4
3	11/ 2/84	16: 0	+3/4	0.7	1.6	7.7	37.5	78.1
4	11/ 3/84	0: 0	+3/4	0.7	1.3	7.1	36.1	71.6
5	11/ 3/84	8: 0	+3/4	2.8	5.3	12.6	43.0	73.0
6	11/ 3/84	16: 0	+3/4	0.6	1.8	9.0	37.9	76.4
7	11/ 4/84	0: 0	+3/4	0.8	2.1	9.1	14.6	77.7
8	11/ 4/84	8: 0	+3/4	0.6	1.3	7.5	10.2	71.1
9	11/ 4/84	16: 0	+1/4	0.4	1.0	3.8	25.3	60.8
10	11/ 5/84	0: 0	+1/4	0.7	2.4	10.6	36.0	68.6
11	11/ 5/84	8: 0	+1/4	3.4	8.1	20.7	42.7	75.7
12	11/ 5/84	16: 0	+1/4	0.8	4.0	16.9	40.0	70.7
13	11/ 6/84	0: 0	+1/4	0.7	7.8	21.6	41.7	72.1
14	11/ 6/84	8: 0	+1/4	1.2	11.6	31.8	50.0	81.7
15	11/ 6/84	16: 0	+1/4	0.9	9.5	27.2	49.2	77.5
16	11/ 7/84	0: 0	+1/4	1.1	7.3	23.0	42.5	74.4
17	11/ 7/84	8: 0	+1/4	2.7	16.5	35.8	57.6	84.3
18	11/ 7/84	16: 0	+1/4	1.1	7.2	21.7	39.5	69.4
19	11/ 8/84	0: 0	+1/4	0.6	5.2	17.3	36.5	69.3
20	11/ 8/84	8: 0	+1/4	1.1	9.5	23.8	40.9	71.6
21	11/ 8/84	16: 0	+1/4	2.8	16.0	35.0	54.5	80.2
AVERAGES			+3/4	1.0	2.0	8.1	30.6	72.1
			+1/4	1.4	8.4	22.9	43.3	73.2

APPENDIX D

Lignite Addition Log

Lignite Weights are given in short tons.

DATE	TIME	SAMPLE NUMBER	SCREEN IN	WASH?	START WT.	STOP WT.	NET WT.
11-01	1315	COKE	.75	NO	10.14	.59	9.55
11-01	1430	COKE		CYCLE COAL VALVES			
11-01	1530	COKE		CYCLE COAL VALVES			
11-01	1630	COKE		CYCLE COAL VALVES			
11-01	1730	COKE		CYCLE COAL VALVES			
11-01	1830	COKE		CYCLE COAL VALVES			
11-01	1930	COKE		CYCLE COAL VALVES			
11-01	2030	COKE		CYCLE COAL VALVES			
11-01	2130	COKE		CYCLE COAL VALVES			
11-01	2230	COKE		CYCLE COAL VALVES			
11-01	2330	COKE		CYCLE COAL VALVES			
11-02	0030	COKE		CYCLE COAL VALVES			
11-02	0130	009-C1	.75	NO	10.06	7.36	2.70
11-02	0230	009-C1	.75	NO	7.36	6.31	1.05
11-02	0330	009-C1	.75	NO	6.31	5.97	.34
11-02	0430	009-C1	.75	NO	5.97	5.31	.66
11-02	0530	009-C1	.75	NO	5.31	4.67	.64
11-02	0630	009-C1	.75	NO	4.65	3.89	.76
11-02	0730	009-C2	.75	NO	3.89	3.22	.67
11-02	0830	009-C2	.75	NO	3.22	2.71	.51
11-02	0930	009-C2	.75	NO	2.71	1.63	1.08
11-02	1030	009-C2	.75	NO	1.63	.55	1.08
11-02	1130	009-C2	.75	NO	.55	.19	.36
11-02	1230	009-C2	.75	NO	CYCLE COAL VALVES		
11-02	1330	009-C2	.75	NO	1.12	.21	.91
11-02	1400	009-C2	.75	NO	3.46	2.12	1.34
11-02	1430	009-C2	.75	NO	2.12	2.07	.05
11-02	1500	009-C2	.75	NO	4.48	3.45	1.03
11-02	1530	009-C3	.75	NO	4.46	3.10	1.36
11-02	1630	009-C3	.75	NO	6.88	5.55	1.33
11-02	1730	009-C3	.75	NO	6.33	5.07	1.26
11-02	1830	009-C3	.75	NO	5.07	3.92	1.15
11-02	1930	009-C3	.75	NO	3.92	2.71	1.21
11-02	2030	009-C3	.75	NO	3.33	2.59	.74
11-02	2130	009-C3	.75	NO	6.38	3.87	2.51
11-02	2230	009-C3	.75	NO	6.53	5.10	1.43
11-02	2330	009-C4	.75	NO	7.71	6.53	1.18
11-03	0030	009-C4	.75	NO	10.32	9.00	1.32
11-03	0130	009-C4	.75	NO	10.06	8.56	1.50
11-03	0230	009-C4	.75	NO	8.54	6.77	1.77
11-03	0330	009-C4	.75	NO	6.77	5.41	1.36
11-03	0430	009-C4	.75	NO	5.41	4.54	.87
11-03	0530	009-C4	.75	NO	5.98	4.85	1.13
11-03	0630	009-C4	.75	NO	6.02	3.45	2.57
11-03	0730	009-C5	.75	NO	4.83	2.85	1.98
11-03	0830	009-C5	.75	NO	3.81	1.78	2.03
11-03	0930	009-C5	.75	NO	4.10	2.62	1.48

DATE	TIME	SAMPLE NUMBER	SCREEN IN	WASH?	START WT.	STOP WT.	NET WT.
11-03	1030	009-C5	.75	NO	8.07	6.20	1.87
11-03	1130	009-C5	.75	NO	10.88	9.08	1.80
11-03	1230	009-C5	.75	NO	9.08	7.17	1.91
11-03	1330	009-C5	.75	NO	7.17	5.39	1.78
11-03	1430	009-C5	.75	NO	7.17	5.51	1.66
11-03	1530	009-C6	.75	NO	8.05	6.31	1.74
11-03	1630	009-C6	.75	NO	10.99	9.38	1.61
11-03	1730	009-C6	.75	NO	9.37	7.38	1.99
11-03	1830	009-C6	.75	NO	7.37	5.37	2.00
11-03	1930	009-C6	.75	NO	5.37	3.33	2.04
11-03	2030	009-C6	.75	NO	11.70	9.68	2.02
11-03	2130	009-C6	.75	NO	9.68	7.09	2.59
11-03	2230	009-C6	.75	NO	11.52	9.66	1.86
11-03	2330	009-C7	.75	NO	9.68	8.12	1.56
11-04	0030	009-C7	.75	NO	8.12	5.98	2.14
11-04	0130	009-C7	.75	NO	5.98	3.94	2.04
11-04	0230	009-C7	.75	NO	3.94	2.26	1.68
11-04	0330	009-C7	.75	NO	3.02	1.00	2.02
11-04	0430	009-C7	.75	NO	4.12	1.78	2.34
11-04	0530	009-C7	.75	NO	9.86	7.63	2.23
11-04	0630	009-C7	.75	NO	12.55	10.30	2.25
11-04	0730	009-C8	.75	NO	10.30	7.98	2.32
11-04	0830	009-C8	.75	NO	7.98	4.36	3.62
11-04	0930	009-C8	.75	NO	9.72	7.79	1.93
11-04	1030	009-C8	.75	NO	10.32	8.04	2.28
11-04	1130	009-C8	.75	NO	8.01	5.82	2.19
11-04	1230	009-C8	.75	NO	5.82	3.11	2.71
11-04	1330	009-C8	.75	NO	9.32	6.51	2.81
11-04	1430	009-C8	.75	NO	11.35	8.32	3.03
11-04	1500	009-C9	.75	NO	11.15	9.59	1.56
11-04	1530	009-C9	.75	NO	9.59	8.00	1.59
11-04	1600	009-C9	.75	NO	8.00	6.44	1.56
11-04	1630	009-C9	.75	NO	6.44	4.85	1.59
11-04	1700	009-C9	.75	NO	8.83	7.32	1.51
11-04	1730	009-C9	.75	NO	11.99	10.39	1.60
11-04	1800	009-C9	.75	NO	10.39	8.35	2.04
11-04	1830	009-C9	.75	NO	8.35	7.03	1.32
11-04	1900	009-C9	.75	NO	7.02	5.76	1.26
11-04	1930	009-C9	.75	NO	5.76	4.09	1.67
11-04	2000	009-C9	.75	NO	7.32	5.76	1.56
11-04	2030	009-C9	.75	NO	7.97	6.48	1.49
11-04	2100	009-C9	.75	NO	10.38	8.49	1.89
11-04	2130	009-C9	.75	NO	11.16	9.83	1.33
11-04	2200	009-C9	.75	NO	9.83	8.48	1.35
11-04	2230	009-C9	.75	NO	9.78	8.11	1.67
11-04	2300	009-C9	.75	NO	9.04	7.38	1.66
11-04	2330	009-C10	.75	NO	9.61	8.13	1.48
11-05	0000	009-C10	.75	NO	8.13	6.83	1.30
11-05	0030	009-C10	.75	NO	9.15	7.81	1.34
11-05	0100	009-C10	.75	NO	11.41	9.51	1.90
11-05	0130	009-C10	.75	NO	9.51	7.89	1.62

DATE	TIME	SAMPLE NUMBER	SCREEN IN	WASH?	START WT.	STOP WT.	NET WT.
11-05	0200	009-C10	.75	NO	7.88	6.24	1.64
11-05	0230	009-C10	.75	NO	6.24	4.66	1.58
11-05	0300	009-C10	.75	NO	5.40	4.16	1.24
11-05	0330	009-C10	.75	NO	4.16	3.01	1.15
11-05	0400	009-C10	.75	NO	3.01	1.32	1.69
11-05	0430	009-C10	.75	NO	3.80	2.00	1.80
11-05	0500	009-C10	.75	NO	6.87	5.38	1.49
11-05	0530	009-C10	.75	NO	10.08	8.70	1.38
11-05	0600	009-C10	.75	NO	8.70	7.26	1.44
11-05	0630	009-C10	.75	NO	11.76	10.36	1.40
11-05	0700	009-C10	.75	NO	11.99	10.44	1.55
11-05	0730	009-C11	.75	NO	10.44	9.00	1.44
11-05	0800	009-C11	.75	NO	9.00	7.42	1.58
11-05	0830	009-C11	.75	NO	7.42	6.17	1.25
11-05	0900	009-C11	.75	NO	6.17	4.79	1.38
11-05	0930	009-C11	.75	NO	7.21	5.97	1.24
11-05	1000	009-C11	.75	NO	10.65	9.39	1.26
11-05	1030	009-C11	.75	NO	9.39	8.14	1.25
11-05	1100	009-C11	.75	NO	8.14	6.89	1.25
11-05	1130	009-C11	.75	NO	6.89	5.49	1.40
11-05	1200	009-C11	.75	NO	5.49	4.00	1.49
11-05	1230	009-C11	.75	NO	4.00	2.52	1.48
11-05	1300	009-C11	.75	NO	6.64	5.22	1.42
11-05	1330	009-C11	.75	NO	9.15	7.78	1.37
11-05	1400	009-C11	.75	NO	10.91	9.57	1.34
11-05	1430	009-C11	.75	NO	10.10	8.73	1.37
11-05	1500	009-C11	.75	NO	11.03	10.38	.65
11-05	1530	009-C12	.75	NO	10.37	9.14	1.23
11-05	1600	009-C12	.75	NO	9.13	6.61	2.52
11-05	1630	009-C12	.75	NO	6.61	5.90	.71
11-05	1700	009-C12	.75	NO	5.90	5.18	.72
11-05	1730	009-C12	.75	NO	5.18	3.58	1.60
11-05	1800	009-C12	.75	NO	3.58	2.95	.63
11-05	1830	009-C12	.75	NO	2.95	2.09	.86
11-05	1900	009-C12	.75	NO	3.58	2.95	.63
11-05	1930	009-C12	.75	NO	2.95	2.09	.86
11-05	2000	009-C12	.75	NO	2.08	1.26	.82
11-05	2030	009-C12	.75	NO	1.26	.76	.50
11-05	2100	009-C12	.75	NO	.76	.53	.23
11-05	2130	009-C12	.75	NO	CYCLE COAL VALVES		
11-05	2230	009-C12	.75	NO	CYCLE COAL VALVES		
11-05	2330	009-C13	.75	NO	CYCLE COAL VALVES		
11-06	0000	009-C13	.25	NO	12.12	8.83	3.29
11-06	0030	009-C13	.25	NO	8.83	7.98	.85
11-06	0130	009-C13	.25	NO	7.97	6.70	1.27
11-06	0230	009-C13	.25	NO	6.70	5.27	1.43
11-06	0330	009-C13	.25	NO	5.27	2.72	2.55
11-06	0430	009-C13	.25	NO	4.88	2.23	2.65
11-06	0500	009-C13	.25	NO	6.11	5.10	1.01
11-06	0530	009-C13	.25	NO	8.75	7.74	1.01
11-06	0600	009-C13	.25	NO	12.05	11.11	.94

DATE	TIME	SAMPLE NUMBER	SCREEN IN	WASH?	START WT.	STOP WT.	NET WT.
11-06	0630	009-C13	.25	NO	12.19	11.52	.67
11-06	0700	009-C13	.25	NO	11.50	10.58	.92
11-06	0730	009-C14	.25	NO	10.58	9.48	1.10
11-06	0800	009-C14	.25	NO	9.48	8.46	1.02
11-06	0830	009-C14	.25	NO	8.46	7.38	1.08
11-06	0900	009-C14	.25	NO	7.38	6.34	1.04
11-06	0930	009-C14	.25	NO	6.34	5.33	1.01
11-06	1000	009-C14	.25	NO	5.33	4.17	1.16
11-06	1030	009-C14	.25	NO	5.54	4.26	1.28
11-06	1100	009-C14	.25	NO	11.89	10.60	1.29
11-06	1130	009-C14	.25	NO	10.60	9.20	1.40
11-06	1200	009-C14	.25	NO	9.20	7.72	1.48
11-06	1230	009-C14	.25	NO	7.72	6.45	1.27
11-06	1300	009-C14	.25	NO	6.64	5.25	1.39
11-06	1330	009-C14	.25	NO	5.25	3.90	1.35
11-06	1400	009-C14	.25	NO	8.13	6.76	1.37
11-06	1440	009-C14	.25	NO	7.90	7.14	.76
11-06	1500	009-C14	.25	NO	10.19	9.36	.83
11-06	1530	009-C15	.25	NO	9.53	8.06	1.47
11-06	1600	009-C15	.25	NO	8.06	6.66	1.40
11-06	1630	009-C15	.25	NO	6.66	5.30	1.36
11-06	1700	009-C15	.25	NO	7.70	6.26	1.44
11-06	1730	009-C15	.25	NO	10.28	8.98	1.30
11-06	1800	009-C15	.25	NO	8.98	7.51	1.47
11-06	1830	009-C15	.25	NO	7.51	6.25	1.26
11-06	1900	009-C15	.25	NO	6.25	4.83	1.42
11-06	1930	009-C15	.25	NO	4.83	3.26	1.57
11-06	2000	009-C15	.25	NO	REPAIRING THE CONVEYOR		
11-06	2030	009-C15	.25	NO	8.19	5.60	2.59
11-06	2100	009-C15	.25	NO	5.60	4.93	.67
11-06	2130	009-C15	.25	NO	4.93	3.96	.97
11-06	2200	009-C15	.25	NO	3.96	2.68	1.28
11-06	2230	009-C15	.25	NO	2.68	2.33	.35
11-06	2300	009-C15	.25	NO	2.33	2.30	.03
11-06	2305			CYCLED COAL VALVES			
11-06	2330	009-C16	.25	NO	4.25	2.59	1.66
11-06	2345	009-C16	.25	NO	2.59	2.40	.19
11-07	0000	009-C16	.25	NO	2.85	2.39	.46
11-07	0030	009-C16	.25	NO	3.98	1.46	2.52
11-07	0100	009-C16	.25	NO	1.46	.12	1.34
11-07	0130	009-C16	.25	NO	5.87	5.05	.82
11-07	0200	009-C16	.25	NO	5.05	4.68	.37
11-07	0230	009-C16	.25	NO	4.68	4.07	.61
11-07	0300	009-C16	.25	NO	4.07	3.55	.52
11-07	0330	009-C16	.25	NO	3.55	3.10	.45
11-07	0400	009-C16	.25	NO	7.46	5.26	2.20
11-07	0430	009-C16	.25	NO	5.99	4.75	1.24
11-07	0500	009-C16	.25	NO	4.75	4.13	.62
11-07	0530	009-C16	.25	NO	6.93	6.23	.70
11-07	0600	009-C16		SHUT DOWN FOR CONVEYOR REPAIR			

DATE	TIME	SAMPLE NUMBER	SCREEN IN	WASH?	START WT.	STOP WT.	NET WT.
11-07	1130	009-C17	.25	NO	6.75	5.93	.82
11-07	1230	009-C17	.25	NO	5.93	5.25	.68
11-07	1300	009-C17	.25	NO	5.25	4.43	.82
11-07	1330	009-C17	.25	NO	4.43	3.60	.83
11-07	1400	009-C17	.25	NO	4.92	3.98	.94
11-07	1430	009-C17	.25	NO	6.72	5.67	1.05
11-07	1500	009-C17	.25	NO	12.18	11.10	1.08
11-07	1530	009-C18	.25	NO	11.10	9.92	1.18
11-07	1600	009-C18	.25	NO	9.92	8.68	1.24
11-07	1630	009-C18	.25	NO	8.68	7.50	1.18
11-07	1700	009-C18	.25	NO	7.50	6.21	1.29
11-07	1730	009-C18	.25	NO	6.21	4.95	1.26
11-07	1815	009-C18	.25	NO	11.14	9.64	1.50
11-07	1830	009-C18	.25	NO	9.64	8.85	.79
11-07	1900	009-C18	.25	NO	8.85	7.62	1.23
11-07	1930	009-C18	.25	NO	7.62	6.20	1.42
11-07	2012	009-C18	.25	NO	6.20	4.60	1.60
11-07	2030	009-C18	.25	NO	4.60	3.71	.89
11-07	2100	009-C18	.25	NO	5.21	3.90	1.31
11-07	2130	009-C18	.25	NO	3.90	2.82	1.08
11-07	2230	009-C18	.25	NO	9.31	6.36	2.95
11-07	2300	009-C18	.25	NO	10.46	9.37	1.09
11-07	2330	009-C19	.25	NO	9.37	8.14	1.23
11-08	0000	009-C19	.25	NO	8.14	6.83	1.31
11-08	0030	009-C19	.25	NO	6.82	5.57	1.25
11-08	0100	009-C19	.25	NO	7.24	6.01	1.23
11-08	0130	009-C19	.25	NO	8.47	7.19	1.28
11-08	0200	009-C19	.25	NO	10.94	9.66	1.28
11-08	0230	009-C19	.25	NO	10.80	9.44	1.36
11-08	0300	009-C19	.25	NO	9.44	8.10	1.34
11-08	0330	009-C19	.25	NO	8.09	6.78	1.31
11-08	0400	009-C19	.25	NO	9.11	7.96	1.15
11-08	0430	009-C19	.25	NO	11.00	9.75	1.25
11-08	0500	009-C19	.25	NO	12.15	10.90	1.25
11-08	0530	009-C19	.25	NO	12.52	11.29	1.23
11-08	0600	009-C19	.25	NO	12.39	11.30	1.09
11-08	0630	009-C19	.25	NO	11.30	10.22	1.08
11-08	0700	009-C19	.25	NO	10.22	8.92	1.30
11-08	0730	009-C20	.25	NO	8.92	7.00	1.92
11-08	0800	009-C20	.25	NO	7.00	5.62	1.38
11-08	0830	009-C20	.25	NO	5.62	4.28	1.34
11-08	0900	009-C20	.25	NO	7.52	6.16	1.36
11-08	0930	009-C20	.25	NO	7.58	6.22	1.36
11-08	1000	009-C20	.25	NO	6.21	4.84	1.37
11-08	1030	009-C20	.25	NO	4.82	3.46	1.36
11-08	1100	009-C20	.25	NO	3.46	2.10	1.36
11-08	1130	009-C20	.25	NO	3.24	1.82	1.42
11-08	1200	009-C20	.25	NO	5.73	4.69	1.04
11-08	1230	009-C20	.25	NO	9.95	8.67	1.28
11-08	1300	009-C20	.25	NO	8.67	7.32	1.35
11-08	1330	009-C20	.25	NO	7.30	5.99	1.31

DATE	TIME	SAMPLE NUMBER	SCREEN IN	WASH?	START WT.	STOP WT.	NET WT.
11-08	1400	009-C20	.25	NO	5.99	5.69	1.30
11-08	1430	009-C20	.25	NO	11.38	10.47	.91
11-08	1500	009-C20	.25	NO	11.60	10.80	.80
11-08	1530	009-C21	.25	NO	10.80	9.56	1.24
11-08	1600	009-C21	.25	NO	9.56	8.27	1.29
11-08	1630	009-C21	.25	NO	8.27	7.31	.96
11-08	1700	009-C21	.25	NO	7.31	6.48	.83
11-08	1730	009-C21	.25	NO	6.48	5.72	.76
11-08	1800	009-C21	.25	NO	5.72	4.94	.78
11-08	1830	009-C21	.25	NO	4.94	4.17	.77
11-08	1900	009-C21	.25	NO	4.17	3.54	.63
11-08	1930	009-C21	.25	NO	3.54	2.91	.63
11-08	2000	009-C21	.25	NO	2.91	2.44	.47
11-08	2030	009-C21	.25	NO	2.44	1.64	.80
11-08	2100	009-C21	.25	NO	1.64	.91	.73
11-08	2130	009-C21	.25	NO	.91	.43	.48

ASH ANALYSIS FOR BQM/FGI-009

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	11/ 2/84	3:00	41.5	66.5	83.3	91.8	100.0	—	10	3.6	3.90
2	11/ 2/84	5:00									
3	11/ 2/84	9:00	15.6	38.3	57.6	70.3	94.0	1.03	11	8.6	1.50
4	11/ 2/84	11:00									
5	11/ 2/84	13:00	3.2	9.2	16.8	24.9	54.1	1.15	4	8.4	0.36
6	11/ 2/84	15:00									
7	11/ 2/84	18:29	13.4	21.8	30.5	44.4	71.6	1.12	9	12.4	0.37
8	11/ 2/84	20:45									
9	11/ 2/84	22:14	18.7	35.4	49.1	63.1	94.9	0.99	7	14.5	0.27
10	11/ 3/84	1:00									
11	11/ 3/84	2:29	26.5	40.2	52.2	66.7	93.2	0.88	7	14.6	0.54
12	11/ 3/84	5:00									
13	11/ 3/84	7:30	19.9	30.6	39.9	52.6	83.7	0.94	5	10.5	0.33
14	11/ 3/84	10:30									
15	11/ 3/84	14:14	29.4	45.5	57.7	71.9	95.6	0.74	32	9.4	0.33
16	11/ 3/84	17:00									
17	11/ 3/84	21:29	35.0	44.3	50.1	57.7	82.4	0.70	39	10.3	0.35
18	11/ 4/84	6:15	26.4	39.5	49.7	60.2	91.9	0.70	16	6.1	0.25
19	11/ 4/84	9:00	13.6	28.1	35.1	40.1	67.4	0.66	5	5.8	0.24
20	11/ 4/84	13:00	27.9	47.8	61.3	72.6	93.6	0.80	15	6.3	0.21
21	11/ 4/84	15:00	59.7	72.4	79.0	82.9	91.9	0.85	31	9.2	0.33
23	11/ 4/84	19:00	22.4	38.5	47.2	53.5	72.7	0.73	15	2.3	0.12
24	11/ 4/84	21:00									
25	11/ 5/84	0:30	13.8	29.7	41.2	50.5	81.2	0.71	15	2.1	0.15
26	11/ 5/84	5:00	33.1	46.0	56.1	65.0	81.9	0.81	19	2.7	0.16
27	11/ 5/84	9:00	27.6	45.8	53.9	61.0	78.5	0.76	19	2.2	0.13
28	11/ 5/84	13:00	41.4	56.7	60.1	63.5	69.6	0.81	12	4.5	0.16
29	11/ 5/84	15:00	28.3	43.5	54.9	63.4	87.8	0.82	15	2.7	0.11
30	11/ 5/84	20:14	31.0	47.3	57.9	67.2	82.4	0.85	15	5.8	0.30
31	11/ 6/84	1:00	13.9	26.4	37.7	44.5	74.9	0.82	—	2.9	0.14
32	11/ 6/84	3:00	12.5	20.7	22.1	23.6	47.0	0.67	11	7.8	0.36
33	11/ 6/84	10:30	33.9	47.3	54.2	59.3	74.0	0.76	15	1.9	0.23
34	11/ 6/84	13:44	37.8	61.0	68.4	75.2	88.5	0.87	4	1.3	0.19
35	11/ 6/84	16:39									
36	11/ 6/84	19:20	6.3	11.9	16.8	23.4	42.9	0.64	13	0.8	0.13
37	11/ 6/84	22:20	33.0	40.8	44.8	54.4	82.1	—	13	3.4	0.17
38	11/ 7/84	1:00	50.2	59.5	66.7	73.0	96.6	0.75	22	2.7	0.09
39	11/ 7/84	5:00	47.2	66.8	79.5	87.3	100.0	0.71	16	9.2	0.25

APPENDIX E
Ash Analysis Data

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				
40	11/ 7/84	13:14	38.4	44.4	46.6	49.2	56.3	---	35	9.0	0.25
41	11/ 7/84	17:29	48.3	63.1	72.3	75.9	96.4	0.79	24	9.6	0.23
42	11/ 7/84	22:14	29.6	46.9	55.9	64.1	90.1	0.76	14	4.2	0.10
43	11/ 8/84	0:30	25.3	35.0	41.0	45.2	69.1	---	2	6.4	0.17
44	11/ 8/84	5:00	22.5	34.2	43.3	52.4	66.1	0.73	15	4.4	0.12
45	11/ 8/84	8:35	19.3	30.5	38.3	47.7	61.4	0.74	10	5.4	0.13
46	11/ 8/84	12:19	21.8	35.5	45.3	53.8	80.8	0.77	17	2.3	0.11
47	11/ 8/84	17:00	37.7	55.4	66.5	73.5	97.1	0.82	18	0.9	0.07
48	11/ 8/84	20:29	24.6	41.1	53.8	63.6	79.2	0.77	16	1.8	0.10
49	11/ 9/84	1:00	45.8	61.0	70.5	75.3	97.0	0.84	44	1.2	0.11
AVERAGES											
Samples, 5 - 32			24.9	38.5	47.6	56.5	79.8	0.83	15.2	7.0	0.26
33 - 49			32.6	45.9	54.0	60.8	79.9	0.77	17.4	4.0	0.15
OVERALL AVERAGE			28.3	41.8	50.5	58.4	79.8	0.80	16.2	5.7	0.21

APPENDIX F

Ash Removal Log

Ash weights are given in pounds.

Flush water is given in gallons.

GASIFIER ASH

DATE	TIME	SAMPLE NUMBER	INITIAL DRY	FINAL DRY	NET DRY	INITIAL WET	FINAL WET	NET WET	NET DRY +NET WET	FLUSH WATER
11-02	0300	A-1	483	219	264	496	244	252	516	60L
11-02	0530	A-2	537	492	45	722	160	562	607	30L
11-02	0900	A-3	583	160	423	535	158	377	800	30L
11-02	1100	A-4	677	163	514	440	161	279	793	30U
11-02	1300	A-5	870	179	691	529	189	340	1031	30U
11-02	1500	A-6	893	186	707	569	167	402	1109	30L
11-02	1830	A-7	1504	156	1348	538	158	380	1728	30L
11-02	2045	A-8	1300	219	1081	588	185	403	1484	30L
11-02	2215	A-9	1201	185	1016	541	184	357	1373	30L
11-03	0100	A-10	1357	190	1167	584	183	401	1568	30L
11-03	0230	A-11	1145	190	955	564	181	383	1338	30L
11-03	0500	A-12	1157	187	970	653	188	465	1435	30U
11-03	0715	A-13	977	186	791	490	184	306	1097	30U
11-03	1020	A-14	1320	228	1092	523	244	279	1371	30U
11-03	1415	A-15	900	207	693	497	164	333	1026	30U
11-03	1700	A-15	609	158	451	350	158	192	643	30L
11-03	2130	A-16	850	150	700	358	158	200	900	30L
11-04	0100	A-17	920	205	715	659	157	497	1212	30L
11-04	0615	A-18	944	145	799	598	142	456	1255	30L
11-04	0900	A-19	956	214	742	625	168	457	1199	30L
11-04	1300	A-20	1060	152	908	557	151	406	1314	30U
11-04	1500	A-21	599	153	446	491	151	340	786	30U
11-04	1700	A-22	852	151	701	786	151	635	1336	30L
11-04	1900	A-23	807	151	656	260	151	109	765	30L
11-04	2100	A-24	645	157	488	574	166	408	896	30U
11-05	0030	A-25	988	164	824	670	173	497	1321	30U
11-05	0500	A-26	1088	168	920	584	163	421	1341	30L
11-05	0915	A-27	1120	295	825	668	264	404	1229	30U
11-05	1300	A-28	1068	268	800	682	168	514	1314	30L
11-05	1510	A-29	861	172	689	536	169	367	1056	30L
11-05	2015	A-30	954	217	737	612	195	417	1154	30U
11-06	0100	A-31	1012	162	850	580	214	366	1216	30L
11-06	0300	A-32	643	190	453	590	165	425	878	30L
11-06	0500	A-3*	730	177	553	612	315	297	850	30L
11-06	0700	A-34	930	226	704	603	220	383	1087	30L
11-06	1030	A-33	1147	164	983	644	160	484	1467	30U
11-06	1315	A-34B	1024	166	858	815	161	654	1512	30L
11-06	1630	A-35	1066	166	900	684	158	526	1426	30L
11-06	1920	A-36	1198	164	1034	715	179	536	1570	30L
11-06	2230	A-37	1167	216	951	584	167	417	1368	30L
11-07	0100	A-38	1050	176	874	520	168	352	1226	30L
11-07	0500	A-39	1254	178	1076	712	176	536	1612	30U
11-07	1315	A-40	1892	185	1707	613	143	470	2177	30L
11-07	1730	A-41	850	137	713	548	133	415	1128	30L
11-07	2215	A-42	1100	139	961	592	133	459	1420	30L
11-08	0030	A-43	789	134	655	565	134	431	1086	30L
11-08	0500	A-44	1085	139	946	735	132	603	1549	30U
11-08	0835	A-45	907	140	767	675	146	529	1296	30L

DATE	TIME	SAMPLE NUMBER	INITIAL DRY	FINAL DRY	NET DRY	INITIAL WET	FINAL WET	NET WET	NET DRY +NET WET	FLUSH WATER
11-08	1220	A-46	953	145	808	650	136	514	1322	30L
11-08	1700	A-47	1046	138	908	576	146	430	1338	30L
11-08	2030	A-49	1009	149	860	543	141	402	1262	30L
11-09	0100	A-50	3040	165	2875	495	159	336	3211	30L

APPENDIX G

Retort Particle Sampling Data

Reference: Volume 1, Thimsen, Maurer et al, 1984

- G-1. Dust Loading Data
- G-2. Cumulative Dust Data
- G-3. Cumulative Dust Size Distributions (1 included)
- G-4. Dust Size Distribution Modal Analysis (1 included)
- G-5. Explanation of Modal Fitting Parameters

TABLE G-1

DUST DATA for BOM/FGT-009

Grand Average Gas/Air Ratio
2.65

Estimated Offtake Elbow Area/ Sampler Inlet Area
6888

Retort Area Less Draft Shroud Area
28.75 square feet

Equation of Fitted Curve : Dust (#/hr)/ Coal Feed (#/hr) (%) = 0.423*Face Velocity**1.29 R Squared = 0.951

RUN #	DATE	TEST LENGTH (min)	MASS PARTICLES (milligram)	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)
3	3-NOV-83 07:36	1	40.71	4380	345	29.64	882	2760	0.847	34	300	0.0	46
4	5-NOV-83 21:30	2	81.60	2900	423	29.21	875	3394	1.28	34	300	0.0	41
5	5-NOV-83 22:53	2	51.92	2900	396	29.20	872	3166	0.816	28	300	0.0	42
6	6-NOV-83 04:52	2	108.77	4800	388	29.18	1030	3664	1.19	34	300	0.0	46
8	8-NOV-83 12:26	2	244.83	5140	422	29.25	1335	5154	1.99	34	300	0.0	41
9	8-NOV-83 13:03	2	87.89	4633	357	29.23	1335	4360	0.864	28	300	0.0	42

TABLE G-2
CUMULATIVE DUST SIZING DATA

SIEVING				Run # 009-05
ASTM SIEVE NUM.	SIEVE SIZE	SHIFT SIZE	Percent Less Than Stated Size	
	(um)	(um)	(%<)	
	SIEVING NOT DONE ON THIS SAMPLE			

MICROSCOPY	PARTICLE DIAMETER	Percent Less Than Stated Size
	(um)	(%<)
	320.0	100.0
	178.0	93.2
	100.0	81.6
	56.0	71.1
	32.0	53.1
	17.8	33.8
	10.0	19.9
	5.60	9.61
	3.20	3.36
	1.78	0.760

Table G-3

Cummulative Dust Size Distribution

Table G-4

Dust Size Distribution Modal Analysis

009-05 VOLUME DISTRIBUTION 009-05 SURFACE DISTRIBUTION

CHN= .018 CHS= .01 CHU= .014

F1= 0 DG1= 1 SG1= 2

F2= 0 DG2= 1 SG2= 2

F3= 6.08E+10 DG3= 42.12 SG3= 3.25

CHN= .018 CHS= .01 CHU= .014

F1= 0 DG1= 1 SG1= 2

F2= 0 DG2= 1 SG2= 2

F3= 1.73E+10 DG3= 10.5 SG3= 3.25

009-05 NUMBER DISTRIBUTION

CHN= .018 CHS= .01 CHU= .014

F1= 0 DG1= 1 SG1= 2

F2= 0 DG2= 1 SG2= 2

F3= 8.06E+08 DG3= .652 SG3= 3.25

Table G-5

Description of Modal Fitting Parameters
(Associated with Figure G-4)

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.

APPENDIX H

Gasifier Operator Logged Data

Included are three tables of data:

H-1. Freeboard Data

H-2. Firetest Data

H - Relatively hot incandescent zone

D - Multiple incandescent zones

C - Relatively cold incandescent zone

H-3. Operator Logged Data I

Water flows in gpm.

Water totals in gallons.

Steam flows in lb/min.

H-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, Maurer et al, 1984).

TABLE H-1
FREEBOARD HEIGHT

DATE	TIME	#1	#2	#3	#4	#5	#6	#7	AVE
11-01	1530	41			42				40.5
11-01	1630	41			43				42.0
11-01	1730	42			42				42.0
11-01	1830	41			41				41.0
11-01	1930	40			40				40.0
11-01	2030	41			40				40.5
11-01	2130	43			42				42.5
11-01	2230	42			42				42.0
11-01	2330	43			45				44.0
11-02	0030	48			40				44.0
11-02	0130	45			40				42.5
11-02	0230	44			48				46.0
11-02	0330	43			45				44.0
11-02	0430	43			47				45.0
11-02	0530	44			47				45.5
11-02	0630	45			47				46.0
11-02	0730	43			44				43.5
11-02	0830	43			42				42.3
11-02	0930	42			44				43.0
11-02	1030	41			42				41.5
11-02	1130	40			42				41.0
11-02	1230	41			41				41.0
11-02	1330	42			40				41.0
11-02	1430	45			41				43.0
11-02	1530	50			46				48.0
11-02	1630	41			44				42.5
11-02	1730	41			56				48.5
11-02	1830	45			42				43.5
11-02	1930	45			43				44.0
11-02	2030	50			42				46.0
11-02	2130	39			41				40.0
11-02	2230	40			41				40.5
11-02	2330	45			47				46.0
11-03	0030	45			44				44.5
11-03	0130	45			45				45.0
11-03	0230	45			45				45.0
11-03	0330	46			47				46.5
11-03	0430	47			50				48.5
11-03	0530	45			45				45.0
11-03	0630	45			48				46.5
11-03	0730	47			43				45.0
11-03	0830		45			47			46.0
11-03	0930			43			43		43.0
11-03	1030	44			50				47.0
11-03	1130		45			45			45.0
11-03	1230			43			44		43.5
11-03	1330	41			44				42.5
11-03	1430		42			43			42.5
11-03	1530	43			43				43.0

DATE	TIME	#1	#2	#3	#4	#5	#6	#7	AVE
11-03	1630			43.5			43.5		43.5
11-03	1730		43.5			44.5			44.0
11-03	1830	43.5			41.5				42.5
11-03	1930		43.5			41.5			42.5
11-03	2030			43			42		42.5
11-03	2130	43.5			41.5				42.5
11-03	2230		43			41			42.0
11-03	2330	42		42					42.0
11-04	0030	43		42					42.5
11-04	0130	44		46					45.0
11-04	0230	42		42					42.0
11-04	0330	41		45					43.0
11-04	0430	44		44					44.0
11-04	0530	43		47					45.0
11-04	0630	43		44					43.5
11-04	0730	44			57				50.5
11-04	0830		42			44			43.0
11-04	0930			43			44		43.5
11-04	1030	41			42				41.5
11-04	1130		44			44			44.0
11-04	1230			43			43		43.0
11-04	1330	43			45				44.0
11-04	1430		45			44			44.5
11-04	1530			44			44		44.0
11-04	1630	41			41				41.0
11-04	1730		43			42			42.5
11-04	1800			43.5			42.5		43.0
11-04	1830	43			43				43.0
11-04	1900		43.5			43			43.25
11-04	1930		43.5			42.5			43.0
11-04	2030			44			45		44.5
11-04	2130		45			46			45.5
11-04	2230			44.5			43.5		44.0
11-04	2330	44			45				44.5
11-05	0030		45			43			44.0
11-05	0130			44			44		44.0
11-05	0230	45			47				46.0
11-05	0330		46			46			46.0
11-05	0430			46			47		46.5
11-05	0530	45			46				45.5
11-05	0630		46			46			46.0
11-05	0730			43			44		43.5
11-05	0830	41			42				41.5
11-05	0930		42			45			43.5
11-05	1030			42			43		42.5
11-05	1130	42			42				42.0
11-05	1230		43			44			43.5
11-05	1330			44			42		43.0
11-05	1430		43			44			43.5
11-05	1530	43			42				42.5
11-05	1630			41			39		40.0
11-05	1730		41			44			42.5

DATE	TIME	#1	#2	#3	#4	#5	#6	#7	AVE
11-05	1830	45			44				44.5
11-05	1930		42			44			43.0
11-05	2030			42			41		41.5
11-05	2130	42			40				41.0
11-05	2230		41			39			40.0
11-05	2330		44			46			45.0
11-06	0030	44			45				44.5
11-06	0130	44			45				44.5
11-06	0230			46			44		45.0
11-06	0330	44			45				44.5
11-06	0430			47			45		46.0
11-06	0530		46			47			46.5
11-06	0630	45			45				45.0
11-06	0730		43			44			43.5
11-06	0830			42			42		42.0
11-06	0930	41			40				40.5
11-06	1030		43			46			44.5
11-06	1130			42			43		42.5
11-06	1230	42			40				41.0
11-06	1330		43			44			43.5
11-06	1430			43			45		44.0
11-06	1530	43			41				42.0
11-06	1630		45			45			45.0
11-06	1730			41			42		41.5
11-06	1830	42			41				41.5
11-06	1930		42			41			41.5
11-06	2030			39			42		40.5
11-06	2130	45			43				44.0
11-06	2230		46			41			43.5
11-06	2330	43			41				42.0
11-07	0030		44			39			41.5
11-07	0130			40			43		41.5
11-07	0230	43			42				42.5
11-07	0330			42			43		42.5
11-07	0430		45			45			45.0
11-07	0530		DOWN FOR CONVEYOR REPAIR						
11-07	1330			42			44		43.0
11-07	1430	42			43				42.5
11-07	1530		43			41			42.0
11-07	1630			44			42		43.0
11-07	1730	42			41				41.5
11-07	1830		43			41			42.0
11-07	1930			43			41		42.0
11-07	2030	44			41				42.5
11-07	2130		44			43			43.5
11-07	2230			42			40		41.0
11-07	2330	42			40				41.0
11-08	0030		44			42			43.0
11-08	0130			45			46		45.5
11-08	0230	43			44				43.5
11-08	0330		44			45			44.5
11-08	0430			46			48		47.0

DATE	TIME	#1	#2	#3	#4	#5	#6	#7	AVE
11-08	0530		44			46			45.0
11-08	0630	45			45				45.0
11-08	0730		44			44			44.0
11-08	0830			42			42		42.0
11-08	0930	44			44				44.0
11-08	1030		45			44			44.5
11-08	1100			46			47		46.5
11-08	1230	41			41				41.0
11-08	1330		42			42			42.0
11-08	1430			42			43		42.5
11-08	1530	41			40				40.5
11-08	1630		44			43			43.5
11-08	1730			43			41		42.0
11-08	1830	41			40				40.5
11-08	1930		42			41			41.5
11-08	2030			43			41		42.0
11-08	2130	42			41				41.5

TABLE H-2

FIRE TEST DATA

Date	Time	Insertion Time (min)	#1	#2	#3	#4	#5	#6	#7	Average
11-01	1600	3.0	5	7	10	4	7	3	6	6.0
11-01	1800	3.0	4	9	7	4	5	3	3	5.0
11-01	2000	3.0	13	8	12	4	4	8	4	7.6
11-01	2200	3.0	4	7	4	3	9	12	3	6.0
11-02	0000	3.0	15	10						12.5
11-02	0200	3.0	12	14	14	14				13.5
11-02	0400	3.0	16	18	16	15	10	22	20	16.7
11-02	0600	3.0	15	10	14	11	14	15	19	14.0
11-02	0800	3.0	18	24	12	18	15	12	23	17.4
11-02	1000	3.0	15D	14	12D	C	13	11D	17	11.7
11-02	1200	3.0	19	13	24D	15	16	13D	22	17.4
11-02	1400	3.0	17	13D	18	16D	18	10D	24	16.6
11-02	1600	3.0	16	9D	22	14	13D	15D	19	15.4
11-02	1800	3.0	14	11D	22	13D	18D	11D	21	15.7
11-02	2000	3.0	24	22	17D	15D	13	18D	21	18.6
11-02	2200	3.0	30	26	13	6D	12	11C	10C	15.4
11-03	0000	3.0	C	34	33	15D	21	14	26	20.4
11-03	0200	3.0	14	24	13	16	22	28	26	20.4
11-03	0400	3.0	7	10	18	18	32D	21	18D	17.7
11-03	0600	3.0	25	12	8	7	10	10	16	12.6
11-03	0800	4.5	19	10	7	7C	6C	15	17	11.6
11-03	1000	5.0	4	7C	6C	8	6	15	6C	7.4
11-03	1200	5.0	11C	8	1	15C	7	12	15	9.9
11-03	1400	5.0	3C	10	15	1	10C	8C	2	7.0
11-03	1600	5.0	14	9C	8	15C	7	17C	8	11.1
11-03	1800	5.0	14C	18C	7D	14C	10	11	9C	11.9
11-03	2000	5.0	14C	18C	17C	7C	6	6C	13C	11.6
11-03	2200	5.0	5C	27	25	8D	5	5	18	13.3
11-04	0000	5.0	7	10	1	11	23	13	10	12.1
11-04	0200	5.0	13	12	15	12	21	18	12	14.7
11-04	0400	5.0	20	18	12	16	18	22	16	17.4
11-04	0600	5.0	12	14	15	11	10	14	10	12.3
11-04	0800	5.0	8C	5C	30	8C	4	4	7C	9.4
11-04	1000	5.0	10	10C	12	10C	12	2	9	9.3
11-04	1200	5.0	6C	5	15	10	4	6C	17	9.0
11-04	1400	5.0	6	26	26	1	7	3	28	13.9
11-04	1600	5.0	24C	13	32	11	24	16C	12C	18.9
11-04	1800	8.0	11	7	5	4	7	1	7	6.0
11-04	2000	8.0	0	9C	12	13	20	41	0	13.6
11-04	2200	10.0	20	12	0	13	7	4	8D	9.1
11-05	0000	8.0	10	18	28	7	22	31	14	18.6
11-05	0200	8.0	12	10	8	10	18	18	14	12.9
11-05	0400	8.0	6	49	6	7	9	10	7	13.4
11-05	0600	8.0	13	12	10	14	17	12	13	13.0
11-05	0800	8.0	5	7	7D	16D	9	20	10	10.0
11-05	1000	8.0	7	12	20D	4D	24	13	7	12.4
11-05	1200	8.0	6	18	16	50	3D	21	8	17.4

Date	Time	Insertion Time (min)	#1	#2	#3	#4	#5	#6	#7	Average
11-05	1400	6.0	5C	4C	10	11D	21	19C	11	11.6
11-05	1600	6.0	1	12C	6D	11D	11D	27	1D	9.9
11-05	1800	6.0	13	10	12D	24	11D	13	4	12.4
11-05	2000	6.0	6	42	1D	12D	4D	7	21	13.3
11-05	2200	6.0	15	16D	45	25	3D	8D	6	16.9
11-06	0000	6.0	46	10	39	42D	33	6	10	26.6
11-06	0200	6.0	12	26	42	38D	6	8	10	20.3
11-06	0400	6.0	44	16	41	48	38	24	10	31.6
11-06	0600	6.0	33	20	36	32	40	8	15	26.3
11-06	0800	5.0	8	31	28	17	10	14	22	18.6
11-06	1000	6.0	12	28	4D	15C	17	8	7	13.0
11-06	1200	5.0	15	9	7	34	42	23	12	20.3
11-06	1400	5.0	6	25	4D	20	25	6	20	15.1
11-06	1600	6.0	11	15	16	18	10D	8C	18	13.7
11-06	1800	6.0	9	11D	15	22	19	9	5	12.9
11-06	2000	7.0	22	16D	17D	10	5D	11	6	12.4
11-06	2200	7.0	4	23	6	9	14	8	3	9.6
11-07	0035	5.0	3	6	20C	16D	5	8	6	9.1
11-07	0400	5.0	7	10	11	9	9	5	12	9.0
11-07	1300	6.0	15C	4D	15	1	14	13	13	10.7
11-07	1400	6.0	17C	16	5D	4	1	8	9	8.6
11-07	1600	6.0	3	4	11	10	6	8	15C	8.1
11-07	1800	7.0	7	6	5	11	8	17D	8	8.9
11-07	2000	7.0	9C	12	8	9	14D	5D	7C	9.1
11-07	2200	7.0	6	8	10	12	6D	12	15	9.9
11-08	0000	5.0	16	18	35	11D	9	7	10	15.1
11-08	0200	5.0	14	16	20	18D	12	6	11	13.9
11-08	0400	5.0	14	17	10	11	7	13	8	11.4
11-08	0600	5.0	12	13	48	10	11	20	6	17.1
11-08	0800	5.0	10	16D	13	15	13	7	16	12.9
11-08	1000	5.0	12	10D	24D	15D	16	9	18	14.9
11-08	1200	6.0	14C	20	35	8D	3D	6	18C	14.9
11-08	1400	6.0	10	18	22	13C	15	10	14	14.6
11-08	1600	7.0	15	14	36	13	11	15	20	17.7
11-08	1800	7.0	18	16	35	11	12	11	10C	16.1
11-08	2000	11.0	12	47	38	32	14	9	14	23.7
11-08	2120	10.0	10	9D	13	11	10	14	15	11.7

TABLE H-3

OPERATOR LOG I

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.
1101	1530	4.5	3.0	25613		-2.42			2.2	12.0
1101	1630	4.5	7.0	25616	300	-2.42			1.5	
1101	1730	4.5	11.0	25619	300	-2.42			1.2	
1101	1830	4.5	11.0	25625	600	-2.42			2.0	14.0
1101	1930	4.5	11.0	25631	600	-2.42			2.2	14.0
1101	2030	4.5	10.0	25637	600	-2.42			1.8	10.0
1101	2130	4.5	10.0	25643	600	-2.42			2.0	14.0
1101	2230	4.5	12.0	25650	700	-2.42			2.0	14.0
1101	2330	4.5	13.0	25655	500	2.42	+30	+30	1.4	11.0
1102	0030	4.5	13.0	25662	700	1.0	+30	+30	3.0	13.0
1102	0130	4.5	13.0	25669	700	1.0	+30	+30	3.0	15.0
1102	0230	4.5	13.0	25676	700	1.0	+30	+30	3.0	15.0
1102	0330	4.5	13.0	25682	600	1.0	28	28	3.0	20.0
1102	0430	4.5	13.0	25690	800	1.0	28	30	4.0	20.0
1102	0530	4.5	13.0	25696	600	2.42	28	25	4.0	20.0
1102	0630	4.5	13.0	25703	700	3.0	28	28	7.0	20.0
1102	0730	4.5	12.0	25708	500	4.0	22	24	6.0	22.0
1102	0830	4.5	12.0	25715	700	5.0	23	25	8.0	22.0
1102	0930	4.5	12.0	25721	600	5.0	19	20	8.0	26.0
1102	1030	4.5	12.0	25728	700	5.5	18	20	9.0	30.0
1102	1130	4.5	12.0	25734	600	6.0	17.5	20	9.0	30.0
1102	1230	4.5	12.0	25741	700	6.5	17.5	19	10.0	32.0
1102	1330	4.5	12.0	25748	700	7.0	20.0	22.5	12.0	30.0
1102	1430	4.5	12.0	25754	600	8.0	+30	+30	22.0	24.0
1102	1530	4.5	12.0	25761	700	6.0	+30	+30	15.2	26.0
1102	1630	4.5	12.0	25768	700	5.9	+30	+30	15.5	22.0
1102	1730	4.5	12.0	25775	700	5.9	+30	+30	15.5	22.0
1102	1830	4.5	12.0	25782	700	5.8	+30	+30	15.0	22.0
1102	1930	4.5	12.0	25788	600	5.8	+30	+30	15.7	23.0
1102	2030	4.5	12.0	25794	600	5.8	+30	+30	15.5	24.0
1102	2130	4.5	12.0	25801	700	5.8	+30	+30	15.4	23.0
1102	2230	4.5	12.0	25808	700	5.8	+30	+30	15.5	24.0
1102	2330	4.5	13.0	25815	700	5.5	+30	+30	15.0	26.0
1103	0030	4.5	13.0	25821	600	5.5	+30	+30	15.0	26.0
1103	0130	4.5	13.0	25827	600	5.5	+30	+30	16.5	26.0
1103	0230	4.5	13.0	25834	700	5.5	+30	+30	16.5	26.0
1103	0330	4.5	13.0	25839	500	5.5	+30	+30	18.0	26.0
1103	0430	4.5	13.0	25847	800	5.5	+30	+30	16.5	26.0
1103	0530	4.5	13.0	25854	700	5.5	+30	+30	17.0	26.0
1103	0630	4.5	13.0	25860	600	5.5	+30	+30	19.0	28.0
1103	0730	4.5	12.0	25866	600	9.0	26	26	22.0	66.0
1103	0830	4.5	12.0	25873	700	8.5	22	24	18.0	48.0
1103	0930	4.5	12.0	25879	600	7.0	+30	+30	18.0	28.0
1103	1030	4.5	12.0	25886	700	7.5	+30	+30	22.0	24.0
1103	1130	4.5	12.0	25893	700	7.5	+30	+30	21.0	30.0
1103	1230	4.5	12.0	25899	600	9.0	27	28	20.0	40.0

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.
1103	1330	4.5	12.0	25906	700	8.5	+30	+30	20.0	32.0
1103	1430	4.5	12.0	25913	700	8.0	25	28	20.0	42.0
1103	1530	4.5	12.0	25919	600	7.4	+30	+30	18.5	30.0
1103	1630	4.5	12.0	25926	700	7.5	+30	+30	20.0	30.0
1103	1730	4.5	12.0	25934	800	9.1	26	27.5	23.5	72.0
1103	1830	4.5	8.0	25937	300	8.9	19.7	21.2	17.2	68.0
1103	1930	4.5	7.0	25940	300	6.7	+30	+30	17.0	30.0
1103	2130	4.5	7.0	25947	700	7.0	+30	+30	16.8	28.0
1103	2230	4.5	7.0	25950	300	7.2	+30	+30	17.6	29.0
1103	2330	4.5	7.0	25953	300	8.0	+30	+30	17.0	24.0
1104	0030	4.5	7.0	25956	300	7.0	+30	+30	18.0	25.0
1104	0130	4.5	7.0	25959	300	7.0	+30	+30	18.0	26.0
1104	0230	4.5	7.0	25963	400	7.0	26	28	18.0	31.0
1104	0330	4.5	7.0	25967	400	8.0	25	+30	20.0	28.0
1104	0430	4.5	7.0	25970	300	7.0	28	+30	17.0	24.0
1104	0530	4.5	7.0	25974	400	7.0	+30	+30	18.0	25.0
1104	0630	4.5	7.0	25978	400	7.0	+30	+30	20.0	26.0
1104	0730	4.5	7.0	25980	200	8.0	+30	+30	18.0	30.0
1104	0830	4.5	7.0	25984	400	6.0	+30	+30	18.0	30.0
1104	0930	4.5	7.0	25987	300	6.5	+30	26	19.0	26.0
1104	1030	4.5	6.5	25990	300	7.5	+30	+30	23.0	28.0
1104	1130	4.5	7.0	25993	300	7.5	+30	+30	23.0	26.0
1104	1230	4.5	7.0	25996	300	10.0	+30	+30	+30	90.0
1104	1330	4.5	7.0	26000	400	10.0	27	29	26.0	100.0
1104	1430	4.5	7.0	26003	300	11.0	+30	+30	+30	76.0
1104	1530	4.5	7.0	26006	300	11.0	+30	+30	+30	100.0
1104	1630	4.5	7.0	26010	400	10.5	+30	+30	+30	100.0
1104	1730	4.5	7.0	26014	400	10.2	+30	+30	+30	100.0
1104	1830	4.5	7.0	26017	300	10.1	+30	+30	+30	100.0
1104	1930	4.5	7.0	26020	300	10.0	+30	+30	+30	50.0
1104	2030	4.5	7.0	26024	400	10.1	+30	+30	+30	78.0
1104	2130	4.5	7.0	26027	300	10.2	+30	+30	+30	100.0
1104	2230	4.5	7.0	26030	300	10.1	+30	+30	+30	50.0
1104	2330	4.5	7.0	26033	300	10.0	+30	+30	30.0	75.0
1105	0030	4.5	7.0	26036	300	10.0	+30	+30	+30	92.0
1105	0130	4.5	7.0	26040	400	10.0	+30	+30	+30	90.0
1105	0230	4.5	7.0	26043	300	10.0	+30	+30	29.0	100.0
1105	0330	4.5	7.0	26047	400	10.0	+30	+30	29.0	100.0
1105	0430	4.5	7.0	26050	300	10.0	+30	+30	29.0	100.0
1105	0530	4.5	7.0	26053	300	10.0	+30	+30	29.0	100.0
1105	0630	4.5	7.0	26056	300	10.0	+30	+30	+30	100.0
1105	0730	4.5	6.0	26060	400	8.5	+30	+30	+30	22.0
1105	0830	4.5	6.0	26063	300	9.0	+30	+30	25.0	33.0
1105	0930	4.5	6.0	26066	300	8.5	+30	+30	20.0	28.0
1105	1030	4.5	6.0	26070	400	9.5	+30	+30	+30	45.0
1105	1130	4.5	6.0	26073	300	10.0	+30	+30	+30	70.0
1105	1230	4.5	6.0	26076	300	10.5	+30	+30	+30	65.0
1105	1330	4.5	7.0	26080	400	10.2	29.8	+30	29.0	100.0
1105	1430	4.5	11.0	26084	400	6.0	+30	+30	13.2	22.0
1105	1530	4.5	6.0	26089	500	10.1	+30	+30	+80	100.0

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.
1105	1630	4.5	11.0	26092	300	6.2	+30	+30	14.2	28.0
1105	1730	4.5	11.0	26099	700	6.2	+30	+30	16.7	22.0
1105	1830	4.5	11.0	26105	600	6.1	+30	+30	15.5	25.0
1105	1930	4.5	11.0	26111	600	6.1	+30	+30	15.6	24.0
1105	2030	4.5	11.0	26116	500	6.2	+30	+30	15.5	26.0
1105	2130	4.5	11.0	26123	700	6.0	+30	+30	16.0	24.0
1105	2230	4.5	11.0	26129	600	6.0	+30	+30	16.8	22.0
1105	2330	4.3	12.0	26136	700	5.5	+30	+30	16.5	22.0
1106	0030	4.3	12.0	26141	500	5.5	+30	+30	16.5	22.0
1106	0130	4.3	12.0	26148	700	5.5	+30	+30	15.0	26.0
1106	0230	4.3	12.0	26154	600	5.5	+30	+30	18.0	26.0
1106	0330	4.3	12.0	26160	600	5.5	+30	+30	20.0	26.0
1106	0430	4.3	12.0	26166	600	5.5	+30	+30	20.0	26.0
1106	0530	4.3	12.0	26173	700	5.5	+30	+30	22.0	26.0
1106	0630	4.3	12.0	26178	500	5.5	+30	+30	23.0	28.0
1106	0730	4.5	11.0	26184	600	7.0	+30	22	28.0	28.0
1106	0830	4.5	11.0	26190	600	7.0	+30	+30	23.0	26.0
1106	0930	4.5	11.0	26197	700	7.5	+30	+30	25.0	34.0
1106	1030	4.5	11.0	26203	600	10.0	+30	+30	+30	70.0
1106	1130	4.5	4.0	26205	200	10.0	+30	+30	+30	50.0
1106	1230	4.5	4.0	26207	200	9.0	+30	+30	+30	50.0
1106	1330	4.5	4.0	26209	200	8.5	+30	+30	+30	35.0
1106	1445	4.5	4.0	26211	200	9.5	+30	+30	+30	35.0
1106	1530	4.5	4.0	26212	100	9.8	+30	+30	+30	38.0
1106	1630	4.5	4.0	26214	200	9.1	+30	+30	+30	34.0
1106	1730	4.5	4.0	26216	200	8.8	+30	+30	+30	34.0
1106	1830	4.5	4.0	26218	200	7.0	+30	+30	+30	28.0
1106	1930	4.5	4.0	26220	200	9.1	+30	+30	29.4	52.0
1106	2030	4.5	4.0	26222	200	8.6	+30	+30	+30	44.0
1106	2130	4.5	4.0	26224	200	7.5	+30	+30	+30	45.0
1106	2230	4.5	4.0	26226	200	6.5	+30	+30	+30	28.0
1106	2330	4.3	4.0	26228	200	8.0	+30	+30	+30	40.0
1107	0030	4.3	11.0	26230	200	7.0	+30	+30	+30	22.0
1107	0130	4.5	15.0	26238	800	5.2	+30	+30	14.2	22.0
1107	0230	4.5	12.0	26246	800	5.4	+30	+30	15.2	24.0
1107	0330	4.5	4.0	26250	400	5.4	+30	+30	+30	50.0
1107	0430	4.5	12.0	26253	300	5.5	+30	+30	26.0	30.0
1107	0530				SHUT DOWN FOR CONVEYOR REPAIR					
1107	1230	4.5	4.0	26295	4200	8.0	+30	+30	18.0	30.0
1107	1330	4.5	4.0	26297	200	4.0	+30	+30	7.0	18.0
1107	1430	4.5	6.0	26299	200	3.5	+30	+30	5.0	20.0
1107	1530	4.5	6.0	26302	300	5.1	+30	+30	17.0	24.0
1107	1630	4.5	6.0	26305	300	5.9	+30	+30	20.2	25.0
1107	1730	4.5	6.0	26309	400	6.5	+30	+30	24.5	27.0
1107	1830	4.5	6.0	26312	300	7.7	+30	+30	25.0	28.0
1107	1930	4.5	6.0	26315	300	8.0	+30	+30	27.0	30.0
1107	2030	4.5	6.0	26318	300	8.7	+30	+30	+30	38.0
1107	2130	4.5	6.0	26320	200	8.9	+30	+30	+30	32.0
1107	2230	4.5	6.0	26323	300	9.0	+30	+30	27.8	40.0
1107	2330	4.5	6.0	26326	300	9.5	+30	+30	+30	44.0

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.
1108	0030	4.5	6.0	26330	400	9.5	+30	+30	+30	44.0
1108	0130	4.5	6.0	26333	300	10.0	+30	+30	+30	50.0
1108	0230	4.5	6.0	26337	400	10.0	+30	+30	+30	45.0
1108	0330	4.5	7.0	26340	300	10.0	+30	+30	+30	65.0
1108	0430	4.5	7.0	26343	300	10.0	+30	+30	+30	65.0
1108	0530	4.5	7.0	26346	300	10.0	+30	+30	+30	65.0
1108	0630	4.5	7.0	26349	300	10.0	+30	+30	+30	65.0
1108	0730	4.5	6.0	26352	300	11.0	+30	+30	+30	100.0
1108	0830	4.5	6.0	26355	300	11.0	+30	+30	+30	95.0
1108	0930	4.5	5.0	26358	300	11.0	+30	+30	+30	100.0
1108	1030	4.5	4.7	26360	200	11.0	+30	+30	+30	100.0
1108	1130	4.5	5.0	26362	200	11.0	+30	+30	+30	98.0
1108	1230	4.5	5.0	26364	200	11.0	+30	+30	+30	98.0
1108	1330	4.5	5.0	26367	300	11.0	+30	+30	+30	90.0
1108	1430	4.5	5.0	26369	200	5.0	+30	+30	15.0	22.0
1108	1530	4.5	5.0	26371	200	10.8	+30	+30	+30	98.0
1108	1630	4.5	10.0	26375	400	5.1	+30	+30	14.3	22.0
1108	1730	4.5	10.0	26380	500	6.1	+30	+30	17.5	26.0
1108	1830	4.5	10.0	26385	500	4.75	+30	+30	13.5	28.0
1108	1930	4.5	14.0	26392	700	5.2	+30	+30	11.4	20.0
1108	2030	4.5	14.0	26401	900	4.0	+30	+30	15.0	22.0
1108	2130	4.5	14.0	26410	900	7.0	+30	+30	13.0	20.0
1108	2230			BANKED THE GASIFIER						
1108	2330	5.0	6.0	26416	600	6.0	+30	+30	14.0	20.0
1109	0030	4.5	14.0	26422	600	3.0	+30	+30	12.5	20.0

TABLE H-4
OPERATOR LOG II

DATE	TIME	AGIT. COUNT RDING	AGIT SWEEP PER HR	AGIT DRIVE SETNG	GRATE			FLUE GAS SCRUBBER		
					GEAR COUNTER READING	GRATE GEAR RPH	GRATE DRIVE SETNG	pH	REAGENT PUMP SPEED	REAGENT PUMP STROKE
11-01	1530	0	0	0	50	0	0	7.0	20	30
11-01	1630	0	0	0	50	0	0	7.0	20	30
11-01	1730	0	0	0	50	0	0	7.0	20	30
11-01	1830	0	0	0	50	0	0	7.0	20	30
11-01	1930	0	0	0	50	0	0	7.0	20	30
11-01	2030	0	0	0	50	0	0	7.0	20	30
11-01	2130	0	0	0	50	0	0	7.0	20	30
11-01	2230	0	0	0	50	0	0	7.0	20	30
11-01	2330	0	0	0	50	0	0	7.0	20	30
11-02	0030	0	0	0	53	3	1/1.07	7.0	20	30
11-02	0130	0	0	0	60	7	1.5/3.00	7.0	20	30
11-02	0230	0	0	0	72	12	1.5/3.00	7.0	20	30
11-02	0330	0	0	0	91	19	1.5/3.50	7.0	20	30
11-02	0430	0	0	0	113	22	1.5/3.50	7.0	20	30
11-02	0530	0	0	0	129	16	1.5/3.50	7.0	20	30
11-02	0630	0	0	0	148	19	1.5/3.50	7.0	20	30
11-02	0730	0	0	0	165	17	1/3.50	7.0	20	30
11-02	0830	0	0	0	184	19	3	7.0	20	30
11-02	0930	0	0	0	236	52	3	7.0	20	30
11-02	1030	0	0	0	289	53	3	7.0	20	30
11-02	1130	0	0	0	341	52	3	7.0	20	30
11-02	1230	0	0	0	404	63	4	7.0	20	30
11-02	1330	0	0	0	474	70	4	7.0	20	30
11-02	1430	0	0	0	539	65	4	7.0	20	30
11-02	1530	0	0	0	607	68	4	7.0	20	30
11-02	1630	0	0	0	676	69	4	7.0	20	30
11-02	1730	0	0	0	751	75	4	7.0	20	30
11-02	1830	0	0	0	823	72	4	7.0	20	30
11-02	1930	0	0	0	885	62	4	4.0	20	30
11-02	2030	0	0	0	945	60	4	7.0	20	30
11-02	2130	0	0	0	1025	80	5	7.0	20	30
11-02	2230	0	0	0	1104	79	4	7.0	20	30
11-02	2330	5	0	0	1206	102	4	7.0	20	30
11-03	0030	5	0	0	1244	38	4	7.0	20	30
11-03	0130	5	0	0	1297	53	4	7.0	20	30
11-03	0230	5	0	0	1368	71	4	7.0	20	30
11-03	0330	5	0	0	1430	62	4	7.0	20	30
11-03	0430	5	0	0	1507	77	4	7.0	20	30
11-03	0530	5	0	0	1574	67	4	7.0	20	30
11-03	0630	5	0	0	1638	64	4	7.0	20	30
11-03	0730	0	0	0	1703	65	4	7.0	45	50
11-03	0830	0	0	0	1774	71	4	7.0	45	50
11-03	0930	0	0	0	1837	63	4	7.0	45	50
11-03	1030	0	0	0	1903	66	3	7.0	45	50
11-03	1130	0	0	0	1952	49	3	7.0	45	50

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
11-03	1230	0	0	0	2003	51	3	7.0	45	50
11-03	1330	0	0	0	2053	50	3	7.0	45	50
11-03	1430	0	0	0	2106	53	3	7.0	45	50
11-03	1530	5	5	0	2140	34	2	7.0	45	50
11-03	1630	5	0	0	2172	32	2	7.0	45	50
11-03	1730	5	0	0	2208	36	2	7.0	45	50
11-03	1830	5	0	0	2249	41	2	7.0	45	50
11-03	1930	5	0	0	2274	25	2	7.0	45	50
11-03	2130	5	0	0	2342	68	2	7.0	45	50
11-03	2230	5	0	0	2378	36	2	7.0	45	50
11-03	2330	0	0	0	2410	32	2	7.0	45	50
11-04	0030	0	0	0	2442	32	2	7.0	45	50
11-04	0130	0	0	0	2477	35	2	7.0	45	50
11-04	0230	0	0	0	2512	35	2	7.0	45	50
11-04	0330	0	0	0	2546	34	2	7.0	45	50
11-04	0430	0	0	0	2583	37	2	7.0	45	50
11-04	0530	0	0	0	2620	37	2	7.0	45	50
11-04	0630	0	0	0	2654	34	2	7.0	45	50
11-04	0730	0	0	0	2680	26	2	7.0	45	50
11-04	0830	0	0	0	2713	33	2	7.0	45	50
11-04	0930	0	0	0	2749	36	2	7.0	45	50
11-04	1030	0	0	0	2780	31	2	7.0	45	50
11-04	1130	0	0	0	2812	32	2	7.0	45	50
11-04	1230	0	0	0	2847	35	2	7.0	45	50
11-04	1330	0	0	0	2883	36	2	7.0	45	50
11-04	1430	0	0	0	2921	38	3	7.0	45	50
11-04	1530	0	0	0	2972	51	3	7.0	45	50
11-04	1630	0	0	0	3029	57	4	7.0	45	50
11-04	1730	5	5	0	3112	83	4	7.0	45	50
11-04	1830	5	0	0	3161	49	2	7.0	45	50
11-04	1930	5	0	0	3192	31	2	7.0	45	50
11-04	2030	5	0	0	3224	32	2	7.0	45	50
11-04	2130	5	0	0	3272	48	3	7.0	45	50
11-04	2230	5	0	0	3318	46	2	7.0	45	50
11-04	2330	5	0	0	3355	37	2	7.0	45	50
11-05	0030	5	0	0	3385	30	2	7.0	45	50
11-05	0130	5	0	0	3415	30	2	7.0	45	50
11-05	0230	5	0	0	3457	42	2	7.0	45	50
11-05	0330	5	0	0	3489	32	2	7.0	45	50
11-05	0430	5	0	0	3523	34	2	7.0	45	50
11-05	0530	5	0	0	3555	32	2	7.0	45	50
11-05	0630	5	0	0	3588	33	2	7.0	45	50
11-05	0730	5	0	0	3621	33	2	7.0	45	50
11-05	0830	5	0	0	3655	34	2	7.0	45	50
11-05	0930	5	0	0	3689	34	2	7.0	45	50
11-05	1030	9	4	0	3723	34	2	7.0	45	50
11-05	1130	9	0	0	3756	33	2	7.0	45	50
11-05	1230	9	0	0	3794	38	3	7.0	45	50
11-05	1330	9	0	0	3846	52	3	7.0	45	50
11-05	1430	9	0	0	3893	47	2	7.0	45	50

DATE	TIME	AGIT. COUNT RDING	AGIT SWEEP PER HR	AGIT DRIVE SETNG	GRATE	GRATE	GRATE	FLUE GAS SCRUBBER	FLUE GAS SCRUBBER	FLUE GAS SCRUBBER
					GEAR COUNTER READING	GEAR RPH	DRIVE SETNG	pH	REAGENT PUMP SPEED	REAGENT PUMP STROKE
11-05	1530	9	0	0	3927	34	2	7.0	45	50
11-05	1630	9	0	0	3963	36	1	7.0	45	50
11-05	1730	9	0	0	3983	20	1	7.0	45	50
11-05	1830	9	0	0	3995	12	1	7.0	45	50
11-05	1930	9	0	0	4018	23	1	7.0	45	50
11-05	2030	9	0	0	4031	13	1	7.0	45	50
11-05	2130	9	0	0	4047	16	1	7.0	45	50
11-05	2230	9	0	0	4073	26	2	7.0	45	50
11-05	2330	9	0	0	4111	38	2	7.0	45	50
11-06	0030	9	0	0	4142	31	2	7.0	45	50
11-06	0130	9	0	0	4178	36	2	7.0	45	50
11-06	0230	9	0	0	4212	34	2	7.0	45	50
11-06	0330	9	0	0	4245	33	2	7.0	45	50
11-06	0430	9	0	0	4293	48	4	7.0	45	50
11-06	0530	9	0	0	4343	50	4	7.0	45	50
11-06	0630	9	0	0	4388	45	4	7.0	45	50
11-06	0730	9	0	0	4436	48	3	7.0	45	50
11-06	0830	9	0	0	4492	56	4	6.5	45	50
11-06	0930	9	0	0	4560	68	4	6.5	45	50
11-06	1030	9	0	0	4622	62	3	6.5	45	50
11-06	1130	9	0	0	4672	50	3	6.5	45	50
11-06	1230	9	0	0	4733	61	4	6.5	45	50
11-06	1330	9	0	0	4798	65	4	7.0	45	50
11-06	1430	9	0	0	4848	50	4	7.0	45	50
11-06	1530	9	0	0	4895	47	4	7.0	45	50
11-06	1630	9	0	0	4963	68	4	7.0	45	50
11-06	1730	9	0	0	5037	74	4	7.0	45	50
11-06	1830	9	0	0	5110	73	4	7.0	45	50
11-06	1930	9	0	0	5193	83	4	7.0	45	50
11-06	2030	9	0	0	5247	54	4	7.0	45	50
11-06	2130	9	0	0	5315	68	4	7.0	45	50
11-06	2230	9	0	0	5368	53	3	7.0	45	50
11-06	2330	9	0	0	5419	51	3	7.0	45	50
11-07	0030	9	0	0	5474	55	3	7.0	45	50
11-07	0130	9	0	0	5517	43	2	7.0	45	50
11-07	0230	9	0	0	5550	33	2	7.0	45	50
11-07	0330	9	0	0	5579	29	2	7.0	45	50
11-07	0430	9	0	0	5632	53	3	7.0	45	50
11-07	0530	9	0	0			2			
SHUT DOWN FOR CONVEYOR REPAIR										
11-07	1230	9	0	0	5715	83	2			
11-07	1330	9	0	0	5749	34	2	5.0	45	45
11-07	1430	9	0	0	5783	34	2	7.0	45	45
11-07	1530	9	0	0	5817	34	2	6.5	45	45
11-07	1630	9	0	0	5853	36	2	7.0	45	50
11-07	1730	9	0	0	5894	41	2	7.0	45	50
11-07	1830	9	0	0	5923	29	2	7.0	45	50
11-07	1930	9	0	0	5955	32	2	7.0	45	50
11-07	2030	9	0	0	5991	36	2	7.0	45	50
11-07	2130	9	0	0	6027	36	2	7.0	45	50

DATE	TIME	AGIT. COUNT RDING	AGIT SWEEP PER HR	AGIT DRIVE SETNG	GRATE	GRATE GEAR RPH	GRATE DRIVE SETNG	FLUE	GAS	SCRUBBER
					GEAR COUNTER READING			pH	REAGENT PUMP SPEED	REAGENT PUMP STROKE
11-07	2230	9	0	0	6053	26	2	7.0	45	50
11-07	2330	9	0	0	6090	37	2	7.0	45	50
11-08	0030	9	0	0	6126	36	2	7.0	45	50
11-08	0130	9	0	0	6157	31	2	7.0	45	50
11-08	0230	9	0	0	6194	37	2	7.0	45	50
11-08	0330	9	0	0	6228	34	2	7.0	45	50
11-08	0430	9	0	0	6259	31	2	7.0	45	50
11-08	0530	9	0	0	6294	35	2	7.0	45	50
11-08	0630	9	0	0	6323	29	2	7.0	45	50
11-08	0730	9	0	0	6359	36	2	7.0	45	50
11-08	0830	9	0	0	6393	34	2	6.5	45	50
11-08	0930	9	0	0	6430	37	2	7.0	45	50
11-08	1030	9	0	0	6464	34	2	7.0	45	50
11-08	1130	9	0	0	6498	34	2	7.0	45	50
11-08	1230	9	0	0	6529	31	2	7.0	45	50
11-08	1330	9	0	0	6562	33	2	7.0	45	50
11-08	1430	9	0	0	6596	34	2	7.0	45	50
11-08	1530	9	0	0	6630	34	2	7.0	45	50
11-08	1630	9	0	0	6673	43	3	7.0	45	50
11-08	1730	9	0	0	6713	40	2	7.0	45	50
11-08	1830	9	0	0	6747	34	2	7.0	45	50
11-08	1930	9	0	0	6778	31	2	7.0	45	50
11-08	2030	9	0	0	6819	41	3	7.0	45	50
11-08	2130	9	0	0	6876	57	3	7.0	45	50
11-08					BANKED THE GASIFIER					
11-08	2330	9	0	0	6888	12	1	7.0	45	50
11-09	0030	9	0	0	6899	11	1	7.0	45	50

APPENDIX I

Gas Chromatograph Data

The results of each successful gas chromatograph analysis are included here. Results from both the HP5880A (analysis for permanent gasses and hydrocarbons) and the HP5793 (analysis for gaseous sulfur species) are included in separate tables.

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

11/ 1/1983

17:45	11.518	9.775	0.001	0.003	0.000	54.78	0.063	21.00	0.001	0.001	105.5	99.6	97.14	25.78	0.890
18: 2	10.067	9.940	0.001	0.003	0.000	56.92	0.055	19.91	0.001	0.002	97.2	92.1	96.90	26.11	0.901
18:20	10.132	9.863	0.001	0.003	0.000	56.64	0.055	20.24	0.001	0.002	98.5	93.4	96.94	26.09	0.901
19: 1	10.373	9.767	0.001	0.003	0.000	56.54	0.056	20.92	0.001	0.002	101.4	96.2	97.66	26.22	0.905
19:19	10.418	9.631	0.001	0.003	0.000	56.10	0.055	20.95	0.000	0.002	101.7	96.4	97.16	26.04	0.899
19:37	10.799	9.521	0.001	0.003	0.000	56.36	0.060	20.49	0.001	0.002	101.5	96.0	97.24	25.95	0.896
19:54	11.075	9.690	0.001	0.003	0.000	55.26	0.062	21.05	0.000	0.001	104.2	98.6	97.14	25.88	0.893
20:30	11.189	9.881	0.001	0.003	0.000	55.37	0.064	20.70	0.001	0.002	103.5	97.8	97.21	25.90	0.894
20:48	11.147	9.865	0.001	0.004	0.000	55.37	0.067	20.73	0.001	0.002	103.5	97.8	97.18	25.90	0.894
21: 5	10.943	9.912	0.001	0.004	0.000	55.63	0.069	20.52	0.001	0.001	102.1	96.6	97.09	25.93	0.895
21:23	11.103	10.136	0.001	0.004	0.000	55.66	0.072	20.17	0.001	0.001	101.6	96.0	97.15	25.94	0.896
21:41	11.004	10.234	0.001	0.004	0.000	55.88	0.071	19.94	0.001	0.001	100.5	94.9	97.13	25.98	0.897
21:59	11.014	10.028	0.001	0.003	0.000	55.68	0.068	20.30	0.001	0.001	101.6	96.1	97.10	25.93	0.895
22:17	10.939	10.155	0.001	0.003	0.000	55.97	0.068	19.90	0.001	0.001	100.1	94.6	97.04	25.96	0.896
22:34	11.047	10.081	0.001	0.002	0.000	55.63	0.058	20.17	0.000	0.000	101.2	95.6	96.99	25.91	0.894
22:52	10.943	9.972	0.001	0.001	0.000	55.69	0.052	20.31	0.000	0.000	101.2	95.7	96.96	25.91	0.894
23:10	11.016	9.936	0.000	0.001	0.000	55.64	0.045	20.38	0.000	0.000	101.6	96.1	97.03	25.90	0.894
23:28	10.849	9.649	0.000	0.001	0.000	56.05	0.042	20.42	0.000	0.000	101.1	95.7	97.01	25.89	0.894
23:46	10.857	9.765	0.000	0.001	0.000	55.60	0.042	20.58	0.000	0.000	101.7	96.2	96.84	25.87	0.893

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0:22	10.998	9.722	0.000	0.001	0.000	55.21	0.042	20.43	0.000	0.000	101.7	96.1	96.41	25.70	0.887
0:40	11.001	9.412	0.001	0.001	0.000	55.71	0.041	20.03	0.000	0.000	100.4	94.9	96.20	25.59	0.883
0:58	11.362	9.555	0.001	0.001	0.000	54.20	0.042	20.68	0.000	0.001	103.7	97.9	95.84	25.42	0.877
1:34	11.498	9.262	0.001	0.001	0.000	53.80	0.040	21.15	0.000	0.000	105.6	99.8	95.75	25.31	0.874
1:52	11.604	9.175	0.003	0.002	0.000	53.60	0.049	21.33	0.001	0.001	106.7	100.8	95.76	25.27	0.872
2:10	11.787	9.110	0.018	0.012	0.000	53.12	0.127	21.58	0.010	0.005	109.6	103.5	95.76	25.21	0.870
2:28	12.161	9.176	0.031	0.023	0.000	52.34	0.246	21.62	0.019	0.010	112.8	106.4	95.62	25.07	0.865
2:45	12.461	9.103	0.034	0.027	0.000	51.80	0.308	21.84	0.021	0.012	115.4	108.7	95.61	24.97	0.862
3: 3	12.842	9.328	0.042	0.035	0.000	51.42	0.395	21.50	0.027	0.015	116.9	109.9	95.60	24.90	0.859
3:21	12.973	9.172	0.046	0.036	0.000	51.15	0.431	21.73	0.029	0.016	118.6	111.5	95.59	24.83	0.857
3:39	13.377	9.057	0.058	0.043	0.000	50.46	0.498	22.07	0.035	0.018	122.2	114.8	95.62	24.71	0.853
3:57	13.724	8.872	0.064	0.048	0.000	49.75	0.560	22.51	0.040	0.021	125.7	118.0	95.58	24.57	0.848
4:15	14.427	8.300	0.074	0.059	0.000	48.36	0.678	23.62	0.047	0.026	133.3	125.2	95.59	24.29	0.838
4:33	14.995	7.789	0.087	0.066	0.000	47.33	0.798	24.68	0.043	0.029	140.1	131.6	95.82	24.11	0.832
4:51	15.561	7.509	0.097	0.070	0.000	46.52	0.865	25.18	0.054	0.030	144.8	135.8	95.89	23.93	0.826
5: 9	15.414	7.067	0.113	0.072	0.000	47.38	0.880	25.03	0.058	0.031	144.4	135.4	96.05	23.94	0.826
5:27	15.896	7.617	0.176	0.084	0.000	46.14	1.048	24.87	0.071	0.036	148.8	139.3	95.94	23.85	0.823
5:45	15.535	7.610	0.196	0.088	0.000	46.62	1.096	24.60	0.076	0.037	147.8	138.4	95.86	23.92	0.826
6:23	15.549	8.292	0.260	0.094	0.000	46.98	1.195	23.49	0.087	0.037	146.6	137.1	95.98	24.05	0.830
6:41	14.987	8.741	0.283	0.093	0.000	48.16	1.227	22.31	0.087	0.036	141.7	132.3	95.93	24.25	0.837
6:59	14.663	8.821	0.294	0.091	0.000	48.65	1.203	22.11	0.089	0.035	139.9	130.7	95.95	24.35	0.841
7:18	14.457	8.929	0.302	0.094	0.000	49.18	1.241	21.66	0.091	0.035	138.4	129.3	95.98	24.43	0.843
7:36	14.887	8.669	0.276	0.092	0.000	48.52	1.204	21.74	0.086	0.035	139.1	129.9	95.51	24.15	0.834
7:54	14.168	9.347	0.366	0.093	0.000	50.46	1.299	21.12	0.099	0.033	137.5	128.4	96.98	24.85	0.858

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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8:31	15.931	8.842	0.348	0.100	0.000	47.79	1.353	22.72	0.101	0.037	148.8	138.8	97.23	24.37	0.841
8:49	16.720	8.679	0.354	0.108	0.000	46.57	1.439	23.20	0.106	0.040	154.2	143.7	97.22	24.13	0.833
9: 7	16.596	8.456	0.330	0.108	0.000	46.51	1.441	23.58	0.105	0.041	154.7	144.2	97.17	24.11	0.832
9:25	16.587	8.143	0.325	0.105	0.000	46.31	1.400	24.00	0.103	0.040	155.4	145.0	97.01	24.02	0.829
9:44	16.728	8.210	0.333	0.109	0.000	46.46	1.419	23.86	0.109	0.041	155.9	145.4	97.26	24.07	0.831
10: 2	16.482	8.515	0.334	0.109	0.000	46.67	1.431	23.45	0.109	0.041	154.0	143.6	97.15	24.14	0.833
10:52	17.694	9.359	0.343	0.122	0.000	46.23	1.592	22.72	0.119	0.051	158.0	146.8	98.23	24.25	0.837
11:10	17.518	8.825	0.322	0.115	0.000	45.68	1.532	23.20	0.110	0.046	157.6	146.6	97.34	23.97	0.827
11:28	17.985	8.832	0.306	0.116	0.000	44.75	1.487	23.36	0.108	0.043	158.8	147.6	96.99	23.75	0.820
11:48	17.945	8.848	0.276	0.112	0.000	45.03	1.455	23.47	0.102	0.042	158.0	146.9	97.28	23.85	0.823
12: 6	17.670	9.068	0.254	0.103	0.000	45.67	1.344	23.13	0.094	0.038	154.1	143.3	97.37	23.99	0.828
12:24	17.807	9.641	0.302	0.106	0.000	45.76	1.402	22.35	0.106	0.040	153.8	142.8	97.51	24.09	0.831
12:43	17.877	9.273	0.291	0.105	0.000	45.87	1.380	22.57	0.103	0.040	154.2	143.3	97.51	24.01	0.829
13: 1	17.594	9.429	0.286	0.099	0.000	46.09	1.332	22.64	0.096	0.037	152.6	141.8	97.61	24.14	0.833
13:19	17.258	9.435	0.333	0.104	0.000	46.41	1.420	22.52	0.096	0.038	152.9	142.1	97.62	24.22	0.836
13:37	18.222	9.556	0.271	0.101	0.000	45.57	1.342	22.54	0.095	0.039	154.3	143.2	97.74	24.03	0.830
13:56	18.706	9.648	0.335	0.123	0.000	44.54	1.583	22.68	0.111	0.046	160.7	149.0	97.78	23.91	0.825
14:33	20.130	10.301	0.280	0.116	0.000	43.19	1.554	22.27	0.111	0.043	162.6	150.3	97.99	23.70	0.818
14:52	19.918	10.843	0.274	0.115	0.000	43.48	1.543	21.39	0.093	0.044	158.4	146.3	97.70	23.76	0.820
15:10	19.652	10.118	0.236	0.106	0.000	43.71	1.440	22.37	0.095	0.040	158.9	147.0	97.77	23.75	0.820
15:28	19.885	10.448	0.300	0.112	0.000	43.63	1.542	21.75	0.111	0.040	160.2	148.0	97.82	23.75	0.820
15:47	18.527	10.447	0.372	0.093	0.000	45.67	1.449	20.73	0.106	0.028	152.0	140.6	97.41	23.99	0.828
17: 0	20.860	9.645	0.241	0.128	0.000	42.32	1.619	22.92	0.110	0.054	167.5	154.8	97.90	23.38	0.807
17:19	21.230	9.582	0.224	0.128	0.000	41.38	1.653	23.48	0.094	0.050	170.2	157.3	97.83	23.25	0.802
17:56	19.992	10.145	0.287	0.116	0.000	43.29	1.498	22.34	0.105	0.044	161.8	149.7	97.83	23.68	0.817
18:51	17.505	12.719	0.429	0.112	0.000	48.34	1.470	17.23	0.133	0.043	139.9	128.8	97.98	24.79	0.856
19: 9	20.453	12.150	0.299	0.151	0.000	43.44	1.823	19.47	0.120	0.061	159.0	146.1	97.97	23.88	0.824
19:28	21.309	11.304	0.248	0.152	0.000	42.15	1.857	20.98	0.123	0.061	166.2	152.9	98.18	23.58	0.814
19:46	21.106	11.009	0.202	0.143	0.000	42.43	1.739	21.24	0.111	0.058	163.9	151.0	98.03	23.56	0.813
20: 5	20.440	11.774	0.225	0.147	0.000	43.46	1.750	19.99	0.115	0.061	158.5	145.8	97.96	23.83	0.823
21:55	20.839	11.472	0.237	0.139	0.000	42.76	1.707	20.67	0.118	0.058	161.6	148.7	98.00	23.70	0.818
23: 9	21.850	10.384	0.165	0.151	0.000	40.65	1.856	22.80	0.093	0.066	171.9	158.5	98.02	23.24	0.802
23:27	22.165	9.884	0.174	0.154	0.000	39.96	1.901	23.63	0.097	0.067	176.3	162.7	98.04	23.08	0.797
23:45	22.078	9.977	0.168	0.150	0.000	40.15	1.858	23.52	0.102	0.066	175.2	161.6	98.07	23.13	0.799

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0: 4	21.866	10.120	0.161	0.151	0.000	40.47	1.842	23.26	0.100	0.066	173.4	159.9	98.04	23.21	0.801
0:22	22.149	10.324	0.168	0.152	0.000	40.23	1.875	23.03	0.103	0.067	174.1	160.5	98.09	23.18	0.800
0:40	21.781	10.600	0.168	0.156	0.000	40.83	1.906	22.47	0.104	0.068	171.5	158.1	98.08	23.31	0.805
0:58	21.760	10.501	0.175	0.154	0.000	40.80	1.931	22.58	0.104	0.067	172.1	158.6	98.07	23.29	0.804
1:17	21.862	9.845	0.153	0.147	0.000	40.32	1.837	23.88	0.098	0.064	175.0	161.6	98.21	23.21	0.801
1:35	22.220	10.084	0.153	0.149	0.000	40.02	1.857	23.60	0.099	0.065	175.5	161.9	98.25	23.17	0.800
1:53	22.360	9.874	0.161	0.151	0.000	39.75	1.879	23.90	0.092	0.066	177.2	163.5	98.23	23.09	0.797
2:30	22.291	10.160	0.162	0.145	0.000	40.20	1.819	23.46	0.101	0.063	175.0	161.4	98.40	23.21	0.801
2:48	22.185	10.353	0.185	0.153	0.000	40.39	1.887	23.01	0.100	0.065	174.4	160.8	98.32	23.23	0.802

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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3: 7	21.900	9.795	0.169	0.149	0.000	40.44	1.837	23.75	0.102	0.065	175.1	161.6	98.21	23.19	0.801
3:25	22.192	10.816	0.169	0.154	0.000	40.59	1.883	22.30	0.106	0.067	172.1	158.5	98.28	23.30	0.804
3:43	22.328	10.767	0.168	0.155	0.000	40.42	1.922	22.35	0.104	0.068	173.0	159.3	98.28	23.25	0.802
4: 2	22.159	10.768	0.166	0.149	0.000	40.65	1.857	22.22	0.097	0.065	171.1	157.5	98.14	23.26	0.803
4:20	21.753	11.386	0.160	0.148	0.000	41.69	1.819	21.05	0.102	0.065	165.6	152.3	98.17	23.48	0.810
4:38	21.778	11.486	0.185	0.155	0.000	41.62	1.867	21.10	0.107	0.071	167.1	153.7	98.36	23.54	0.812
4:57	22.812	10.688	0.182	0.157	0.000	39.91	1.976	22.48	0.107	0.071	176.0	161.9	98.38	23.13	0.799
5:33	22.748	10.016	0.152	0.155	0.000	39.51	1.953	23.64	0.100	0.069	178.5	164.6	98.34	23.03	0.795
5:52	22.240	10.465	0.146	0.145	0.000	40.44	1.857	22.76	0.095	0.064	172.6	159.0	98.21	23.21	0.801
6:10	22.057	10.523	0.151	0.142	0.000	40.87	1.795	22.60	0.096	0.062	170.9	157.4	98.30	23.30	0.804
7: 4	22.274	10.511	0.197	0.145	0.000	41.46	1.824	23.19	0.107	0.067	174.9	161.3	99.77	23.65	0.816
7:22	20.446	9.059	0.183	0.145	0.000	42.07	1.769	24.47	0.113	0.076	172.7	160.0	98.32	23.50	0.811
7:40	21.634	10.225	0.177	0.146	0.000	40.94	1.802	23.02	0.113	0.072	172.1	158.7	98.14	23.32	0.805
7:58	21.756	10.449	0.167	0.151	0.000	40.76	1.842	22.84	0.111	0.074	172.2	158.8	98.15	23.32	0.805
8:16	21.478	9.806	0.195	0.156	0.000	40.67	1.889	23.72	0.117	0.075	175.3	161.9	98.10	23.27	0.803
8:33	21.628	9.495	0.192	0.163	0.000	40.37	1.996	24.05	0.116	0.074	177.9	164.4	98.09	23.17	0.800
8:51	21.301	9.642	0.170	0.151	0.000	41.11	1.867	23.84	0.105	0.068	173.9	160.8	98.25	23.34	0.805
9: 9	21.629	9.725	0.156	0.149	0.000	40.76	1.890	23.72	0.100	0.067	174.4	161.1	98.19	23.24	0.802
9:27	21.376	9.471	0.155	0.144	0.000	40.98	1.801	24.03	0.098	0.066	173.5	160.4	98.12	23.26	0.803
9:45	21.250	9.810	0.166	0.149	0.000	41.30	1.820	23.50	0.103	0.067	172.1	159.0	98.17	23.36	0.806
10: 3	20.959	9.401	0.168	0.150	0.567	41.78	1.856	23.12	0.102	0.067	170.3	157.3	98.18	23.39	0.807
10:21	22.063	9.475	0.172	0.149	0.000	40.04	1.868	24.23	0.105	0.066	177.6	164.1	98.16	23.08	0.797
10:38	21.326	10.126	0.202	0.146	0.000	41.65	1.802	22.69	0.109	0.064	170.1	156.9	98.12	23.37	0.807
10:56	20.514	10.424	0.217	0.162	0.000	42.73	1.918	21.88	0.112	0.072	166.8	153.9	98.03	23.60	0.815
11:14	21.109	10.195	0.197	0.151	0.000	41.90	1.910	22.58	0.112	0.067	170.3	157.1	98.22	23.46	0.810
11:32	20.885	10.090	0.182	0.159	0.000	41.65	1.884	23.11	0.105	0.073	170.9	157.9	98.14	23.48	0.811
11:50	21.668	9.816	0.186	0.162	0.000	40.41	2.026	23.61	0.104	0.073	176.5	163.0	98.06	23.19	0.801
12: 8	20.840	9.419	0.170	0.151	0.000	42.04	1.874	23.31	0.104	0.068	170.8	157.8	97.98	23.34	0.806
12:26	21.853	9.363	0.151	0.147	0.000	40.11	1.896	24.18	0.099	0.066	176.6	163.1	97.87	23.03	0.795
12:43	21.490	9.498	0.162	0.148	0.000	40.58	1.876	23.84	0.098	0.067	174.3	161.0	97.76	23.12	0.798
13: 1	21.195	10.057	0.176	0.147	0.000	41.32	1.829	22.82	0.107	0.066	170.0	156.9	97.72	23.28	0.804
13:19	20.435	10.106	0.188	0.153	0.000	42.13	1.859	22.60	0.110	0.069	167.5	154.8	97.65	23.47	0.810
13:37	21.103	10.021	0.172	0.155	0.000	41.35	1.930	22.92	0.106	0.069	171.1	158.0	97.83	23.32	0.805
13:55	20.893	10.090	0.201	0.154	0.000	41.73	1.933	22.58	0.111	0.068	169.9	156.9	97.77	23.37	0.807
14:13	20.424	9.249	0.182	0.144	0.000	42.99	1.811	22.90	0.106	0.065	167.5	154.9	97.88	23.40	0.808
14:31	21.074	9.997	0.198	0.162	0.000	41.19	1.992	23.13	0.115	0.071	173.2	159.9	97.93	23.35	0.806
14:50	21.224	9.657	0.172	0.163	0.000	40.92	2.015	23.61	0.105	0.070	174.7	161.4	97.94	23.25	0.803
15: 8	21.289	9.676	0.160	0.146	0.000	41.04	1.868	23.60	0.098	0.063	172.6	159.5	97.94	23.25	0.803
15:25	21.200	9.771	0.165	0.144	0.000	41.19	1.808	23.38	0.095	0.063	171.0	157.9	97.82	23.27	0.803
15:43	21.054	9.634	0.159	0.150	0.000	41.34	1.832	23.56	0.102	0.066	171.6	158.6	97.90	23.30	0.804
16: 1	20.510	9.611	0.161	0.149	0.798	42.65	1.854	22.23	0.089	0.065	165.5	152.7	98.12	23.53	0.812
16:19	21.008	10.148	0.195	0.155	0.000	41.82	1.946	22.46	0.111	0.066	169.9	156.8	97.91	23.39	0.807
16:37	21.006	10.160	0.204	0.151	0.000	41.68	1.876	22.64	0.111	0.064	169.8	156.7	97.89	23.39	0.807
16:55	20.394	10.247	0.211	0.157	0.000	42.38	1.894	22.34	0.116	0.067	167.5	154.6	97.81	23.54	0.813
17:13	20.230	9.706	0.201	0.156	0.000	42.37	1.917	23.11	0.113	0.067	169.4	156.6	97.86	23.51	0.812
17:31	20.018	9.447	0.181	0.148	0.000	42.58	1.809	23.43	0.107	0.065	168.0	155.5	97.79	23.51	0.812

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

11/ 3/1983

17:49	19.957	9.511	0.206	0.157	0.000	42.60	1.916	23.30	0.106	0.070	169.1	156.5	97.83	23.54	0.813
18: 7	19.632	8.877	0.188	0.147	0.000	43.55	1.843	23.35	0.106	0.067	166.9	154.6	97.76	23.51	0.812
18:25	20.785	9.483	0.189	0.149	0.000	41.47	1.828	23.67	0.109	0.068	171.7	158.8	97.75	23.31	0.805
18:43	20.979	9.920	0.176	0.156	0.000	41.39	1.929	23.06	0.108	0.071	171.3	158.2	97.79	23.33	0.805
19:19	20.251	9.795	0.165	0.146	0.000	42.25	1.788	23.18	0.102	0.067	167.4	154.8	97.74	23.50	0.811
19:37	20.538	9.561	0.156	0.147	0.000	41.77	1.820	23.66	0.098	0.066	169.9	157.2	97.81	23.40	0.808
19:55	20.622	9.235	0.156	0.141	0.000	41.66	1.777	24.16	0.099	0.064	171.2	158.5	97.91	23.36	0.806
20:13	20.305	9.298	0.164	0.146	0.000	42.41	1.796	23.58	0.105	0.065	168.9	156.3	97.87	23.44	0.809
20:31	20.430	9.526	0.197	0.150	0.000	41.95	1.810	23.65	0.114	0.067	170.5	157.8	97.89	23.45	0.809
20:49	20.349	9.131	0.194	0.153	0.000	41.84	1.852	24.15	0.116	0.067	172.4	159.6	97.85	23.39	0.807
21: 7	20.276	8.870	0.205	0.157	0.000	41.74	1.863	24.55	0.121	0.068	173.9	161.2	97.85	23.37	0.807
21:43	20.609	8.252	0.167	0.150	0.000	41.06	1.848	25.64	0.109	0.068	177.3	164.5	97.90	23.20	0.801
22:19	20.528	8.638	0.181	0.154	0.000	41.26	1.885	25.10	0.101	0.069	175.8	163.0	97.91	23.28	0.804
22:38	20.574	8.277	0.178	0.155	0.000	41.12	1.865	25.72	0.098	0.068	177.6	164.8	98.06	23.25	0.803
22:56	20.096	8.842	0.185	0.147	0.000	42.06	1.789	24.67	0.108	0.063	172.0	159.5	97.96	23.45	0.809
23:14	20.031	9.184	0.202	0.151	0.000	42.27	1.821	24.07	0.117	0.066	170.9	158.3	97.91	23.50	0.811
23:32	19.926	9.565	0.215	0.159	0.000	42.49	1.871	23.35	0.115	0.069	169.1	156.5	97.77	23.55	0.813
23:50	20.364	8.736	0.177	0.139	0.000	41.92	1.735	24.72	0.099	0.062	172.0	159.4	97.95	23.36	0.806

11/ 4/1983

0: 8	20.518	8.426	0.188	0.149	0.000	41.48	1.816	25.31	0.111	0.066	175.9	163.2	98.06	23.30	0.804
0:26	20.632	8.657	0.187	0.149	0.000	41.40	1.844	24.99	0.110	0.067	175.6	162.7	98.05	23.30	0.804
0:44	20.616	8.554	0.186	0.153	0.000	41.23	1.840	25.29	0.112	0.068	176.6	163.7	98.05	23.29	0.804
1: 2	20.511	8.395	0.187	0.147	0.000	41.31	1.785	25.55	0.109	0.067	176.3	163.6	98.06	23.30	0.804
1:20	20.141	8.277	0.183	0.151	0.000	41.70	1.790	25.59	0.113	0.069	175.4	162.9	98.01	23.36	0.806
1:38	20.419	8.753	0.193	0.154	0.000	41.52	1.867	24.93	0.111	0.070	175.2	162.4	98.02	23.36	0.806
1:57	20.183	8.911	0.191	0.152	0.000	41.87	1.828	24.64	0.112	0.069	173.0	160.4	97.96	23.43	0.809
2:15	20.246	8.701	0.219	0.156	0.000	41.54	1.841	24.95	0.117	0.070	175.0	162.3	97.85	23.35	0.806
2:33	20.524	8.631	0.229	0.162	0.000	41.11	1.954	24.99	0.128	0.072	177.8	164.8	97.80	23.24	0.802
2:51	20.478	8.660	0.203	0.153	0.000	41.30	1.855	24.93	0.118	0.067	175.5	162.7	97.77	23.26	0.803
3: 9	19.979	8.874	0.192	0.149	0.000	41.98	1.768	24.66	0.116	0.067	171.9	159.4	97.78	23.44	0.809
3:27	20.170	8.962	0.187	0.159	0.000	41.55	1.918	24.52	0.115	0.070	173.7	161.0	97.66	23.35	0.806
3:45	20.134	8.834	0.173	0.144	0.000	41.94	1.784	24.57	0.109	0.065	171.6	159.1	97.75	23.38	0.807
4: 3	19.970	8.937	0.184	0.152	0.000	41.95	1.786	24.55	0.114	0.067	171.5	159.0	97.71	23.43	0.809
4:21	20.218	8.935	0.185	0.162	0.000	41.44	1.917	24.64	0.119	0.071	174.3	161.6	97.69	23.34	0.806
4:39	20.466	8.360	0.177	0.153	0.000	40.93	1.873	25.50	0.105	0.068	176.8	164.0	97.63	23.17	0.800
4:58	20.514	8.413	0.169	0.152	0.000	41.03	1.865	25.48	0.101	0.069	176.6	163.8	97.79	23.21	0.801
5:16	20.256	8.531	0.163	0.144	0.000	41.39	1.766	25.20	0.107	0.064	173.6	161.1	97.62	23.26	0.803
5:34	20.220	8.377	0.174	0.152	0.000	41.18	1.855	25.39	0.108	0.066	175.4	162.8	97.53	23.21	0.801
5:52	20.209	8.469	0.163	0.144	0.000	41.59	1.762	25.31	0.104	0.065	173.7	161.2	97.81	23.32	0.805
6:55	20.494	8.491	0.188	0.147	0.000	42.03	1.813	25.77	0.106	0.067	177.2	164.5	99.11	23.61	0.815
7:12	19.180	7.938	0.175	0.134	1.122	43.40	1.643	24.30	0.102	0.064	165.9	154.0	98.06	23.63	0.816
7:30	20.308	8.225	0.181	0.154	0.000	40.93	1.851	26.01	0.105	0.068	177.8	165.1	97.83	23.25	0.803
7:48	20.302	8.230	0.172	0.141	0.000	41.03	1.762	25.87	0.094	0.062	175.6	163.1	97.66	23.21	0.801
8: 6	19.925	8.674	0.180	0.154	0.000	41.85	1.819	24.89	0.113	0.068	172.8	160.3	97.67	23.38	0.807

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

11/ 4/1983															
8:24	20.146	8.674	0.194	0.154	0.000	41.88	1.885	24.63	0.111	0.067	173.5	160.8	97.74	23.34	0.806
8:42	20.148	8.553	0.182	0.146	0.000	41.86	1.794	24.89	0.111	0.063	173.0	160.4	97.75	23.33	0.805
8:59	20.150	8.503	0.184	0.148	0.000	41.34	1.779	25.30	0.113	0.065	174.3	161.8	97.59	23.28	0.803
9:17	19.926	8.149	0.200	0.150	0.000	41.51	1.799	25.68	0.116	0.065	175.4	162.9	97.60	23.28	0.804
10:52	20.323	7.942	0.193	0.143	0.000	41.82	1.731	26.50	0.109	0.062	178.1	165.5	98.82	23.49	0.811
11:10	19.955	8.029	0.198	0.143	0.000	41.23	1.709	25.88	0.108	0.062	174.8	162.4	97.31	23.18	0.800
11:28	20.287	8.243	0.180	0.144	0.000	40.69	1.727	25.60	0.108	0.062	174.9	162.3	97.04	23.05	0.796
11:46	19.431	8.237	0.185	0.129	0.000	42.97	1.602	24.39	0.102	0.055	166.4	154.5	97.10	23.30	0.804
12:22	19.154	7.603	0.228	0.138	0.000	43.05	1.653	24.94	0.116	0.057	169.0	157.1	96.94	23.22	0.802
12:40	19.036	8.296	0.234	0.142	0.847	43.11	1.679	23.66	0.120	0.060	165.1	153.2	97.18	23.47	0.810
13:52	19.942	8.870	0.248	0.140	0.000	42.28	1.673	23.91	0.123	0.059	169.0	156.7	97.24	23.31	0.804
14:11	20.341	8.597	0.218	0.138	0.000	41.13	1.655	24.84	0.114	0.059	172.4	159.9	97.09	23.12	0.798
14:29	19.637	8.997	0.216	0.134	0.000	43.01	1.610	23.29	0.114	0.057	164.6	152.5	97.06	23.36	0.806
14:52	19.922	9.864	0.261	0.142	0.000	42.96	1.691	22.13	0.126	0.061	163.8	151.4	97.16	23.45	0.809
15:28	20.281	9.231	0.213	0.137	0.000	41.36	1.669	23.98	0.111	0.059	169.4	157.0	97.04	23.22	0.801
15:46	20.775	8.720	0.219	0.142	0.000	40.38	1.698	24.95	0.118	0.061	174.8	162.0	97.07	23.01	0.794
16: 5	20.412	9.531	0.245	0.146	0.000	41.13	1.722	23.68	0.123	0.062	170.5	157.8	97.05	23.23	0.802
16:23	20.328	9.923	0.231	0.145	0.000	41.67	1.760	22.88	0.119	0.061	167.6	155.0	97.12	23.33	0.805
16:41	20.407	9.623	0.232	0.139	0.000	41.49	1.705	23.37	0.117	0.058	168.7	156.1	97.14	23.27	0.803
16:59	20.240	9.216	0.215	0.136	0.000	41.55	1.675	23.97	0.113	0.058	169.4	156.9	97.17	23.26	0.803
17:17	20.575	8.571	0.225	0.136	0.000	40.78	1.657	25.12	0.118	0.058	174.3	161.6	97.24	23.09	0.797
17:35	20.597	9.513	0.244	0.140	0.000	41.21	1.672	23.76	0.119	0.060	170.5	157.8	97.31	23.26	0.803
17:53	20.548	9.677	0.239	0.139	0.000	41.46	1.681	23.33	0.124	0.059	169.1	156.4	97.26	23.28	0.804
18:11	18.978	9.981	0.248	0.129	0.000	44.72	1.561	21.36	0.118	0.053	156.2	144.4	97.15	23.72	0.819
18:30	20.179	9.739	0.271	0.144	0.000	41.91	1.722	23.06	0.125	0.060	168.1	155.5	97.20	23.37	0.807
18:48	20.389	9.757	0.267	0.150	0.000	41.63	1.794	22.97	0.127	0.063	169.4	156.6	97.14	23.29	0.804
19: 6	20.667	9.635	0.240	0.144	0.000	41.19	1.719	23.38	0.124	0.061	170.2	157.4	97.16	23.21	0.801
19:24	20.682	9.244	0.247	0.142	0.000	40.92	1.707	24.03	0.125	0.060	172.3	159.5	97.16	23.15	0.799
19:42	20.671	9.312	0.262	0.145	0.000	40.84	1.744	23.95	0.133	0.061	172.9	160.0	97.12	23.15	0.799
20: 0	20.667	9.436	0.272	0.142	0.000	41.11	1.740	23.57	0.132	0.059	171.6	158.8	97.13	23.17	0.800
20:18	19.912	9.275	0.273	0.139	0.000	42.78	1.693	22.79	0.131	0.058	166.1	153.7	97.04	23.32	0.805
20:36	20.134	9.667	0.287	0.140	0.000	41.90	1.711	23.15	0.124	0.058	168.2	155.7	97.17	23.36	0.806
20:54	19.463	10.279	0.247	0.145	0.000	42.93	1.717	22.08	0.129	0.062	162.4	150.1	97.05	23.60	0.815
21:12	20.236	8.736	0.224	0.137	0.000	41.31	1.678	24.64	0.119	0.060	171.9	159.4	97.14	23.18	0.800
21:30	20.408	8.928	0.226	0.138	0.000	41.13	1.680	24.41	0.122	0.060	171.8	159.2	97.10	23.15	0.799
21:48	20.512	9.267	0.237	0.135	0.000	41.34	1.662	23.82	0.121	0.058	170.1	157.5	97.15	23.19	0.801
22: 6	19.717	9.590	0.230	0.133	0.000	43.03	1.618	22.59	0.119	0.058	163.0	150.8	97.08	23.44	0.809
22:24	20.444	9.487	0.227	0.135	0.000	41.49	1.659	23.52	0.119	0.058	168.8	156.2	97.14	23.25	0.802
22:43	20.474	9.090	0.254	0.135	0.000	41.19	1.640	24.15	0.121	0.057	171.1	158.5	97.12	23.17	0.800
23: 1	20.202	8.924	0.246	0.135	0.000	41.32	1.625	24.33	0.114	0.057	170.4	157.9	96.95	23.17	0.800
23:19	19.943	9.010	0.259	0.139	0.000	41.59	1.682	24.07	0.124	0.059	169.8	157.4	96.87	23.22	0.802
23:37	20.159	8.719	0.274	0.143	0.000	41.12	1.716	24.57	0.130	0.060	172.9	160.4	96.88	23.12	0.798
23:55	20.239	9.297	0.283	0.144	0.000	41.18	1.727	23.65	0.135	0.060	170.6	158.0	96.71	23.14	0.799

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

11/ 5/1983															
0:13	20.197	9.033	0.263	0.142	0.000	41.50	1.713	23.67	0.130	0.059	170.0	157.4	96.71	23.11	0.798
0:31	20.077	9.737	0.263	0.138	0.000	41.66	1.644	22.98	0.128	0.057	166.5	154.0	96.68	23.26	0.803
0:49	19.903	9.321	0.247	0.137	0.000	41.66	1.659	23.52	0.122	0.057	167.4	155.0	96.62	23.22	0.801
1: 7	19.717	9.152	0.294	0.140	0.000	41.71	1.683	23.73	0.135	0.057	168.8	156.5	96.62	23.24	0.802
1:25	19.606	9.093	0.271	0.139	0.000	41.82	1.656	23.84	0.131	0.058	168.1	155.8	96.62	23.26	0.803
1:44	19.720	8.714	0.271	0.140	0.000	41.45	1.695	24.32	0.124	0.058	170.2	157.9	96.49	23.12	0.798
2: 2	19.774	8.686	0.284	0.141	0.000	41.47	1.694	24.33	0.134	0.058	170.9	158.5	96.57	23.13	0.798
2:20	19.954	8.678	0.260	0.137	0.000	41.36	1.679	24.31	0.127	0.056	170.6	158.2	96.56	23.08	0.797
2:38	19.899	9.350	0.286	0.136	0.000	41.48	1.659	23.44	0.133	0.056	167.9	155.6	96.43	23.17	0.800
2:56	19.893	9.516	0.277	0.125	0.000	41.87	1.544	23.15	0.125	0.051	165.2	152.9	96.55	23.24	0.802
3:14	19.622	10.106	0.296	0.134	0.000	42.38	1.634	22.26	0.131	0.053	163.0	150.8	96.62	23.42	0.808
3:32	19.608	9.692	0.290	0.131	0.000	42.17	1.624	22.80	0.129	0.053	164.4	152.2	96.50	23.32	0.805
3:50	19.713	9.330	0.294	0.138	0.000	41.62	1.667	23.49	0.136	0.057	167.8	155.5	96.44	23.22	0.801
4: 8	19.479	9.147	0.276	0.130	0.000	42.18	1.603	23.57	0.126	0.052	165.9	153.8	96.56	23.29	0.804
4:26	19.168	9.317	0.329	0.135	0.000	42.83	1.643	22.88	0.139	0.053	164.4	152.3	96.49	23.37	0.807
4:45	19.568	9.549	0.304	0.136	0.000	42.14	1.642	22.94	0.137	0.055	165.5	153.2	96.47	23.30	0.804
5: 3	19.805	9.834	0.326	0.141	0.000	41.85	1.718	22.61	0.141	0.056	166.5	154.0	96.48	23.28	0.804
5:21	19.031	10.127	0.281	0.133	0.000	43.16	1.597	21.92	0.129	0.054	159.4	147.5	96.43	23.52	0.812
5:39	18.989	10.228	0.310	0.130	0.000	43.54	1.602	21.50	0.131	0.051	158.3	146.4	96.48	23.56	0.813
5:57	18.951	10.716	0.338	0.132	0.000	43.75	1.609	20.66	0.138	0.051	156.2	144.3	96.34	23.61	0.815
6:15	19.060	11.294	0.372	0.137	0.000	43.92	1.682	19.65	0.142	0.051	154.8	142.7	96.31	23.66	0.817
6:34	19.526	11.074	0.344	0.133	0.000	43.33	1.648	20.24	0.137	0.051	157.2	145.0	96.49	23.56	0.813
6:52	19.473	10.894	0.348	0.135	0.000	42.99	1.655	20.55	0.135	0.051	158.2	145.9	96.24	23.47	0.810
7:11	18.853	11.393	0.318	0.132	0.000	44.05	1.594	19.72	0.128	0.052	152.2	140.4	96.24	23.72	0.819
7:29	18.607	11.923	0.320	0.137	0.000	44.65	1.657	18.76	0.131	0.054	149.2	137.4	96.24	23.86	0.824
7:47	19.039	11.459	0.335	0.135	0.000	43.96	1.695	19.35	0.132	0.051	153.0	141.0	96.16	23.65	0.816
8: 5	19.295	10.796	0.294	0.130	0.000	43.18	1.597	20.69	0.124	0.051	156.2	144.2	96.16	23.49	0.811
8:23	19.024	11.176	0.380	0.136	0.000	43.88	1.708	19.89	0.138	0.055	155.8	143.7	96.39	23.67	0.817
8:42	18.637	11.393	0.344	0.129	0.000	44.72	1.612	19.41	0.134	0.052	151.2	139.4	96.43	23.83	0.822
9: 0	18.769	11.518	0.345	0.130	0.000	44.50	1.602	19.42	0.137	0.053	151.7	139.8	96.47	23.83	0.823
9:18	18.790	11.690	0.368	0.127	0.000	44.72	1.608	18.88	0.140	0.051	150.4	138.5	96.37	23.82	0.822
9:36	17.620	10.313	0.365	0.122	0.000	46.39	1.535	18.53	0.129	0.049	144.3	133.1	95.05	23.54	0.813
9:54	18.812	11.465	0.420	0.131	0.000	44.55	1.662	19.28	0.148	0.052	153.4	141.4	96.52	23.82	0.822
10:13	17.747	11.410	0.404	0.125	0.000	47.00	1.603	18.04	0.140	0.050	144.8	133.4	96.52	24.09	0.832
10:31	18.549	11.663	0.425	0.139	0.000	45.29	1.742	18.38	0.151	0.050	150.7	138.8	96.39	23.87	0.824
11:30	20.108	10.288	0.335	0.136	0.000	43.20	1.678	21.57	0.131	0.053	163.5	150.9	97.51	23.56	0.813
11:49	19.973	10.185	0.351	0.135	0.000	43.25	1.717	21.65	0.133	0.052	164.0	151.4	97.45	23.56	0.813
12: 7	19.332	9.953	0.348	0.135	0.000	44.48	1.693	21.24	0.132	0.052	160.2	148.0	97.36	23.67	0.817
12:25	19.864	9.749	0.360	0.139	0.000	43.11	1.756	22.28	0.138	0.053	166.4	153.8	97.45	23.51	0.812
12:43	19.518	10.016	0.366	0.140	0.000	43.52	1.712	21.81	0.142	0.054	163.5	151.2	97.28	23.61	0.815
13: 2	20.377	9.501	0.364	0.140	0.000	42.02	1.758	22.89	0.142	0.054	170.2	157.4	97.24	23.29	0.804
13:20	20.024	10.037	0.364	0.142	0.000	42.55	1.780	22.04	0.142	0.055	166.6	154.0	97.14	23.43	0.809
13:38	19.489	9.872	0.362	0.142	0.000	43.04	1.747	22.18	0.143	0.055	165.0	152.6	97.03	23.52	0.812
13:57	18.870	10.203	0.362	0.139	0.000	44.07	1.720	21.45	0.143	0.054	160.3	148.3	97.01	23.73	0.819
14:15	18.541	9.827	0.361	0.133	0.000	45.03	1.647	21.24	0.135	0.052	157.5	145.7	96.96	23.75	0.820
14:33	20.926	10.422	0.264	0.158	0.000	41.33	1.945	21.89	0.130	0.066	169.4	156.2	97.13	23.24	0.802

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

11/ 5/1983															
15: 1	21.533	10.231	0.239	0.167	0.000	40.92	2.045	22.83	0.124	0.074	175.2	161.6	98.16	23.33	0.805
15:19	20.881	10.932	0.210	0.161	0.000	41.68	1.972	21.22	0.112	0.069	166.3	153.1	97.24	23.35	0.806
15:36	20.326	8.615	0.337	0.135	0.000	41.59	1.738	24.19	0.134	0.054	173.3	160.6	97.12	23.12	0.798
15:54	20.532	9.172	0.317	0.135	0.000	41.40	1.709	23.61	0.136	0.055	171.6	158.8	97.07	23.15	0.799
16:12	20.253	9.760	0.314	0.138	0.000	42.01	1.717	22.66	0.135	0.055	167.7	155.0	97.04	23.31	0.804
16:30	21.347	10.127	0.228	0.150	0.000	40.72	1.891	22.50	0.121	0.064	171.2	157.9	97.15	23.09	0.797
16:48	21.288	9.928	0.219	0.154	0.000	40.59	1.900	22.91	0.122	0.068	172.5	159.2	97.18	23.08	0.797
17: 5	21.290	9.976	0.195	0.155	0.000	40.58	1.897	22.89	0.116	0.069	171.9	158.7	97.18	23.09	0.797
17:23	21.185	9.729	0.200	0.149	0.000	40.64	1.846	23.22	0.119	0.067	172.1	158.9	97.15	23.07	0.796
17:41	21.027	9.417	0.224	0.149	0.000	40.62	1.819	23.70	0.123	0.065	173.3	160.2	97.14	23.07	0.796
17:59	20.608	10.020	0.257	0.155	0.000	41.37	1.867	22.57	0.130	0.066	169.6	156.6	97.04	23.24	0.802
18:17	20.227	10.088	0.251	0.150	0.000	42.49	1.830	21.80	0.118	0.064	165.0	152.3	97.01	23.34	0.806
18:35	20.666	10.139	0.234	0.147	0.000	41.51	1.809	22.42	0.117	0.064	167.9	155.0	97.12	23.27	0.803
18:52	20.657	10.147	0.231	0.150	0.000	41.44	1.826	22.41	0.125	0.066	168.2	155.3	97.06	23.26	0.803
19:10	20.700	10.022	0.235	0.151	0.000	41.32	1.826	22.67	0.123	0.066	169.2	156.3	97.11	23.24	0.802
19:28	20.749	10.303	0.230	0.155	0.000	41.39	1.874	22.23	0.126	0.067	168.6	155.5	97.12	23.27	0.803
19:46	20.948	9.634	0.221	0.152	0.000	40.83	1.880	23.17	0.123	0.067	172.0	158.9	97.02	23.08	0.797
20: 4	20.615	9.433	0.216	0.149	0.000	41.97	1.859	22.67	0.118	0.066	168.8	155.9	97.09	23.16	0.799
20:22	20.736	9.698	0.213	0.148	0.000	41.17	1.849	23.10	0.112	0.064	170.3	157.3	97.10	23.17	0.800
20:40	20.959	10.134	0.212	0.150	0.000	41.04	1.859	22.64	0.122	0.067	169.9	156.8	97.18	23.20	0.801
20:58	21.437	9.632	0.202	0.151	0.000	40.16	1.906	23.53	0.119	0.067	174.6	161.3	97.20	23.00	0.794
21:15	21.279	9.290	0.186	0.141	0.000	40.30	1.797	24.03	0.111	0.063	173.9	160.8	97.20	23.00	0.794
21:33	21.001	9.808	0.206	0.143	0.000	40.95	1.811	23.09	0.113	0.063	170.5	157.5	97.19	23.15	0.799
21:51	21.195	9.580	0.202	0.143	0.000	40.47	1.800	23.59	0.108	0.063	172.4	159.4	97.16	23.05	0.796
22:27	20.715	10.086	0.217	0.136	0.000	41.45	1.784	22.46	0.109	0.060	167.2	154.3	97.02	23.22	0.802
22:46	20.550	10.162	0.238	0.130	0.000	41.72	1.719	22.36	0.117	0.057	166.0	153.3	97.06	23.30	0.804
23: 4	20.685	10.185	0.259	0.135	0.000	41.56	1.732	22.23	0.123	0.055	166.7	153.8	96.96	23.24	0.802
23:22	20.225	10.646	0.256	0.136	0.000	42.27	1.717	21.41	0.118	0.058	162.3	149.7	96.83	23.40	0.808
23:40	20.372	10.057	0.226	0.125	0.000	42.18	1.641	21.98	0.114	0.053	163.0	150.5	96.75	23.25	0.802
23:58	19.918	10.086	0.283	0.119	0.000	42.71	1.601	21.94	0.111	0.048	161.5	149.3	96.81	23.39	0.807
11/ 6/1983															
0:34	20.797	10.249	0.198	0.146	0.000	41.01	1.796	22.46	0.110	0.066	167.6	154.7	96.84	23.17	0.800
0:52	21.142	9.858	0.179	0.146	0.000	40.29	1.810	23.17	0.103	0.066	170.7	157.6	96.77	23.00	0.794
1:10	20.987	9.086	0.148	0.138	0.000	40.32	1.740	24.78	0.099	0.064	173.8	161.0	97.36	23.09	0.797
1:28	21.441	9.150	0.162	0.139	0.000	39.90	1.770	24.64	0.103	0.064	175.5	162.4	97.37	22.98	0.793
1:46	21.223	9.109	0.178	0.137	0.000	40.24	1.727	24.55	0.102	0.061	174.2	161.2	97.33	23.03	0.795
2: 4	21.165	9.239	0.182	0.140	0.000	40.20	1.763	24.39	0.106	0.064	174.1	161.1	97.25	23.04	0.795
2:22	21.056	9.706	0.174	0.140	0.000	40.71	1.762	23.56	0.106	0.064	171.0	158.0	97.28	23.15	0.799
2:40	21.284	9.255	0.151	0.136	0.000	40.24	1.723	24.33	0.100	0.063	173.2	160.2	97.28	23.02	0.795
2:58	20.802	9.421	0.177	0.131	0.000	40.91	1.639	23.94	0.103	0.060	169.9	157.2	97.19	23.16	0.799
3:16	20.799	9.554	0.183	0.140	0.000	40.99	1.741	23.62	0.106	0.064	170.3	157.5	97.19	23.17	0.800
3:34	21.288	8.828	0.146	0.129	0.000	40.13	1.677	24.86	0.097	0.060	174.1	161.2	97.22	22.94	0.792
3:52	21.318	8.651	0.160	0.125	0.000	39.86	1.622	25.34	0.099	0.059	175.3	162.5	97.23	22.91	0.791
4:10	20.781	8.852	0.174	0.131	0.000	41.27	1.673	24.07	0.095	0.060	170.3	157.6	97.11	23.04	0.795

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

11/ 6/1983															
4:28	21.291	8.690	0.158	0.123	0.000	40.04	1.605	25.20	0.085	0.057	174.2	161.4	97.25	22.93	0.791
4:46	21.143	8.711	0.164	0.124	0.000	40.15	1.595	25.17	0.096	0.057	173.9	161.2	97.21	22.96	0.793
5: 4	21.166	8.980	0.163	0.129	0.000	40.22	1.636	24.77	0.098	0.060	173.3	160.5	97.22	23.00	0.794
5:22	21.131	8.922	0.178	0.134	0.000	40.15	1.682	24.88	0.105	0.063	174.6	161.7	97.24	23.00	0.794
5:40	21.032	9.372	0.163	0.134	0.000	40.54	1.676	24.07	0.100	0.062	171.2	158.4	97.15	23.07	0.796
5:58	21.071	9.179	0.163	0.135	0.000	40.32	1.667	24.48	0.103	0.063	172.7	159.8	97.18	23.04	0.795
6:16	20.916	9.053	0.174	0.135	0.000	40.95	1.689	24.11	0.098	0.063	171.3	158.5	97.18	23.06	0.796
6:35	21.278	8.801	0.173	0.136	0.000	40.03	1.691	25.06	0.105	0.064	175.7	162.7	97.35	22.97	0.793
6:53	21.093	9.223	0.191	0.140	0.000	40.40	1.724	24.33	0.112	0.064	173.6	160.6	97.27	23.06	0.796
7:11	20.649	9.238	0.188	0.142	0.000	41.56	1.300	23.47	0.111	0.066	165.1	152.8	96.72	23.08	0.797
7:29	21.190	8.819	0.188	0.141	0.000	40.04	1.779	24.88	0.114	0.067	176.3	163.3	97.22	22.95	0.792
8: 5	19.876	8.818	0.166	0.136	0.000	43.35	1.711	23.03	0.103	0.065	164.7	152.4	97.26	23.31	0.805
8:23	20.973	9.172	0.180	0.144	0.000	40.53	1.773	24.29	0.111	0.068	173.6	160.6	97.24	23.07	0.796
8:41	20.841	9.167	0.184	0.152	0.000	40.93	1.862	23.94	0.114	0.072	173.3	160.3	97.27	23.11	0.798
8:59	21.215	9.101	0.164	0.145	0.000	40.05	1.857	24.57	0.102	0.070	175.7	162.6	97.27	23.00	0.794
9:17	20.995	9.111	0.184	0.142	0.000	40.35	1.803	24.52	0.112	0.067	174.7	161.7	97.29	23.07	0.796
9:36	20.771	9.422	0.177	0.142	0.000	40.81	1.763	24.05	0.111	0.067	171.9	159.1	97.31	23.19	0.800
9:54	20.846	9.346	0.184	0.136	0.000	40.84	1.733	24.05	0.102	0.064	171.6	158.8	97.30	23.15	0.799
10:12	21.018	9.145	0.190	0.137	0.000	40.69	1.734	24.19	0.110	0.063	172.9	160.0	97.28	23.07	0.796
11:50	21.490	9.836	0.216	0.133	0.000	40.99	1.150	23.85	0.114	0.062	167.8	155.3	97.84	23.29	0.804
12: 9	20.404	9.838	0.223	0.130	0.000	42.62	1.679	22.00	0.102	0.060	163.4	150.9	97.06	23.28	0.804
12:27	21.171	10.281	0.223	0.136	0.000	40.65	1.729	22.56	0.123	0.064	168.9	155.9	96.94	23.12	0.798
12:45	21.309	10.244	0.216	0.140	0.000	40.38	1.769	22.66	0.122	0.066	170.1	156.9	96.90	23.06	0.796
13: 3	21.251	10.084	0.231	0.138	0.000	40.52	1.751	22.69	0.129	0.061	170.1	157.0	96.85	23.04	0.795
13:21	21.320	9.993	0.212	0.138	0.000	40.28	1.743	23.01	0.116	0.064	170.7	157.6	96.88	23.02	0.794
15:18	21.275	10.018	0.227	0.137	0.000	40.03	1.760	22.96	0.122	0.064	170.9	157.8	96.60	22.95	0.792
15:36	21.413	9.780	0.195	0.133	0.000	39.87	1.725	23.43	0.114	0.065	171.8	158.7	96.73	22.92	0.791
15:40	20.816	10.079	0.254	0.135	0.000	40.69	1.703	22.69	0.126	0.061	168.4	155.6	96.55	23.08	0.797
16:10	21.085	10.307	0.210	0.133	0.000	41.47	1.685	23.01	0.121	0.063	169.3	156.4	98.09	23.47	0.810
16:28	21.147	10.475	0.221	0.139	0.000	40.79	1.765	22.26	0.113	0.062	168.0	154.9	96.97	23.16	0.799
16:46	21.248	10.385	0.241	0.141	0.000	40.55	1.834	22.29	0.121	0.064	169.7	156.5	96.88	23.09	0.797
17: 3	21.067	10.673	0.225	0.131	0.000	41.03	1.750	21.83	0.112	0.062	166.1	153.1	96.89	23.19	0.801
17:21	21.238	10.254	0.226	0.138	0.000	40.52	1.746	22.64	0.120	0.063	169.6	156.5	96.95	23.10	0.797
17:39	20.865	10.864	0.234	0.134	0.000	41.56	1.708	21.59	0.119	0.063	164.6	151.8	97.14	23.35	0.806
17:57	20.664	10.961	0.214	0.135	0.000	41.64	1.680	21.42	0.120	0.063	162.9	150.2	96.89	23.35	0.806
18:15	21.212	10.030	0.225	0.135	0.000	40.54	1.734	22.79	0.115	0.063	169.7	156.6	96.85	23.04	0.795
18:33	21.398	9.722	0.216	0.130	0.000	40.07	1.694	23.54	0.115	0.061	172.0	158.9	96.94	22.98	0.793
18:50	21.282	10.167	0.206	0.132	0.000	40.52	1.704	22.80	0.114	0.063	169.2	156.2	96.98	23.09	0.797
19: 8	21.334	10.131	0.206	0.133	0.000	40.28	1.726	22.93	0.116	0.065	170.1	157.1	96.92	23.05	0.796
19:26	21.029	10.306	0.203	0.130	0.000	40.81	1.662	22.57	0.114	0.063	167.2	154.3	96.89	23.15	0.799
19:44	20.931	10.770	0.230	0.139	0.000	41.04	1.769	21.71	0.122	0.067	166.0	153.1	96.78	23.21	0.801
20: 2	21.005	10.445	0.234	0.136	0.000	40.74	1.731	22.29	0.124	0.066	167.8	154.8	96.78	23.14	0.799
20:20	21.138	10.534	0.228	0.140	0.000	40.70	1.772	22.11	0.123	0.067	168.0	154.9	96.81	23.13	0.798
20:38	21.021	10.532	0.210	0.135	0.000	40.90	1.742	22.00	0.117	0.064	166.4	153.5	96.72	23.14	0.799
20:55	21.001	10.729	0.229	0.137	0.000	40.83	1.777	21.75	0.129	0.066	166.6	153.6	96.65	23.15	0.799
21:13	20.903	10.787	0.206	0.133	0.000	40.99	1.772	21.59	0.112	0.065	164.8	151.9	96.56	23.16	0.799

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

11/ 6/1983

21:31	20.408	10.063	0.196	0.126	0.000	41.44	1.691	22.30	0.110	0.061	164.2	151.7	96.40	23.13	0.799
21:49	20.232	10.364	0.256	0.138	0.000	41.62	1.774	21.76	0.125	0.063	164.3	151.7	96.33	23.20	0.801
22: 7	20.306	10.995	0.248	0.134	0.000	41.81	1.731	20.82	0.118	0.062	160.7	148.1	96.22	23.26	0.803
22:25	20.457	10.131	0.211	0.136	0.000	41.00	1.747	22.40	0.113	0.065	165.9	153.2	96.26	23.09	0.797
22:43	20.680	10.424	0.227	0.137	0.000	40.78	1.767	21.93	0.124	0.065	165.8	153.0	96.14	23.04	0.795
23: 1	20.414	10.716	0.255	0.134	0.000	41.48	1.762	21.15	0.119	0.060	162.6	149.9	96.09	23.14	0.799
23:19	19.975	11.152	0.267	0.133	0.000	42.30	1.724	20.30	0.125	0.060	158.3	145.9	96.03	23.32	0.805
23:36	19.216	10.850	0.196	0.112	0.000	43.99	1.524	19.90	0.105	0.053	150.4	138.7	95.95	23.46	0.810
23:55	20.370	10.961	0.233	0.125	0.000	41.70	1.709	20.80	0.118	0.060	160.2	147.6	96.07	23.20	0.801

11/ 7/1983

0:13	20.232	11.028	0.219	0.132	0.000	41.84	1.708	20.70	0.112	0.061	159.2	146.7	96.03	23.23	0.802
0:31	21.526	11.790	0.147	0.146	0.000	40.70	1.941	20.45	0.101	0.071	164.1	150.7	96.87	23.22	0.802
1: 7	21.738	11.165	0.161	0.157	0.000	40.07	2.002	21.55	0.112	0.077	169.7	156.2	97.04	23.11	0.798
1:25	21.079	10.626	0.161	0.150	0.000	40.59	1.914	22.27	0.109	0.073	168.7	155.6	96.96	23.18	0.800
1:43	20.555	10.935	0.177	0.163	0.000	41.56	2.022	21.34	0.115	0.079	165.9	152.9	96.95	23.36	0.806
2: 1	21.126	11.901	0.179	0.167	0.000	41.17	2.110	20.10	0.120	0.082	165.0	151.6	96.96	23.36	0.806
2:19	21.462	11.521	0.143	0.156	0.000	40.89	2.027	20.74	0.107	0.078	166.1	152.7	97.13	23.26	0.803
2:37	21.675	10.878	0.135	0.146	0.000	40.32	1.995	21.80	0.097	0.074	169.2	155.8	97.12	23.10	0.797
2:55	21.329	10.931	0.134	0.142	0.000	40.72	1.914	21.73	0.099	0.072	167.0	153.8	97.07	23.20	0.801
3:13	20.972	11.509	0.136	0.141	0.000	41.43	1.899	20.78	0.102	0.074	162.7	149.7	97.04	23.38	0.807
3:31	20.223	11.579	0.165	0.138	0.000	42.67	1.820	20.17	0.107	0.070	158.0	145.4	96.94	23.56	0.813
3:49	20.545	11.802	0.202	0.134	0.000	42.60	1.771	19.68	0.109	0.064	157.4	144.7	96.91	23.51	0.812
4: 7	20.600	11.316	0.201	0.121	0.000	43.13	1.733	19.68	0.103	0.057	156.6	144.0	96.94	23.43	0.809
4:25	24.352	16.239	0.132	0.135	0.000	39.89	1.908	14.19	0.099	0.081	152.6	137.9	97.03	23.25	0.803
4:43	23.747	16.650	0.123	0.133	0.000	40.80	1.820	13.57	0.093	0.081	147.4	133.1	97.02	23.48	0.810
5:19	18.849	11.958	0.120	0.124	0.000	44.67	1.739	19.18	0.088	0.072	148.2	136.5	96.81	23.95	0.827
5:37	20.753	11.791	0.134	0.132	0.000	42.16	1.866	19.88	0.089	0.065	158.1	145.3	96.87	23.43	0.809
13:29	20.347	12.517	0.165	0.116	0.000	42.42	1.710	18.17	0.089	0.057	149.7	137.3	95.59	23.31	0.805
13:47	19.960	12.583	0.155	0.115	0.000	42.80	1.633	18.15	0.092	0.057	147.5	135.4	95.55	23.42	0.808
14: 6	19.706	12.337	0.139	0.111	0.000	43.05	1.554	18.43	0.084	0.056	146.2	134.3	95.46	23.43	0.809
14:24	19.763	12.049	0.163	0.119	0.000	42.67	1.633	18.60	0.091	0.056	148.5	136.4	95.15	23.27	0.803
14:42	19.877	11.991	0.185	0.125	0.000	42.24	1.717	18.91	0.101	0.059	151.5	139.2	95.21	23.24	0.802
15:36	20.182	11.212	0.192	0.118	0.000	41.94	1.701	20.05	0.109	0.057	156.0	143.6	95.56	23.14	0.799
15:40	19.942	12.004	0.217	0.117	0.000	42.13	1.767	18.68	0.117	0.063	152.3	139.9	95.04	23.18	0.800
15:54	20.558	11.084	0.188	0.117	0.000	41.41	1.738	20.65	0.104	0.058	159.4	146.8	95.90	23.11	0.798
16:12	20.032	11.232	0.195	0.123	0.000	41.94	1.695	20.08	0.109	0.060	155.8	143.5	95.46	23.16	0.799
16:30	19.895	11.386	0.182	0.117	0.000	41.88	1.655	19.81	0.101	0.060	153.6	141.4	95.08	23.11	0.798
17: 6	20.681	10.592	0.182	0.126	0.000	40.71	1.709	21.41	0.102	0.060	162.0	149.3	95.57	22.91	0.791
17:23	20.573	10.449	0.177	0.127	0.000	40.56	1.683	21.63	0.099	0.060	162.0	149.4	95.35	22.86	0.789
17:41	20.409	10.694	0.181	0.121	0.000	41.07	1.675	21.27	0.103	0.062	160.3	147.8	95.59	23.01	0.794
17:59	20.322	10.628	0.206	0.118	0.000	41.42	1.673	21.17	0.108	0.059	160.1	147.6	95.70	23.05	0.796
18:17	20.461	10.837	0.196	0.125	0.000	41.10	1.685	21.07	0.110	0.061	160.4	147.8	95.64	23.03	0.795
18:35	20.538	10.736	0.198	0.118	0.000	40.99	1.680	21.15	0.105	0.058	160.6	148.0	95.58	22.98	0.793
18:53	20.499	10.779	0.213	0.125	0.000	40.85	1.732	21.12	0.112	0.061	161.5	148.8	95.49	22.97	0.793

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

11/ 7/1983

19:12	20.837	10.401	0.198	0.119	0.000	40.27	1.726	21.80	0.107	0.059	164.2	151.4	95.51	22.82	0.788
19:30	20.923	10.121	0.189	0.123	0.000	40.03	1.714	22.23	0.103	0.059	165.5	152.7	95.49	22.75	0.785
19:48	20.606	10.651	0.218	0.133	0.000	40.51	1.793	21.34	0.119	0.063	163.6	150.8	95.43	22.90	0.790
20: 6	20.260	10.044	0.180	0.120	0.000	41.50	1.697	21.52	0.100	0.060	160.7	148.3	95.48	22.91	0.791
20:24	20.471	10.431	0.188	0.127	0.000	40.74	1.707	21.64	0.044	0.065	161.0	148.5	95.42	22.89	0.790
20:42	19.931	10.855	0.229	0.125	0.000	41.66	1.681	20.74	0.123	0.060	158.4	146.0	95.40	23.11	0.798
21:18	20.681	10.286	0.185	0.121	0.000	40.53	1.702	21.76	0.107	0.060	163.2	150.5	95.43	22.83	0.788
21:37	20.830	9.952	0.221	0.121	0.000	39.94	1.728	22.40	0.113	0.061	166.7	153.9	95.36	22.71	0.784
21:40	20.412	10.574	0.194	0.120	0.000	40.84	1.688	21.37	0.108	0.061	161.1	148.5	95.37	22.93	0.791
22: 1	20.309	10.482	0.224	0.121	0.000	41.57	1.741	21.51	0.110	0.057	162.2	149.6	96.13	23.14	0.799
22:18	20.394	10.263	0.189	0.119	0.000	40.80	1.741	21.76	0.000	0.106	161.3	148.8	95.37	22.87	0.789
22:36	20.612	9.927	0.201	0.117	0.000	40.44	1.677	22.25	0.109	0.058	164.4	151.8	95.39	22.78	0.786
22:54	20.684	10.017	0.222	0.124	0.000	40.04	1.732	22.28	0.039	0.053	164.0	151.4	95.20	22.70	0.784
23:12	20.970	10.408	0.209	0.123	0.000	39.99	1.742	21.72	0.113	0.062	165.0	152.1	95.33	22.74	0.785
23:30	20.796	10.549	0.195	0.120	0.000	40.40	1.668	21.61	0.109	0.060	162.9	150.2	95.51	22.87	0.789
23:47	21.023	10.103	0.174	0.115	0.000	39.73	1.656	22.45	0.107	0.114	167.1	154.2	95.46	22.73	0.785

11/ 8/1983

0: 5	20.557	10.377	0.212	0.108	0.000	40.39	1.660	21.75	0.119	0.098	163.7	151.1	95.27	22.84	0.788
0:23	20.590	10.497	0.199	0.116	0.000	40.30	1.680	21.60	0.118	0.095	163.4	150.7	95.20	22.83	0.788
0:40	20.461	10.330	0.217	0.118	0.000	40.18	1.728	21.92	0.000	0.088	161.9	149.4	95.03	22.77	0.786
0:58	20.564	9.485	0.197	0.111	0.000	39.73	1.691	23.15	0.110	0.089	167.9	155.3	95.13	22.65	0.782
1:16	20.500	9.351	0.212	0.117	0.000	39.74	1.720	23.38	0.124	0.081	169.2	156.5	95.22	22.67	0.782
1:33	20.977	9.787	0.206	0.111	0.000	39.49	1.717	22.83	0.119	0.069	168.3	155.5	95.31	22.64	0.781
1:51	21.335	9.818	0.199	0.109	0.000	39.16	1.758	22.85	0.111	0.066	169.6	156.5	95.41	22.57	0.779
2: 9	20.834	10.562	0.230	0.109	0.000	40.04	1.690	21.95	0.122	0.067	165.2	152.4	95.60	22.88	0.790
2:27	20.887	10.451	0.219	0.116	0.000	39.88	1.734	22.16	0.126	0.066	166.5	153.6	95.64	22.86	0.789
2:44	20.581	10.339	0.228	0.127	0.000	40.43	1.747	22.16	0.046	0.057	163.8	151.2	95.71	22.93	0.791
3: 2	20.531	10.001	0.207	0.103	0.000	40.50	1.661	22.59	0.117	0.061	165.2	152.6	95.77	22.92	0.791
3:20	20.753	10.012	0.197	0.114	0.000	40.21	1.716	22.54	0.120	0.060	166.4	153.7	95.72	22.84	0.789
3:38	21.009	10.029	0.211	0.115	0.000	39.95	1.709	22.45	0.119	0.063	167.2	154.3	95.66	22.76	0.786
3:55	21.490	10.262	0.201	0.107	0.000	39.42	1.749	22.24	0.120	0.063	168.2	155.0	95.66	22.67	0.783
4:13	20.576	10.426	0.203	0.104	0.000	41.33	1.706	21.29	0.066	0.122	161.9	149.3	95.82	22.99	0.794
4:31	21.180	10.259	0.203	0.099	0.000	39.84	1.651	22.45	0.122	0.069	166.9	154.0	95.87	22.83	0.788
4:48	20.918	10.152	0.221	0.099	0.000	40.02	1.685	22.59	0.117	0.062	166.9	154.1	95.86	22.87	0.789
5: 6	20.283	9.937	0.216	0.098	0.000	41.07	1.647	22.68	0.120	0.063	164.7	152.3	96.11	23.07	0.796
5:24	20.544	9.226	0.203	0.098	0.000	39.91	1.667	23.78	0.122	0.063	169.1	156.6	95.62	22.75	0.785
5:42	20.731	9.926	0.231	0.096	0.000	40.20	1.719	22.67	0.125	0.072	167.4	154.7	95.77	22.85	0.789
6:18	20.976	9.649	0.219	0.101	0.000	39.54	1.668	23.16	0.118	0.068	168.9	156.1	95.49	22.67	0.783
6:53	21.000	9.918	0.223	0.098	0.000	39.36	1.727	22.88	0.119	0.067	168.7	155.8	95.39	22.67	0.783
7:11	20.809	9.658	0.201	0.104	0.000	39.73	1.688	23.10	0.116	0.061	167.9	155.2	95.47	22.71	0.784
7:29	20.256	9.486	0.215	0.090	0.000	40.14	1.616	23.44	0.119	0.061	166.5	154.2	95.43	22.82	0.788
7:47	20.172	9.735	0.220	0.108	0.000	40.59	1.717	22.78	0.120	0.065	165.7	153.2	95.51	22.89	0.790
8: 4	20.175	9.435	0.225	0.105	0.000	41.16	1.716	22.62	0.125	0.064	165.3	152.8	95.63	22.88	0.790
8:25	20.858	9.965	0.225	0.099	0.000	40.27	1.701	23.12	0.120	0.063	168.7	155.9	96.42	23.01	0.794

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

11/ 8/1983															
8:43	20.180	9.342	0.243	0.106	0.000	40.55	1.602	23.72	0.124	0.061	167.9	155.5	95.93	22.96	0.793
9: 1	20.415	9.413	0.237	0.106	0.000	40.34	1.686	23.45	0.121	0.060	168.4	155.9	95.83	22.87	0.789
9:19	20.775	10.038	0.250	0.108	0.000	40.00	1.759	22.65	0.128	0.063	168.3	155.4	95.77	22.85	0.789
9:37	20.730	10.538	0.268	0.107	0.000	40.39	1.776	21.75	0.133	0.062	165.8	152.9	95.76	22.94	0.792
9:55	20.513	10.181	0.226	0.102	0.000	40.44	1.703	22.38	0.129	0.063	165.5	152.9	95.74	22.94	0.792
10:13	20.053	9.883	0.216	0.096	0.000	41.44	1.701	22.22	0.112	0.062	162.8	150.5	95.79	23.03	0.795
10:31	20.570	9.775	0.226	0.101	0.000	40.29	1.705	22.97	0.124	0.061	167.4	154.8	95.82	22.89	0.790
10:53	21.680	10.043	0.204	0.031	0.000	40.41	1.701	24.07	0.124	0.061	172.9	159.9	98.33	23.34	0.806
11:11	21.735	10.643	0.235	0.055	0.000	42.42	1.688	23.75	0.133	0.067	173.2	160.0	100.72	24.10	0.832
11:29	20.490	9.841	0.223	0.094	0.000	40.72	1.631	23.09	0.116	0.060	166.4	153.9	96.26	23.05	0.796
11:47	21.154	9.912	0.223	0.087	0.000	39.44	1.714	23.01	0.128	0.063	169.4	156.4	95.73	22.73	0.785
12: 5	20.930	10.089	0.227	0.097	0.000	39.76	1.654	22.68	0.119	0.060	167.0	154.2	95.62	22.79	0.787
12:54	20.304	10.134	0.244	0.091	0.000	40.60	1.683	22.22	0.111	0.054	163.6	151.1	95.43	22.90	0.791
13:12	20.814	10.090	0.244	0.100	0.000	39.72	1.712	22.49	0.122	0.060	166.9	154.1	95.35	22.74	0.785
13:31	20.587	9.961	0.227	0.088	0.000	40.34	1.677	22.43	0.118	0.061	165.1	152.5	95.49	22.82	0.788
13:49	20.778	9.568	0.214	0.096	0.000	39.71	1.708	23.33	0.118	0.061	168.9	156.1	95.59	22.73	0.785
14: 7	19.652	9.305	0.225	0.099	0.000	41.60	1.620	22.89	0.115	0.059	163.0	150.9	95.57	22.99	0.793
14:25	20.872	9.232	0.158	0.100	0.000	39.13	1.824	24.32	0.101	0.067	172.5	159.6	95.81	22.70	0.784
14:43	20.960	9.558	0.178	0.103	0.000	39.20	1.850	24.10	0.112	0.072	173.1	160.1	96.14	22.82	0.788
15:19	20.480	9.965	0.216	0.097	0.000	40.18	1.664	22.96	0.121	0.063	166.4	153.9	95.75	22.92	0.791
15:37	20.464	9.648	0.221	0.095	0.000	40.08	1.639	23.35	0.114	0.060	167.2	154.7	95.67	22.86	0.789
15:55	20.103	9.185	0.224	0.079	0.000	40.18	1.596	23.93	0.116	0.058	167.2	154.9	95.47	22.82	0.788
16:13	21.782	10.956	0.202	0.097	0.000	38.74	1.835	21.83	0.119	0.065	168.5	155.2	95.63	22.69	0.783
16:31	20.704	9.848	0.160	0.097	0.000	39.39	1.844	23.37	0.105	0.071	169.2	156.5	95.59	22.78	0.786
16:49	20.809	9.539	0.168	0.092	0.000	39.18	1.829	23.84	0.107	0.071	171.0	158.2	95.64	22.72	0.784
17:25	21.043	9.066	0.153	0.087	0.000	38.31	1.876	24.60	0.106	0.075	174.4	161.5	95.32	22.49	0.776
17:43	20.867	9.255	0.149	0.088	0.000	38.66	1.856	24.26	0.109	0.074	172.6	159.7	95.32	22.57	0.779
18:19	20.964	9.194	0.156	0.088	0.000	38.73	1.827	24.42	0.104	0.069	173.0	160.1	95.55	22.60	0.780
18:37	21.226	9.054	0.156	0.086	0.000	37.90	1.934	24.69	0.102	0.072	175.8	162.7	95.22	22.40	0.773

SULFUR GAS CHROMATOGRAPH DATA

DATE TIME	H2S % TOT	COS % TOT	C2H5SH % TOT	CH3SH % TOT	TOTAL PPM

11/ 2/1983					
13:23	72.2	13.8	3.4	10.6	1562
13:55	73.3	12.4	3.6	10.7	1658
15:02	69.5	11.9	0.0	18.7	1739
11/ 3/1983					
2:05	73.0	9.8	0.0	17.1	2433
3:05	77.5	10.1	1.5	11.0	2253
5:08	73.2	9.3	4.1	13.4	2408
8:30	81.1	9.6	4.3	5.0	2535
8:55	81.3	9.3	4.0	5.4	2236
10:03	78.9	9.6	4.2	7.4	2335
10:22	82.4	9.7	3.7	4.2	2171
10:43	82.7	9.0	3.9	4.5	2316
11:14	80.0	9.0	3.8	7.2	2263
11:34	82.6	8.9	4.0	4.4	2376
12:24	76.9	9.2	3.9	10.0	2432
13:12	77.0	9.0	3.9	10.0	2248
13:57	77.0	9.1	4.0	9.9	2499
14:25	83.5	10.3	0.0	6.2	2286
15:14	78.7	10.1	0.0	11.2	2229
15:43	83.3	10.1	0.0	6.6	2364
16:20	80.5	9.8	1.4	8.3	2391
16:47	84.0	9.8	0.0	6.1	2364
17:53	72.8	9.8	3.4	14.1	2340
20:15	75.1	10.3	3.5	11.1	2229
11/ 4/1983					
2:03	64.2	10.1	9.0	16.6	2458
5:59	65.5	10.7	10.3	13.6	2868
7:02	74.0	10.9	3.4	11.6	2298
8:05	77.7	10.9	0.0	11.3	2275
8:36	83.0	11.2	0.0	5.8	2355
9:58	76.2	10.9	0.0	13.0	2309
14:13	71.9	10.4	2.7	14.9	2090
17:19	69.5	10.3	2.8	17.4	1496
20:31	70.0	10.0	2.7	17.2	1674
11/ 5/1983					
0:59	82.1	10.9	3.2	3.8	2379
1:56	77.2	9.8	3.2	9.7	2537
2:59	76.7	9.9	2.9	10.5	2578
3:59	79.7	10.1	0.0	10.2	2455
4:57	77.4	9.9	2.0	10.7	2323
6:07	75.9	9.7	2.6	11.7	2452
6:54	77.6	10.1	3.2	9.1	2386
8:21	79.7	10.9	3.1	6.3	2044
8:59	78.0	10.1	3.0	8.8	1865
9:17	81.0	10.4	3.1	5.5	1892
9:38	81.8	9.8	3.0	5.4	2133
9:60	81.4	9.3	3.1	6.1	2009
10:28	68.6	8.1	2.9	20.4	2337
10:50	81.1	9.6	3.3	6.0	1959

SULFUR GAS CHROMATOGRAPH DATA

DATE TIME	H2S % TOT	COS % TOT	C2H5SH % TOT	CH3SH % TOT	TOTAL PPM

11/ 5/1983					
11:18	80.0	9.0	3.4	7.6	1953
11:34	81.5	9.5	3.1	5.9	1764
11:58	79.7	9.1	3.2	7.9	1927
12:31	80.8	9.8	3.3	6.1	2054
12:50	78.8	9.0	0.0	12.2	2209
13:28	84.1	9.4	0.0	6.4	2057
14:06	81.5	9.5	3.0	6.0	2168
14:39	82.6	9.1	3.7	4.7	2128
18:54	77.8	8.6	3.1	10.5	2184
19:37	80.2	8.7	3.3	7.8	2390
20:11	79.6	9.1	3.6	7.7	2051
21:17	77.0	8.9	3.2	11.0	2498
22:19	76.7	9.2	3.2	10.9	2418
23:33	75.2	8.9	2.8	13.1	2334
11/ 6/1983					
0:03	79.1	10.3	2.8	7.7	2146
0:54	77.8	8.8	3.6	9.8	2462
2:03	78.8	9.2	0.0	12.0	2352
4:07	73.8	9.2	0.0	17.0	2441
4:58	78.3	9.3	3.1	9.3	2533
8:10	74.4	9.4	5.3	10.8	2529
15:24	73.5	8.6	3.2	14.8	2248
17:19	74.3	8.7	3.5	13.5	2537
18:37	80.6	9.4	3.4	6.6	2191
19:15	79.4	9.0	3.5	8.1	2160
19:53	78.2	8.7	3.4	9.7	2374
21:09	76.4	8.3	3.3	12.0	2266
22:28	77.4	8.6	3.5	10.6	2252
23:06	72.4	8.5	6.0	13.2	2201
11/ 7/1983					
1:56	84.3	9.6	0.0	6.2	1982
3:13	79.1	8.6	1.4	10.9	2388
3:13	80.3	8.1	4.7	6.9	2631
5:47	68.6	7.5	3.8	20.1	1934
13:28	72.6	9.7	3.6	14.0	1863
14:06	81.2	9.9	4.0	4.9	1936
14:43	85.5	9.4	0.0	5.1	2063
15:24	82.8	9.3	0.0	7.8	1881
16:19	84.3	9.2	0.0	6.6	2283
16:59	82.3	9.1	0.0	8.6	2199
17:19	85.8	9.4	0.0	4.8	2165
17:41	84.8	9.0	2.0	4.3	2285
18:37	83.8	8.8	2.3	5.1	2525
19:15	77.5	8.2	2.7	11.6	2429
20:31	78.6	8.3	3.3	9.8	2687
21:09	73.3	7.6	9.4	9.7	2604
22:28	76.6	8.3	3.2	11.9	2351
23:05	77.2	8.0	3.1	11.7	2309
23:44	77.5	8.4	3.1	11.0	2328

SULFUR GAS CHROMATOGRAPH DATA

DATE TIME	H2S % TOT	COS % TOT	C2H5SH % TOT	CH3SH % TOT	TOTAL PPM

11/ 8/1983					
1:18	78.1	8.8	3.1	9.9	2648
2:34	86.3	9.0	0.0	4.7	2505
3:13	84.6	9.0	0.0	6.4	1971
4:01	81.5	8.8	0.0	9.7	2688
4:31	89.2	3.2	1.7	5.9	2322
5:09	83.0	8.8	1.9	6.2	2428
6:01	80.5	8.9	3.1	7.5	2199
6:25	82.7	9.3	3.3	4.7	2667
7:03	78.7	8.7	3.1	9.5	2881
8:21	80.3	8.7	3.4	7.7	2573
8:59	82.9	9.0	3.4	4.7	2437
9:38	81.4	8.2	3.2	7.2	2601
9:60	82.3	8.5	3.5	5.7	2419
10:16	81.9	8.8	3.6	5.7	2639
11:06	81.1	8.3	3.3	7.3	2623
11:34	83.5	8.6	3.3	4.5	2436
12:50	78.2	8.5	3.0	10.3	2269
13:28	78.1	8.4	3.0	10.4	1959
14:06	75.9	8.8	2.9	12.4	2230
16:41	79.1	8.6	0.0	12.3	2213
17:19	77.9	8.8	1.9	11.4	2319
19:15	73.1	8.3	3.6	15.0	2531
19:53	75.4	8.4	3.0	13.2	2337
20:31	79.6	8.4	3.3	8.7	2426
23:44	72.5	9.0	0.0	18.5	2086
11/ 9/1983					
3:22	84.8	9.1	0.0	6.0	2291
3:58	71.8	9.9	0.0	18.4	1966
4:31	71.8	11.3	5.8	11.1	1322
5:09	67.9	11.7	7.8	12.5	1357
5:47	68.3	11.3	8.3	12.0	1383
6:03	66.9	11.4	8.6	13.1	1298
6:34	67.5	12.0	9.3	11.2	1132
7:03	59.2	11.1	8.8	20.9	1127
11:01	49.0	10.5	17.7	22.7	1362
11:34	67.8	13.4	9.3	9.5	1002
12:12	63.3	11.6	9.4	15.7	1146
13:28	52.6	11.6	9.8	25.9	967
14:06	55.5	12.0	10.5	22.1	931
17:01	40.4	8.3	24.7	26.6	1426
17:19	53.2	11.6	11.9	23.4	896
19:15	54.7	11.1	11.0	23.2	1079
19:53	49.4	11.6	12.1	26.9	856

APPENDIX J

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: 11/ 2/83 15:00 TO 11/ 3/83 6:00

SIGNAL	AVERAGE	UNITS	STD.DEV.
T-701	6.980	DEG C	4.213
T-702	20.490	DEG C	4.054
T-703	68.159	DEG C	0.395
T-710	10.006	DEG C	0.476
T-711	44.030	DEG C	4.420
T-712	9.989	DEG C	0.422
T-713	14.186	DEG C	2.592
T-705	142.989	DEG C	115.248
T-706	133.564	DEG C	78.983
T-707	131.376	DEG C	70.414
T-812	136.294	DEG C	186.908
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	26.369	DEG C	2.145
T-820	305.613	DEG C	38.353
T-823	--OFF--	DEG C	
T-822	62.423	DEG C	1.979
T-806	122.474	DEG C	58.565
T-811	--OFF--	DEG C	
F-701	725.390	SCFM	12.067
TT2-703	70.528	DEG C	0.052
P-703	5.446	IN WC	0.692
P-704	1.158	IN WC	0.524
P-705	4.288	IN WC	0.780
P-706	4.129	IN WC	0.763
F-707	--OFF--	SCFM	
WT-720	5.915	TONS	1.945
P-707	-0.600	IN WC	0.374
P-810	-1.972	IN WC	0.046
F-802	--OFF--	CFM	
F-803	8146.427	CFM	71.504
TT1-703	70.509	DEG C	0.064
CO	22.236	%	2.173
CO2	9.971	%	1.066
O2	-0.034	%	0.485
SIGMA	176.176	BTU/SCF	22.259
T-715	159.340	DEG C	0.867
T-821	35.508	DEG C	1.861
T-703A	26.947	DEG C	4.291
PH	--OFF--	PH	
AG VEL	-0.001	SPH	0.002
GR VEL	-0.003	RPD/T	0.001
P-702	0.000	IN WC	0.000

AVERAGE BASE TEMPERATURE 17.619

AVERAGE FROM PERIOD: 11/ 3/83 7:00 TO 11/ 3/83 18:00

SIGNAL	AVERAGE	UNITS	STD.DEV.
T-701	2.401	DEG C	1.458
T-702	15.179	DEG C	1.448
T-703	66.258	DEG C	0.695
T-710	9.523	DEG C	0.316
T-711	45.581	DEG C	3.271
T-712	9.458	DEG C	0.283
T-713	12.262	DEG C	0.615
T-705	69.799	DEG C	3.884
T-706	67.966	DEG C	1.800
T-707	67.592	DEG C	1.707
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	29.864	DEG C	2.801
T-820	425.235	DEG C	16.207
T-823	--OFF--	DEG C	
T-822	66.361	DEG C	0.828
T-806	65.449	DEG C	1.385
T-811	--OFF--	DEG C	
F-701	893.114	SCFM	36.454
TT2-703	69.120	DEG C	0.586
P-703	10.788	IN WC	0.943
P-704	5.375	IN WC	0.874
P-705	5.413	IN WC	0.871
P-706	5.121	IN WC	0.843
F-707	--OFF--	SCFM	
WT-720	6.687	TONS	2.377
P-707	0.265	IN WC	0.857
P-810	-1.979	IN WC	0.013
F-802	--OFF--	CFM	
F-803	8235.147	CFM	149.975
TT1-703	68.923	DEG C	0.614
CO	23.446	%	0.665
CO2	9.864	%	0.289
O2	-0.124	%	0.222
SIGMA	185.575	BTU/SCF	5.182
T-715	153.546	DEG C	3.154
T-821	34.287	DEG C	1.487
T-703A	22.270	DEG C	1.675
PH	--OFF--	PH	
AG VEL	-0.002	SPH	0.003
GR VEL	-0.004	RPD/T	0.001
P-702	0.000	IN WC	0.000

AVERAGE BASE TEMPERATURE 17.401

AVERAGE FROM PERIOD: 11/ 3/83 18:00 TO 11/ 4/83 9:00

SIGNAL	AVERAGE	UNITS	STD.DEV.
T-701	0.334	DEG C	1.939
T-702	12.573	DEG C	1.925
T-703	64.180	DEG C	0.568
T-710	9.391	DEG C	0.190
T-711	64.749	DEG C	4.706
T-712	9.413	DEG C	0.168
T-713	12.084	DEG C	0.549
T-705	93.014	DEG C	16.239
T-706	84.731	DEG C	9.033
T-707	83.076	DEG C	8.356
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	29.795	DEG C	2.350
T-820	441.945	DEG C	6.778
T-823	--OFF--	DEG C	
T-822	66.076	DEG C	0.449
T-806	76.462	DEG C	5.876
T-811	22.620	DEG C	669.965
F-701	1034.086	SCFM	1.668
TT2-703	67.319	DEG C	0.379
P-703	13.728	IN WC	0.566
P-704	5.581	IN WC	0.457
P-705	8.147	IN WC	0.476
P-706	7.785	IN WC	0.461
F-707	--OFF--	SCFM	
WT-720	6.764	TONS	2.727
P-707	-0.740	IN WC	0.269
P-810	--OFF--	IN WC	
F-802	--OFF--	CFM	
F-803	--OFF--	CFM	
TT1-703	67.020	DEG C	0.394
CO	25.466	%	1.036
CO2	8.942	%	0.489
O2	-0.144	%	0.240
SIGMA	187.231	BTU/SCF	10.746
T-715	155.429	DEG C	2.094
T-821	31.619	DEG C	1.739
T-703A	29.331	DEG C	3.155
PH	--OFF--	PH	
AG VEL	-0.001	SPH	0.002
GR VEL	-0.003	RPD/T	0.001
P-702	0.000	IN WC	0.000

AVERAGE BASE TEMPERATURE 16.891

AVERAGE FROM PERIOD: 11/ 4/83 14:00 TO 11/ 5/83 14:00

SIGNAL	AVERAGE	UNITS	STD.DEV.
T-701	3.677	DEG C	1.949
T-702	14.797	DEG C	1.962
T-703	64.775	DEG C	0.532
T-710	9.265	DEG C	0.339
T-711	66.164	DEG C	6.624
T-712	9.265	DEG C	0.319
T-713	12.265	DEG C	0.618
T-705	159.573	DEG C	38.548
T-706	149.258	DEG C	35.374
T-707	149.038	DEG C	37.277
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	660.433	DEG C	234.780
T-820	800.148	DEG C	36.873
T-823	--OFF--	DEG C	
T-822	75.049	DEG C	1.268
T-806	136.467	DEG C	36.069
T-811	--OFF--	DEG C	
F-701	1486.955	SCFM	4.061
TT2-703	67.901	DEG C	0.497
P-703	18.123	IN WC	3.206
P-704	16.240	IN WC	3.616
P-705	1.883	IN WC	0.573
P-706	1.092	IN WC	0.199
F-707	--OFF--	SCFM	
WT-720	7.493	TONS	1.990
P-707	1.558	IN WC	0.215
P-810	0.074	IN WC	0.268
F-802	--OFF--	CFM	
F-803	--OFF--	CFM	
TT1-703	67.669	DEG C	0.501
CO	24.111	%	2.014
CO2	9.518	%	0.501
O2	-0.161	%	0.239
SIGMA	172.519	BTU/SCF	10.771
T-715	155.326	DEG C	0.898
T-821	81.111	DEG C	17.299
T-703A	30.933	DEG C	4.332
PH	--OFF--	PH	
AG VEL	0.183	SPH	1.479
GR VEL	-0.004	RPD/T	0.001
P-702	0.000	IN WC	0.000

AVERAGE BASE TEMPERATURE 17.667

AVERAGE FROM PERIOD: 11/ 5/83 16:00 TO 11/ 6/83 3:00

SIGNAL	AVERAGE	UNITS	STD.DEV.
T-701	6.823	DEG C	0.418
T-702	19.167	DEG C	0.572
T-703	65.364	DEG C	0.968
T-710	9.309	DEG C	0.177
T-711	46.750	DEG C	7.469
T-712	9.294	DEG C	0.200
T-713	12.195	DEG C	0.785
T-705	142.365	DEG C	26.778
T-706	133.388	DEG C	17.078
T-707	136.103	DEG C	18.153
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	502.732	DEG C	133.166
T-820	641.590	DEG C	83.990
T-823	--OFF--	DEG C	
T-822	68.684	DEG C	3.005
T-806	127.702	DEG C	15.870
T-811	--OFF--	DEG C	
F-701	992.028	SCFM	234.894
TT2-703	68.378	DEG C	0.870
P-703	8.861	IN WC	3.890
P-704	7.934	IN WC	3.547
P-705	0.927	IN WC	0.352
P-706	0.611	IN WC	0.078
F-707	--OFF--	SCFM	
WT-720	7.258	TONS	2.302
P-707	1.149	IN WC	0.058
P-810	0.106	IN WC	0.237
F-802	--OFF--	CFM	
F-803	--OFF--	CFM	
TT1-703	68.151	DEG C	0.929
CO	24.039	%	0.802
CO2	9.795	%	0.387
O2	-0.197	%	0.172
SIGMA	175.550	BTU/SCF	3.951
T-715	160.592	DEG C	3.735
T-821	71.814	DEG C	8.319
T-703A	22.354	DEG C	3.331
PH	--OFF--	PH	
AG VEL	-0.005	SPH	0.006
GR VEL	-0.004	RPD/T	0.001
P-702	0.000	IN WC	0.000

AVERAGE BASE TEMPERATURE 17.157

AVERAGE FROM PERIOD: 11/ 6/83 4:00 TO 11/ 6/83 9:00

SIGNAL	AVERAGE	UNITS	STD.DEV.
T-701	6.241	DEG C	0.178
T-702	18.255	DEG C	0.194
T-703	65.822	DEG C	0.089
T-710	9.657	DEG C	0.191
T-711	40.467	DEG C	1.373
T-712	9.707	DEG C	0.222
T-713	11.903	DEG C	0.275
T-705	105.403	DEG C	13.093
T-706	95.559	DEG C	9.950
T-707	96.675	DEG C	10.704
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	584.434	DEG C	31.955
T-820	601.968	DEG C	12.503
T-823	--OFF--	DEG C	
T-822	70.616	DEG C	0.402
T-806	91.104	DEG C	9.060
T-811	--OFF--	DEG C	
F-701	1034.067	SCFM	6.253
TT2-703	68.641	DEG C	0.030
P-703	10.138	IN WC	0.561
P-704	9.268	IN WC	0.605
P-705	0.870	IN WC	0.081
P-706	0.623	IN WC	0.094
F-707	--OFF--	SCFM	
WT-720	7.907	TONS	2.428
P-707	1.194	IN WC	0.078
P-810	0.185	IN WC	0.083
F-802	--OFF--	CFM	
F-803	--OFF--	CFM	
TT1-703	68.421	DEG C	0.034
CO	25.590	%	0.536
CO2	9.176	%	0.192
O2	-0.158	%	0.186
SIGMA	178.660	BTU/SCF	2.272
T-715	160.326	DEG C	0.328
T-821	72.739	DEG C	4.339
T-703A	19.597	DEG C	0.617
PH	--OFF--	PH	
AG VEL	-0.002	SPH	0.004
GR VEL	-0.004	RPD/T	0.001
P-702	0.000	IN WC	0.000

AVERAGE BASE TEMPERATURE 18.077

AVERAGE FROM PERIOD: 11/ 6/83 10:00 TO 11/ 6/83 24:00

SIGNAL	AVERAGE	UNITS	STD.DEV.
T-701	6.145	DEG C	1.639
T-702	17.458	DEG C	1.583
T-703	66.445	DEG C	0.519
T-710	9.371	DEG C	0.169
T-711	72.968	DEG C	9.560
T-712	9.395	DEG C	0.170
T-713	12.455	DEG C	0.763
T-705	124.393	DEG C	18.936
T-706	107.384	DEG C	12.829
T-707	113.619	DEG C	15.577
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	290.367	DEG C	42.033
T-820	718.159	DEG C	19.393
T-823	--OFF--	DEG C	
T-822	73.663	DEG C	0.720
T-806	106.665	DEG C	18.393
T-811	--OFF--	DEG C	
F-701	1323.115	SCFM	62.171
TT2-703	69.698	DEG C	0.352
P-703	17.234	IN WC	1.448
P-704	16.164	IN WC	1.409
P-705	1.070	IN WC	0.307
P-706	0.498	IN WC	0.065
F-707	--OFF--	SCFM	
WT-720	6.139	TONS	2.251
P-707	0.965	IN WC	0.088
P-810	-0.245	IN WC	0.060
F-802	--OFF--	CFM	
F-803	7902.995	CFM	0.422
TT1-703	69.316	DEG C	0.382
CO	23.399	%	1.956
CO2	9.695	%	0.897
O2	-0.199	%	0.146
SIGMA	169.089	BTU/SCF	12.244
T-715	158.151	DEG C	1.429
T-821	59.456	DEG C	2.729
T-703A	37.182	DEG C	6.305
PH	--OFF--	PH	
AG VEL	-0.007	SPH	0.007
GR VEL	-0.005	RPD/T	0.001
P-702	0.000	IN WC	0.000

AVERAGE BASE TEMPERATURE 18.257

AVERAGE FROM PERIOD: 11/ 7/83 15:00 TO 11/ 8/83 14:00

SIGNAL	AVERAGE	UNITS	STD.DEV.
T-701	7.867	DEG C	3.442
T-702	19.055	DEG C	3.263
T-703	66.801	DEG C	0.708
T-710	9.023	DEG C	0.261
T-711	71.301	DEG C	14.067
T-712	9.042	DEG C	0.278
T-713	11.913	DEG C	0.457
T-705	144.192	DEG C	6.137
T-706	128.186	DEG C	6.839
T-707	139.794	DEG C	5.616
T-812	233.814	DEG C	564.091
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	201.838	DEG C	70.338
T-820	666.650	DEG C	95.651
T-823	--OFF--	DEG C	
T-822	73.573	DEG C	0.747
T-806	129.782	DEG C	6.374
T-811	--OFF--	DEG C	
F-701	1333.181	SCFM	2.767
TT2-703	69.730	DEG C	0.514
P-703	18.119	IN WC	1.478
P-704	16.640	IN WC	1.467
P-705	1.480	IN WC	0.265
P-706	0.503	IN WC	0.100
F-707	--OFF--	SCFM	
WT-720	7.813	TONS	1.982
P-707	0.831	IN WC	0.114
P-810	-0.341	IN WC	0.133
F-802	--OFF--	CFM	
F-803	--OFF--	CFM	
TT1-703	69.607	DEG C	0.646
CO	22.764	%	2.939
CO2	9.669	%	1.074
O2	-0.014	%	0.414
SIGMA	175.735	BTU/SCF	15.064
T-715	157.953	DEG C	3.515
T-821	57.275	DEG C	2.420
T-703A	36.051	DEG C	11.539
PH	--OFF--	PH	
AG VEL	-0.005	SPH	0.006
GR VEL	-0.005	RPD/T	0.002
P-702	0.000	IN WC	0.000

AVERAGE BASE TEMPERATURE 18.547

APPENDIX K

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 NOVEMBER 8, 1983,
BENTON LIGNITE 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 3-1662
December 13, 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
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- 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 input
LB/HMBTU	pounds per million British Thermal Units heat input
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 November 8, 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 D. Stock. 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 10⁶BTU/HR (bituminous coal). A combustion test chamber is attached to the gasifier and it also has a nominal capacity of 30 10⁶BTU/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, Benton lignite 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 concentrations for Runs 2 and 3 are substantially higher than those reported for Run 1. Our analysis of the results and samples show that these high concentrations are sampling artifacts which resulted due to liner decomposition at the high stack gas temperatures encountered.

Fortunately, the filter catches, in the case of Runs 2 and 3 which represent the fine particulate portion of the aerosol samples (less than or equal to five microns), were not affected by the large flakes of material contributed by the probe liner decomposition. Since previous results have shown that the ratio of probe wash to filter catch remains essentially constant from run to run, it was possible to estimate the true particulate concentrations, emission rates and emission factors using this ratio and the filter catches for Runs 2 and 3.

These results are shown in parentheses adjacent to the uncorrected or field results. Because of the field difficulty encountered, the results for Run 1 are considered to be the best estimate of the true particulate concentration and emission factor for this particular test. The particulate emission factor for Run 1 averaged .19 LB/10⁶BTU, the parameter used by most pollution control agencies to regulate emissions from boilers and combustors.

The heat input to the combustion test chamber was estimated to average 45.1 10⁶BTU/HR using the F-factor calculated from the producer gas composition together with the particulate emission factor and the particulate mass rates. This heat input rate was verified by the SO₂ emission factors and rates.

Table 1. Summary of the Results of the November 8, 1983 Particulate Emission Test on the Combustor Outlet at the Bureau of Mines Coal Gasification Plant Located in Minneapolis, Minnesota

ITEM	RUN 1	RUN 2*	RUN 3*
Time of test (HRS)	0630/0730	0805/0905	0930/1030
Estimated gas burning rate (DSCFM)	4630	4410	4550
Estimated heat input (MMBTU/HR) *	46.1	43.9	45.3
Estimated percent of rated capacity	154	146	151
Volumetric flow			
ACTUAL (ACFM)	79300	81800	81200
STANDARD (DSCFM)	15700	15300	16000
Gas temperature (DEG-F)	1789	1814	1799
Moisture content (% v/v)	12.91	17.02	13.05
Gas composition (% v/v dry)			
carbon dioxide	9.40	9.40	9.60
oxygen	10.60	10.60	10.40
nitrogen	80.00	80.00	80.00
Oxygen analyzer (% v/v, dry)	9.97	10.01	10.22
Isokinetic variation (%)	106.8	102.9	95.7
Particulate concentration			
ACTUAL (GR/ACF)	.012	.119(.010)	.093(.010)
STANDARD (GR/DSCF)	.062	.637(.056)	.470(.053)
Particulate mass rate (LB/HR) **	8.6	84.6(7.4)	63.1(7.1)
Particulate emission factor **			
(LB/MMBTU)			
F-factor method (O2 analyzer)	.18	1.82(.16)	1.37(.15)
F-factor method (Orsat)	.19	1.93(.17)	1.39(.16)

* To combustor from producer gas

() Estimated true particulate values

** Dry Catch Plus Orsat Wet Catch

Table 2. Summary of the Results of the November 8, 1983 Sulfur Dioxide Emission Test on the Combustor Outlet at the Bureau of Mines Coal Gasification Plant Located in Minneapolis, Minnesota

ITEM	Run 1	Run 2	Run 3
Time of test (HRS)	630- 730	805- 905	930-1030
SO ₂ concentration (PPM/dry)	460	455	439
(PPM/wet)	400	378	382
SO ₂ mass rate (LB/HR)	72	69	70
SO ₂ emission factor (LB/MMBTU) F-factor method	1.62	1.60	1.51

The results of the SO₂ determinations are given in Table 2. As will be noted, the SO₂ concentrations ranged from 378 to 400 ppm actual. The SO₂ emission rate was approximately 70 LB/HR and the SO₂ emission factor 1.58 LB/HR. The SO₂ emission factor calculated from the sulfur content and the heating value of the coal was 1.91 LB/HR. If the difference between the measured and calculated emission factors is considered to be due to ash fixation, the ash fixation rate for this fuel and these burning conditions was 17.1%.

Nitric oxide concentrations averaged 122 ppm (dry). Plume opacity was zero. Volumetric flow rate determinations were performed at three different locations. The results of the flow rate determinations at the combustor outlet averaged 15,700 DSCFM. The flow rate at the combustion fan inlet duct was measured at 10,600 DSCFM. The flow rate at the stack test site was 15,900 DSCFM.

No other difficulties were encountered in the field or in the laboratory evaluation of the flyash and flue gas samples. On the basis of this fact and a complete review of the entire data and results, it is our opinion that the particulate (Run 1), sulfur dioxide, and oxides of nitrogen concentrations, emission rates and emission factors reported herein are accurate and closely reflect the actual values which existed at the time the tests were performed.

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.

3.1 Results of Orsat and Moisture Analyses

Interpoll Report No. 3-1662
U of M/BOM-Coal Gasification
Minneapolis, Minnesota

Test No. 1
Combustor Outlet

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

	Run 1	Run 2	Run 3
Date of run	11/08/83	11/08/83	11/08/83
Dry basis (orsat)			
carbon dioxide	9.40	9.40	9.60
oxygen	10.60	10.60	10.40
carbon monoxide	.00	.00	.00
nitrogen	80.00	80.00	80.00
Wet basis (orsat)			
carbon dioxide	8.19	7.80	8.35
oxygen	9.23	8.80	9.04
carbon monoxide	.00	.00	.00
nitrogen	69.67	66.39	69.56
Moisture content	12.91	17.02	13.05
Dry molecular weight	29.93	29.93	29.95
Wet molecular weight	28.39	27.90	28.39
Specific gravity (relative to air)	.9806	.9637	.9807
teledyne oxygen analyzer (velocity & time weighted avg.)	9.97	10.01	10.22
FO	1.10	1.10	1.09

Interpoll Report No. 3-1662
U of M/BOM-Coal Gasification
Minneapolis, Minnesota

Test No. 1
Combustor Fan Inlet Duct

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

Run 1

Date of run 11/08/83

Dry basis (orsat)

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

Wet basis (orsat)

carbon dioxide	.03
oxygen	20.72
carbon monoxide	.00
nitrogen	78.40

Moisture content .85

Dry molecular weight 28.84

Wet molecular weight 28.75

Specific gravity
(relative to air) .9930

Teledyne oxygen
analyzer (velocity &
time weighted avg.) 10.30

FO .00

Interpoll Report No. 3-1662
U of M/ROM-Coal Gasification
Minneapolis, Minnesota

Test No. 1
Scrubber Stack

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

Run 1

Date of run 11/08/63

Dry basis (orsat)

carbon dioxide	8.90
oxygen	11.76
carbon monoxide	.00
nitrogen	79.34

Wet basis (orsat)

carbon dioxide	4.99
oxygen	6.59
carbon monoxide	.00
nitrogen	44.47

Moisture content 43.95

Dry molecular weight 29.89

Wet molecular weight 24.67

Specific gravity
(relative to air) .8521

Teledyne oxygen
analyzer (velocity &
time weighted avg.) 10.30

FO 1.03

Interpoll Report No. 3-1662
U of M/BOM-Coal Gasification
Minneapolis, Minnesota

Test No. 1
Combustor Outlet

3.2 Results of Particulate Loading Determinations -- Method 5

	Run 1	Run 2	Run 3
Date of run	11/08/83	11/08/83	11/08/83
Time run start/end (HRS)	0630/0730	0805/0905	0930/1030
Pitot tube coefficient	.856	.856	.856
Water in sample			
condensate (ml)	96.0	118.0	92.0
silica gel (grams)	12.4	22.3	8.1
Total particulate material collected (grams) *	.1374	1.3300	.9564
Meter correction coefficient	.9964	.9946	.9946
Volume through gas meter			
at meter conditions...(CF)	35.04	32.90	32.07
standard conditions...(SCF)	34.43	32.22	31.39
Total sampling time (min)	60.0	60.0	60.0
Nozzle diameter (IN)	.374	.374	.374
Average stack gas temperature during determination (DEG-F)	1789	1813	1799
Volumetric flow			
actual.....(CFM)	79325	81785	81203
standard.....(DSCFM)	15717	15273	15989
Isokinetic variation (%)	106.8	102.9	95.7
Particle concentration			
actual.....(GR/ACF)	.0122	.1194	.0930
dry standard.....(GR/DSCF)	.0616	.6370	.4701
Particle mass flow (LB/HR)	8.58	84.63	63.09
Emission factor (LB/MMBTU)			
by F factor (320-F)	.175	1.822	1.370
by F factor (orsat)	.186	1.926	1.394

* Dry Catch Plus Organic Wet Catch
F factor: Run 1 =10429.0 Run 2 =10429.0 Run 3 =10429.0

Test No. 1
Combustor Outlet

3.3 Results of Sulfur Dioxide Determinations -- Method 6

	Run 1	Run 2	Run 3
Date of run	11/ 8/83	11/ 8/83	11/ 8/83
Time run start/end (HRS)	630/ 730	805/ 905	930/1030
Average stack gas temperature during determination (DEG-F)	1789	1813	1799
Barometric Pressure (IN.HG.)	29.08	29.08	29.08
Meter Temperature (DEG-F)	61.5	62.3	62.5
Meter correction coefficient	.9946	.9946	.9946
Volume through gas meter			
at meter conditions...(CF)	35.04	32.90	32.07
standard conditions...(SCF)	34.37	32.22	31.39
Total sampling time (MIN)	60	60	60
Moisture content (% v/v)	12.91	17.02	13.05
Oxygen content (% v/v dry)	10.60	10.60	10.40
Milliequivalents of SO ₂ in gas sample	37.1731	34.5163	32.4130
Sulfur dioxide concentration			
(GR/DSCF)	.5345	.5295	.5103
(MG/DSCM)	1223	1212	1168
(PPM-dry)	460	455	439
(PPM-wet)	400	378	382
Dry standard volumetric flow (DSCFM)	15717	15273	15989
Sulfur dioxide mass rate (LB/HR)	72.00	69.32	69.94
Sulfur dioxide emission factor (LB/MMBTU)			
F-factor method*	1.616	1.601	1.513

K-17

* F factor: Run 1 =10429.0 Run 2 =10429.0 Run 3 =10429.0

Test No. 1
Combustor Outlet

3.4 Results of NO Measurement--Monitor Labs Chemiluminescent NO
Analyzer

NO Concentration (PPM-DRY)		
Run 1	Run 2	Run 3
100	115	120
103	120	120
112	121	121
114	125	123
119	128	122
122	127	122
121	129	122
124	128	123
123	131	130
125	128	130
122	128	122
118	129	125
Average:	116.9	125.8
		123.3

Test No. 1
Scrubber Stack

3.5 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: D. Stock
Cert. Date: 06-23-83
Date of Observation: 11-08-83
Time of Observation: 1000-1006

APPENDIX L

Retort Pressure and Temperature Probe Data

Reference: Thimsen, Maurer et al (1984)

RETORT TEMPERATURE AND PRESSURE PROBE DATA

TEST: BOM/FGT-009
 DATE: 11/ 3/83
 RETORT ACCESS PORT NUMBER:

COAL: BENTON LIGNITE
 5

DATA: INCHES ABOVE GRATE	PRESSURE (inwc)	TEMPERATURE (deg C)	TIME (hrs)	1040	1043
	1.5	---	Blast Air (scfm)	800	800
6	1.5	---			
12	2.0	---			
18	2.5	1088	Saturation Temperature (deg C)	69.0	69.0
24	2.8	938			
30	2.9	---			
36	3.0	199			
42	3.0	182	Ashpit Pressure (inwc)	10.4	9.6
48	4.1	127			
54	4.1	93			
60	4.1	88			
66	4.1	88	Offtake Temperature (deg C)	72	72

RETORT TEMPERATURE AND PRESSURE PROBE DATA

TEST: BOM/FGT-009

COAL: BENTON LIGNITE

DATE: 11/04/83

RETORT ACCESS PORT NUMBER:

5

DATA: INCHES ABOVE GRATE PRESSURE (inwc) TEMPERATURE (deg C)

TIME (hrs) 820

0	0.5	860	Blast Air	1000
6	0.6	960	(scfm)	
12	0.8	871	Saturation	67.0
18	1.3	832	Temperature	
24	1.5	816	(deg C)	
30	1.7	782	Ashpit	15.1
36	3.3	816	Pressure	
42	3.7	732	(inwc)	
48	4.3	593	Offtake	101
54	4.7	427	Temperature	
60	5.1	238	(deg C)	
66	5.3	132		
72	5.5	116		
78	5.5	116		

RETORT TEMPERATURE AND PRESSURE PROBE DATA

TEST: BOM/FGT-009
DATE: 11/ 5/83
RETORT ACCESS PORT NUMBER:

COAL: BENTON LIGNITE
5

DATA: INCHES ABOVE GRATE	PRESSURE (inwc)	TEMPERATURE (deg C)	TIME (hrs)	1015	1020
	3.9	---	Blast Air (scfm)	1600	1600
6	3.9	---			
12	4.0	---			
18	4.3	---	Saturation Temperature (deg C)	69.0	67.0
24	5.9	---			
30	6.8	---			
36	7.5	1110			
42	9.2	982	Ashpit Pressure (inwc)	22.6	20.9
48	11.9	704			
54	13.2	454			
60	14.8	343			
66	15.8	266	Offtake Temperature (deg C)	205	233
72	16.0	266			
78	16.5	249			
84	16.5	243			

RETORT TEMPERATURE AND PRESSURE PROBE DATA

TEST: BOM/FGT-009 COAL: BENTON LIGNITE
 DATE: 11/ 6/83
 RETORT ACCESS PORT NUMBER: 5

DATA: INCHES ABOVE GRATE	PRESSURE (inwc)	TEMPERATURE (deg C)	TIME (hrs)	820	830
0	1.4	---	Blast Air	1000	1000
6	1.4	---	(scfm)		
12	1.9	---	Saturation	68.0	68.0
18	2.4	---	Temperature		
24	2.4	---	(deg C)		
30	2.9	---			
36	4.9	988	Ashpit	10.6	11.4
42	6.4	871	Pressure		
48	6.4	593	(inwc)		
54	6.9	171			
60	7.4	---	Offtake	93	68
66	7.4	88	Temperature		
72	7.7	104	(deg C)		
78	7.7	96			

RETORT TEMPERATURE AND PRESSURE PROBE DATA

TEST: BOM/FGT-009

COAL: BENTON LIGNITE

DATE: 11/ 8/83

RETORT ACCESS PORT NUMBER:

5

DATA: INCHES ABOVE GRATE	PRESSURE (inwc)	TEMPERATURE (deg C)	TIME (hrs)	1313	1320
0	3.8	---	Blast Air (scfm)	1400	1400
6	4.1	---			
12	4.5	---			
18	6.0	---	Saturation Temperature (deg C)	69.0	70.0
24	7.0	---			
30	9.5	610			
36	10.1	966			
42	11.0	682	Ashpit Pressure (inwc)	20.6	20.0
48	11.5	---			
54	11.5	593			
60	12.0	566			
66	12.0	166	Offtake Temperature (deg C)	145	148