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FIXED-BED GASIFICATION RESEARCH USING U.S. COALS, VOLUME 14 GASIFICATION OF KEMMERER SUBBITUMINOUS COAL

Contract H0222001

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 & Bryson, Incorporated of Houston, Texas under USBM contract number HO222001. 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 March-December 1984. This report was submitted by the authors May 1, 1985.

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The coal gasified during this test was donated by Utah Power and Light, Incorporated. The Electric Power Research Institute (EPRI) funded construction of the scaled up gas cooler/tar separator operated during this test. The EPRI funding was provided to Black, Sivalls and Bryson, Incorporated through EPRI contract number RP2656-1.

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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 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 is subcontractor to BS&B to monitor process parameters, and provide analysis for material inputs and outputs.

This report describes BOM/FGT-015, the gasification of Kemmerer subbituminous coal, and is the fourteenth volume of the contract final report prepared under contract H0222001. The report covers the test period August 11, 1984 to August 15, 1984.

Section 1 is a brief summary of the testing. Section 2 identifies the test objectives. Section 3 describes the fuel. Sections 4 and 5 describe the facility and monitoring systems. Sections 6 and 7 describe the test and results. Section 8 gives conclusions.

SECTION 1

TEST SUMMARY

Kemmerer subbituminous coal is a non-swelling, low sulfur, medium ash fusion temperature, subbituminous B coal mined in large quantities in southwest Wyoming. The coal's properties fill gaps in the gasification test objective matrix.

The coal was gasified in a 6.5 foot I.D. Wellman-Galusha atmospheric pressure, air-blown, fixed-bed gas producer. The hot, raw gas was partially cleaned of dust in a cyclone and incinerated in a cylindrical combustion chamber. The products of combustion were water-quenched, cleaned of particles and sulfur oxides in a wet caustic scrubber and exhausted.

A slipstream of the coal gas was cooled and cleaned of tar by a surface contact condenser and electrostatic precipitator. This gas cleaning system was scaled up from the successful gas sampling and conditioning system. The enlarged gas cooler/tar separator operated throughout the gasification of the Kemmerer subbituminous, but operation was restricted to low gas flows and was interrupted twice due to dust accumulations in the duct bringing dirty gas to the system. Approximately 140 pounds of tar and 70 pounds of aqueous condensate were collected throughout operation.

The coal gasified well throughout the test. Gas quality ranged from 165-175 Btu/dscf. Moderate throughputs were achieved. Throughput was not limited by the gasification process, but was limited by a leaking section in the gas duct leading to the combustion chamber. The throughput limitations of the gasifier were not investigated during this test. Table 1-1 gives data for gasification of this coal for a throughput of 1.54 ton/hour and a blast saturation temperature of 140 F (60 C).

Due to acceptably high throughputs achieved and high gas quality observed during this test, the Kemmerer subbituminous coal can be recommended as a single-stage, fixed-bed gasifier feedstock.

Table 1-1

Maximum Throughput Characteristics for Gasification
of Kemmerer Subbituminous Coal

Coal Throughput - 1.54 tons/hour (92.8 lb/hr/sq ft grate)		
Air/Coal	1.966	lb/lb
Steam/Coal	.304	lb/lb
Blast Saturation Temperature	140	deg F
Gas Offtake Temperature	752	deg F
Gas/Coal	51.7	scf/lb
Gas Dewpoint	131	deg F
Tar Yield	9.3	lb/100 lb coal
Tar Analysis		
HHV (dry)	16200	Btu/lb
Pourpoint	95	deg F
Viscosity (210 F)	63.7	SUS
Specific Gravity (60/60 F)	1.079	
Dry Gas Composition (mol%)		
Hydrogen	16.3	
Carbon Monoxide	29.7	
Methane	1.72	
Ethane	.157	
Ethylene	.119	
Propane	.033	
Propylene	.041	
Carbon Dioxide	4.98	
Nitrogen + Argon	46.6	
Water	8.44	lb/1000 dscf
Dry Gas HHV	173	Btu/dscf
Dry Gas LHV	163	Btu/dscf
Thermal Efficiencies		
Hot, Raw	95	%
Cold, with Tar	84	%
Cold, without Tar	70	%

SECTION 2

TEST OBJECTIVES

2.1 Selection of Coal for Testing

Kemmerer subbituminous coal is a subbituminous B coal mined in large quantities in southwestern Wyoming. Gasification of this coal expands the data base for fixed-bed gasification of subbituminous coals.

The coal was donated to the program by Utah Power and Light Company, which is considering the coal for gasification at an existing mine mouth power plant.

2.2 Operation of a Gas Cooler/Tar Separator

The notable success of the gas sampling and conditioning system (Section 4.2) in cooling and cleaning the raw gas, in previous tests, led to an effort to scale up the system by a factor of approximately 30. Details of this system are given in Volume 13 of this series by Thimsen, Maurer et al (1985). Operation of this system to clean a subbituminous coal gas was desirable in order to compare with the operation of the system cleaning a bituminous coal gas (Volume 13, Thimsen, Maurer et al, 1985).

Operation of this system would provide important information that could be used to scale the system up to treat the entire raw gas stream.

2.3 Test Objectives

- A. Identify maximum gasifier throughput and the limitations to throughput gasifying this friable subbituminous coal.
- B. Determine total product composition and conversion efficiency from gasification of this subbituminous B coal.
- C. Identify gasifier operational requirements for gasifying friable coals.
- D. Identify operational and performance characteristics of a gas cooler/tar separator scaled up from the gas sampling and conditioning system.
- E. Evaluate gasifier response to step changes in blast air flow.

2.4 Test Plan

The proposed test plan is shown in Figure 2-1. An initial coal bottom size of 1/2 inch is proposed with change to a bottom size of 1/4 inch should no operational problems be observed. Several load levels are shown for a coal bottom size of 1/4 inch.

Use of the agitator and establishment of optimum blast saturation temperature (steam/air ratio) were left to the facility manager's judgement, based on observed performance during the test. The grate spacings were 5-1/2 inches between the top and middle levels and 6 inches between the middle and bottom levels.

Figure 2-1

Proposed Test Plan, BOM/FGT-015

SECTION 3

DESCRIPTION OF FUEL GASIFIED

The Kemmerer coal gasified during BOM/FGT-015 is a subbituminous B coal mined by the Pittsburgh and Midway Coal Mining Company in Lincoln County, Wyoming. Figure 3-1 shows the location of the mine 5 miles southwest of Kemmerer, Wyoming. The coal is surface mined from the Adaville seam. Reserves within the current mining area are in excess of 100 million tons with annual production capacity of 4 million tons.

The coal gasified during this test was obtained from the delivery conveyor at Utah Power and Light's Naughton generating station which is located near the mine. 544 tons of Kemmerer coal were loaded onto rail cars on July 30, 1984 and arrived in the Twin Cities on August 6, 1984. 387 tons of coal screened at +1/4 inch at the unloading site were trucked 15 miles to the test site between August 8 & 14, 1984.

A complete analysis of the coal is given in Table 3-1. The location of this fuel in the coal test objective matrix is shown in Table 3-2.

Figure 3-1

Location of the Kemmerer Subbituminous Coal Mine

Table 3-1

Average Analysis of Kemmerer Subbituminous Coal

Proximate Analysis (wt%)

Volatile Matter	35.13
Fixed Carbon	42.44
Ash	5.67
Moisture	16.76
Sulfur	0.79

Heating Value	10513
---------------	-------

Ultimate Analysis (wt%)

Hydrogen	4.37
Carbon	60.11
Nitrogen	0.90
Sulfur	0.79
Oxygen	11.40
Ash	5.67
Moisture	16.76

Ash Fusion Temperatures (deg. F.)

	Oxidizing	Reducing
Initial Deformation	2245	2205
Softening	2330	2300
Hemispherical	2410	2380
Fluid	2535	2465

Table 3-2

Characteristics of Kemmerer Subbituminous Coal with
 Regard to the Coal Test Objective Matrix.

COAL TEST OBJECTIVE MATRIX									
PHYSICAL CHARACTERISTICS		COAL RANK							
TYPE	RANGE	BITUMINOUS	SUB-BITUMINOUS			LIGNITE	PEAT/BIO MASS	PETROLEUM COKE	BRIQUETTES
			A	B	C				
ASH CONTENT	H + 20%								
	M 10 - 20%								
	L - 10%			O15					
ASH FUSION	H + 2700 F								
	M 2300-2700 F			O15					
	L - 2300 F								
FREE SWELLING INDEX	H 3 +								
	M 1 - 3								
	L 0 - 1			O15					
MOISTURE CONTENT	H + 15%			O15					
	M 5 - 15%								
	L - 5%								
FRIABILITY (GRINDABILITY)	H								
	M			O15					
	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. Equipment installed specifically for this test is also described.

4.1 Test Facility

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

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

4.1.1 Gas Producer

The gas producer is a 6.5 foot I.D. 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 by controlling the temperature of the saturated steam/air mixture. Steam is imported if that generated in the water jacket is not adequate for the process.

4.1.2 Gas Combustor

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

4.2 Gas Sampling and Conditioning System

Figure 4-2 is a schematic of the gas sampling and conditioning

Figure 4-1

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

Figure 4-2

Schematic Diagram of the Gas Sampling and Conditioning System

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

4.3 Gas Analysis Equipment

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

Detailed gas composition is determined approximately every 20 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 HP5793 gas chromatograph by manual injection of grab samples. The principal features of the HP 5793 are given in Table 4-2.

4.4 Enlarged Gas Cooler/Tar Separator

The enlarged gas cooler/tar separator operated during this test is scaled up by a factor of approximately 30 from the gas sampling and conditioning system described in Section 4.2 and Volume 1 (Thimsen, Maurer et al, 1984) of this series. The enlarged gas cooler/tar scrubber is described in more detail in Volume 13 of this series (Thimsen, Maurer et al, 1985).

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

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

5.2 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 other 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 gas sampling and conditioning system accumulation reservoirs daily. Water collected in the surface condenser and 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 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 Retort Particle Sampling

Sampling of the gasifier offtake for particles is performed periodically as operating conditions permit.

5.2.8 Enlarged Gas Cooler and Tar Separator

The tar reservoir of the enlarged gas cooler and tar separator is drained into sealed 30 gallon drums approximately every 8 hours, or as needed.

5.2.9 Retort Temperature and Pressure Sampling

Vertical temperature and pressure profiles are taken at a single location periodically. The measurements are made at the end of relatively stable periods of operation just before operational changes are made.

SECTION 6

CONDUCT OF THE TEST

6.1 Gasifier Operation

BOM/FGT-015, gasification of Kemmerer subbituminous coal began at 1600 on August 11, 1984. Prior to this time BOM/FGT-014, gasification of Blind Canyon bituminous coal had been underway as described in Volume 13 of this series (Thimsen, Maurer et al, 1985). Figure 6-1 shows the history of the test. Coal for this test was screened at 1/2 inch prior to August 13. Thereafter, all coal was screened at 1/4 inch.

The most noticeable difference in operation of the gasifier when the Kemmerer coal replaced the Blind Canyon bituminous coal was the lack of "noise" observed in the NDIR carbon monoxide and carbon dioxide signals, the fire loss pressure and the offtake temperature. It is surmized that the noise observed in these signals during gasification of the bituminous coal was related to the agglomerating properties of the bituminous coal (Volume 13, Thimsen, Maurer et al, 1985). This is consistent with the lack of noise observed during gasification of the non-swelling subbituminous coal throughout this test.

Initial test conditions were a blast air flow of 800 cfm and blast saturation temperature (BST) of 60 C (140 F). These conditions were maintained until 0850, August 13, at which time the blast air flow was increased to 1200 cfm. A final increase in blast air flow to 1500 cfm occurred at 0830, August 14. At this blast air flow rate there was some gas leaking out of a duct section prior to the combustion chamber. Any attempts to increase blast air flow rate beyond this value produced unacceptable gas leaks. This problem is more fully described in Volume 13, Thimsen, Maurer et al (1985).

Throughout the test, the BST was maintained at 60 C (140 F). Early in the morning of August 13, some difficulty was encountered with the BST control and the actual BST wandered between 58.5 C (137 F) and 61.5 C (143 F) for a short period of time.

On August 15, two rapid drops in blast air flow from 1500 cfm to 600 cfm with corresponding rises back to 1500 cfm 1 hour later were undertaken to observe transient response of the gasifier.

The test was terminated at 2000 on August 15 due to high top gas pressure (9 in wc) and excessive gas leaking as described above. This high pressure was caused by dust accumulations in the horizontal duct leading to the combustion chamber. Coal consumption at 1500 cfm was 1.5 tons/hour. This does not represent the maximum throughput of this coal, however. Throughput (and gas flow) could, in all likelihood, be increased

Figure 6-1

Test History, BOM/FGT-015

further before gas channeling in the retort would occur.

Firetests taken during this test were mostly normal with few multiple zones. Ash removed contained 1 to 3 inch chunks that were friable. No clinkering was evident.

Substantial amounts of cyclone dust were collected. The plugging of the downstream ductwork indicated significant carryover of dust particles through the cyclone.

6.2 Gas Cooler/Tar Separator Operation

The enlarged gas cooler/tar separator described in Volume 13 of this series (Thimsen, Maurer et al, 1985) was operated for approximately 85 hours during the test.

The operation of the gas cooler/tar separator remained essentially unchanged when the gasifier feedstock was switched from Blind Canyon bituminous coal to Kemmerer subbituminous coal. The final gas temperature was maintained at 120-130 F (49-54 C). At this temperature, substantial quantities of aqueous condensate were collected along with the tar.

During the course of the test, the gas flow rate through the system had to be reduced due to pressures below atmospheric at the inlet to the condenser. A maximum gas flow of 4 dscfm was maintained. Inspection of the sampling nozzle, after the test, showed severe dust plugging which caused a large pressure drop, necessitating the reduced flow.

The system was shut down twice to inspect the high voltage insulator, which required cleaning once. The system was shut down for two periods during which attempts were made to clear the sampling nozzle.

A total of approximately 140 pounds of tar and 70 pounds of aqueous condensate was collected during the test. Samples of these materials were sent on behalf of the Electric Power Research Institute to the SRI, International, Menlo Park, California, Biomaterials Profiling Center, University of Utah, Salt Lake City, Utah, and the Alberta Research Council at Nisku, Alberta.

SECTION 7

TEST RESULTS

7.1 Data Summary

7.1.1 Continuous Output Transducers

The data acquisition system operated well throughout the test. There were no data gaps greater than 30 minutes.

Figure 7-1 shows the offtake temperature, fire loss pressure, and dry gas higher heating value, along with the gasifier operating parameters observed during the test period. At a low throughput, the offtake temperature was approximately 250 C (480 F). At medium throughput, the offtake temperature rose to approximately 400 C (750 F).

At the medium throughput, there was some wander in the offtake temperature and gas quality. An increase in offtake temperature was accompanied by a decrease in gas quality and vice versa. This indicates periods of poor reduction of the gas phase, possibly due to uneven gas flow distribution in the retort. Gas quality fell in the range of 165-175 Btu/dscf throughout the test.

Fire loss pressure was relatively steady and generally tracked the blast air flow.

On August 15, a series of rapid changes in blast air flow were undertaken to observe the transient response of the gasifier. The physical parameters measured during these step changes are shown in Figure 7-2. There was no change in blast saturation temperature controller setpoint during the blast air flow changes. The import steam controller responded fairly quickly to changes in blast air flow. The blast saturation temperature transients lasted no longer than about 2 minutes.

The offtake temperature was strongly affected by blast air flow. High flow corresponded to high offtake temperatures, while low air flow corresponded to lower offtake temperatures. The offtake temperature exhibited a first order response to step changes in blast air flow. The transient response lasted approximately 45 minutes on a drop in blast air flow and 30 minutes on a rise in blast air flow.

The NDIR carbon monoxide concentration rose on a drop in blast air flow and dropped on a rise in blast air flow. Exactly the opposite was true of the NDIR carbon dioxide concentration. The concentrations exhibit a first order response to step changes in blast air flow. The transient response lasted approximately 15 minutes. (The sudden drop in both of these concentrations during 9:15 to 9:45 corresponds to maintenance of the gas

Figure 7-1

Physical Characteristics of the Gasifier Operation.

Figure 7-2

Gasifier Response to Step Changes in Blast Air Flow.

sampling and conditioning system and dilution of the gas with air.)

7.1.2 Coal, Ash, and Dust Data

A complete list of the tests performed on the bulk coal, ash, and cyclone dust samples collected during BOM/FGT-015, together with the number of samples analyzed, is given in Table 7-1.

7.1.2.1 Coal Data

The mass fraction of coal less than each of the five indicated mesh sizes and the mean coal particle size are given in Figure 7-3. The feed coal size distribution averaged over the entire test is shown in Figure 7-4. Prior to the morning of August 13, a 1/2 inch mesh screen was used to remove undersized coal. During this period approximately 20% of the coal leaving the weigh bin was less than 1/2 inch. As no screening difficulties were observed during this period, the undersize fraction was probably generated in transit from the screen to the weigh bin outlet.

After August 13, a 1/4 inch bottom size screen was used to remove undersize material. This resulted in a significant increase in -1/2 inch coal and a slight decrease in geometrical mean size.

The results of the physical and chemical analysis of a single Kemmerer coal sample composited over the entire test period are 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 geometrical mean ash particle size are shown in Figure 7-5. The geometrical mean ash particle size fluctuated between 0.5 inches and 0.9 inches.

Figure 7-6 shows the physical and chemical characteristics of the ash along with gasifier operating parameters. The ash bulk density ranged from 0.7 to 0.95 gm/cc (dry basis), ash sulfur content was approximately 0.2%, ash carbon content was approximately 6% after an initial period near 10%. The resolution of the ash data does not allow an analysis of trends.

Table 7-3 gives the chemical analysis of a single ash sample composited over the entire test period. The ash is high in silicon and aluminum, with moderate amounts of calcium and magnesium.

7.1.2.3 Cyclone Dust Data

The chemical analyses of a single cyclone dust sample composited from 4 samples collected over the entire test period is given in

Table 7-1

Summary of Coal, Ash and Cyclone Dust Analyses

Material Analyzed	Type of Analysis	Number of Samples Collected and	Number of composite Samples Analyzed
Coal	Particle size distribution	12	---
	Proximate analysis	---	1
	Ultimate analysis	---	1
	Ash fusion temperature	---	1
	Free swelling index	---	1
Ash	Particle size distribution	12	---
	Bulk density	12	---
	Moisture content	12	---
	Carbon content	12	1
	Sulfur content	12	1
	Chemical analysis	---	1
Cyclone Dust	Proximate analysis	---	1(**)
	Ultimate analysis	---	1(**)

(**) Composite from 4 cyclone dust samples.

Figure 7-3

Feed Coal Size Distribution Analysis and
Geometrical Mean Coal Size.

Figure 7-4

Average Particle Size Distribution of Feed Coal.

Table 7-2

Physical and Chemical Properties of Coal and Cyclone Dust

Material ----- Type of Analysis (*) -----	Coal -----	Cyclone Dust (**) -----
Proximate Analysis, wt % :		
Moisture	16.76	---
Volatile Matter	35.13	17.86
Ash	5.67	26.43
Fixed Carbon (**)	42.44	55.71
Ultimate Analysis, wt % :		
Hydrogen	4.37	2.40
Carbon	60.11	65.80
Nitrogen	0.90	0.86
Sulfur	0.79	1.05
Oxygen (**)	11.40	3.45
Ash	5.67	26.43
Moisture	16.76	---
Heating Value, Btu/lb :		
As Received	10513	---
Moisture Free	12630	10686
Ash Fusion Temp. Deg F:		
(Oxidizing Atmosphere)		
Initial Def., IT	2245	---
Softening, ST	2330	---
Softening, HT	2410	---
Fluid, FT	2535	---
(Reducing Atmosphere)		
Initial Def., IT	2205	---
Softening, ST	2300	---
Softening, HT	2380	---
Fluid, FT	2465	---
Free Swelling Index	0	---

(*) All values as received unless otherwise noted.

(**) By difference.

Figure 7-5

Ash Size Distribution Analysis and
Geometrical Mean Ash Particle Size.

Figure 7-6

Ash Characteristics and Operating Conditions.

Table 7-3

Elemental Analysis of Moisture-Free Ash

Element	Mass Fraction, % (**)
Fe	3.00
Fe(2+)	.70
Si	26.10
Al	10.50
C	3.40
Ca	6.30
Mg	1.50
K	.45
P	.16
Na	.42
S	.16
Ti	.44

(**) Unaccounted for mass is presumed to be oxygen included in metal oxides.

Table 7-2. The analyses shown are on a dry basis, as the sample passes through a water seal and is dried prior to analysis.

The volatile matter to fixed carbon ratio of the cyclone dust is only 39% that of the feed coal. This is consistent with partial devolatilization of the coal dust in the higher temperatures of the offtake duct and the cyclone. This partial devolatilization is not adequate to explain the dry basis increase in ash content of the cyclone dust compared to the feed coal. The ash to fixed carbon ratio of the dust is three and a half times the ash to fixed carbon ratio of the feed coal. High ash materials are, apparently, preferentially blown over. These materials may come from the lower region of the retort where some fixed carbon has been lost to the gas phase through gasification.

7.1.3 Gas Analysis Data

There are two periods of time, during which HP5880A chromatograph data are not available. The first period is from approximately 2300 on August 12 to 1830 on August 13. During this period, a valve on the gas chromatograph failed and was repaired. The second period was from 2330 on August 14 to 0800 on August 15. Operator errors caused this loss of data.

The concentrations of the major gas species are shown in Figure 7-7. These concentrations along with gas heating value, offtake temperature, and operating parameters are shown in Figure 7-8. The only apparent trend is that gas heating value, hydrogen and carbon monoxide concentrations rose along with a fall in carbon dioxide concentration when the blast air flow was increased on August 14. Otherwise, the major gas species concentrations appear relatively steady.

The hydrocarbon concentrations in the gas are shown in Figure 7-9. Ethylene and propylene concentrations rose on August 13-15. This is consistent with hydrocarbon cracking at the higher gas temperatures observed during this period.

The gas phase sulfur species were measured using hand-injected, syringe samples. These data are shown in Figure 7-10. As these samples were injected by hand, the total quantity of gas varied from injection to injection. The normalized gas phase sulfur concentrations are reported here along with the total gas phase sulfur measured. Mercaptan concentrations amounted to approximately 9% of the gas phase sulfur, as did carbonyl sulfide concentrations. The bulk of the gas phase sulfur (>80%) appeared as hydrogen sulfide. Total gas phase sulfur was approximately 2600 ppmv.

7.1.4 Tar and Water Yield Data

The gas sampling and conditioning system operated through the whole test with three short periods out of service for cleaning and collection of a special tar sample (see Section 7.6). Total

Figure 7-7

Major Gas Species Measured by the Gas Chromatograph.

Figure 7-8

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

Figure 7-9

Minor Gas Species Measured by the Gas Chromatograph.

Figure 7-10

Sulfur Species Measured by the Gas Chromatograph.

time during which clean gas samples were unavailable to the analyzers was less than 2 hours.

The daily average condensate loadings, along with gasifier operating parameters are shown in Figure 7-11. The decreasing condensate loadings, as the test progressed, may be related to the rise in offtake temperature. The data, however, lacks the resolution to make strong conclusions in this matter.

A single sample, composited from the 4 samples collected during the course of the test, was submitted for analysis. The results of these analyses are shown in Table 7-4.

7.2 Material and Energy Balances

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

The measured data to calculate balances around the gasifier include process temperatures, pressures, coal flow, condensate and dust loadings, and material analyses.

While relative measurements of gas phase sulfur species are made, the total sulfur loading in the gas is calculated from the coal sulfur content, coal rate, ash sulfur content, ash rate, dust sulfur content, dust rate, tar/oil sulfur content and tar/oil rate. Sulfur species concentrations reported are obtained by normalizing GC data to the total sulfur loading in the gas as calculated by difference. 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 and a blast saturation temperature (blast steam/air ratio). Tables 7-5 to 7-7 show the results of the calculations. Table 7-8 shows the results of the calculations over the entire test period.

Tables 7-5 and 7-6 include portions of a time period for which no gas analysis data is available. Gas composition data is, however, available for parts of the material and energy balance calculation time periods. This data is assumed to represent gas composition over the entire calculation time period.

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 7-11

Tar/Oil Yield and Water Yield with Operating Conditions.

Table 7-4
Condensed Material Analysis

Water

Total Organics, %	1.51		
-------------------	------	--	--

Tar (As received)

Heating Value, btu/lb (**)	14448	(16199)	14105	(16971)
Flash point, Deg. F	212		208	
Water by distillation, %	10.81		16.89	
Specific gravity, 60/60 Deg. F	1.079		0.972	
Pour point, Deg. F	95		95	
Cold (solid) point, Deg. F	90		90	

Viscosity at :

122 Deg. F Saybolt Furol, Sec.	107.6	---
122 Deg. F Kinematic, centistoks	227.3	---
210 Deg. F Saybolt Universal, Sec.	63.7	---
210 Deg. F Kinematic, centistoks	11.3	---

Ultimate Analysis, WT% (**)

Hydrogen	7.62	(8.54)	8.47	(10.19)
Carbon	73.88	(82.83)	71.31	(85.80)
Nitrogen	0.62	(0.70)	0.34	(0.41)
Oxygen (by difference)	6.52	(7.31)	2.60	(3.13)
Sulfur	0.49	(0.55)	0.36	(0.43)
Moisture (total)	10.81		16.89	
Ash	0.06	(0.07)	0.03	(0.04)
Sediment (solids)	0.63	(0.71)	0.32	(0.39)

(**) Dry basis values in parentheses

Table 7-5

Material Balance and Thermal Efficiency Calculation
0.83 tn/hr, 139 F

Input Data

Time period: 8/12/84 0:00 - 8/13/84 8:00 (32.0 hours)

Gasifier Operation:		Coal Data:	
Coal feed, Ton/hour	= 0.83	Type	= Kemmerer
Blast air flow (dry) , Scfm	= 793.	Mass Fraction Carbon	% = 60.1
Saturated air temperature, F	= 139.	Mass Fraction Fixed Carbon	= 42.44
Steam/Air Ratio (lb./lb.)	= 0.15	Mass Fraction Moisture	% = 16.76
Ambient air temperature, F	= 70.	Mass Fraction nitrogen	% = 0.90
Off-take temperature, F	= 449.	Mass Percent sulfur	= 0.79
		Heating value, Btu/lb	= 10513

Tar and Water Yield (dry basis):		Ash and Dust Data:(dry basis)	
Water yield, lb./1000 SCF	= 8.64	Ash discharge ,lb/hour	= 10.
Tar yield, lb/1000 SCF	= 2.05	Ash carbon ,percent	= 9.4
Carbon in Tar (percent)	= 82.8	Ash sulfur ,percent	= 0.22
Sulfur in Tar (percent)	= 0.55	Ash moisture (wet),percent	= 23.4
Tar HHV, thou. Btu/lb	= 16.20	Cyclone dust,lb/hour(est.)	= 4.

Gas Composition (Dry): (normalized to 99.90)

H2	% = 16.5	CH4	% = 1.82	H2S	(est ppm) = 1639
CO	% = 29.3	C2H4	% = 0.041	COS	(est ppm) = 167
CO2	% = 5.51	C2H6	% = 0.144	CH3SH	(est ppm) = 123
N2	% = 45.8	C3H6	% = 0.021	C2H5SH	(est ppm) = 16
O2	% = 0.00	C3H8	% = 0.041	HHV,	Btu/SCF = 172
Molec. Weight= 24.25		Argon(est. %)= 0.545		LHV,	Btu/SCF = 162

Calculation Results (based on nitrogen and carbon balance)

Material Balance (Percent unaccounted for: -2.91)

Input,	lb/hr	% Total	Output,	lb/hr	% Total
Coal	= 1663.	30.7	Dry gas	= 4688.	84.0
Steam (total)	= 492.	9.1	Water in gas	= 634.	11.4
Air(calc,dry)	= 3266.	60.2	Oil and tar	= 150.	2.7
			Ash(calc,dry)	= 103.	1.8
			Dust	= 4.	0.1
Total	= 5421.		Total	= 5579.	

Energy Balance (Percent unaccounted for: 4.36)

Input,	MM BTU/hr	Output,	MM Btu/hr	% Total
Coal	= 17.5	Dry coal gas	= 12.6	72.9
Air	= 0.008	Oil and tar	= 2.44	14.1
Steam(import)	= 0.533	Sensible	= 0.67	3.8
Cooling water	= 0.055	Latent	= 0.684	4.0
		Ash	= 0.139	0.8
		Dust	= 0.040	0.2
		Cooling water	= 0.718	4.2
Total	= 18.1	Total	= 17.3	

Performance Data

Cold gas efficiency,	percent = 69.8
Cold gas with tar efficiency,	percent = 83.2
Hot gas without tar efficiency	percent = 76.9
Hot gas with tar efficiency,	percent = 90.6
Air/Coal	(lb./lb.) = 1.963
Steam/Coal	(lb./lb.) = 0.296
Air/Fixed Carbon	(lb./lb.) = 4.626
Coal/Gasifier Area	(lb./hr./sqft) = 50.1
Fixed Carbon/Area	(lb./hr./sqft) = 21.3
Producer Gas/Coal	(SCF/lb.) = 52.2
Producer Gas/Fixed Carbon	(SCF/lb.) = 123.1
Tar Yield	(lb./lb. coal) = 0.090

Table 7-6

Material Balance and Thermal Efficiency Calculation
1.13 tn/hr, 139 F

Input Data

Time period: 8/13/84 9:00 - 8/14/84 8:00 (23.0 hours)

Gasifier Operation:

Coal feed, Ton/hour = 1.13
Blast air flow (dry) , Scfm = 1190.
Saturated air temperature, F = 139.
Steam/Air Ratio (lb./lb.) = 0.15
Ambient air temperature, F = 71.
Off-take temperature, F = 861.

Coal Data:

Type = Kemmerer
Mass Fraction Carbon % = 60.1
Mass Fraction Fixed Carbon = 42.44
Mass Fraction Moisture % = 16.76
Mass Fraction nitrogen % = 0.90
Mass Percent sulfur = 0.79
Heating value, Btu/lb = 10513

Tar and Water Yield (dry basis):

Water yield, lb./1000 SCF = 8.06
Tar yield, lb./1000 SCF = 1.82
Carbon in Tar (percent) = 82.8
Sulfur in Tar (percent) = 0.55
Tar HHV, thou. Btu/lb = 16.20

Ash and Dust Data:(dry basis)

Ash discharge ,lb/hour = 35.
Ash carbon ,percent = 5.9
Ash sulfur ,percent = 0.22
Ash moisture (wet), percent = 13.1
Cyclone dust, lb/hour (est.) = 20.

Gas Composition (Dry): (normalized to 99.90)

H2 % = 16.3	CH4 % = 1.79	H2S (est ppm) = 1612
CO % = 29.5	C2H4 % = 0.101	COS (est ppm) = 164
CO2 % = 4.96	C2H6 % = 0.161	CH3SH (est ppm) = 121
N2 % = 46.3	C3H6 % = 0.050	C2H5SH (est ppm) = 15
O2 % = 0.00	C3H8 % = 0.040	HHV, Btu/SCF = 173
Molec. Weight = 24.23	Argon (est. %) = 0.551	LHV, Btu/SCF = 163

Calculation Results (based on nitrogen and carbon balance)

Material Balance (Percent unaccounted for: -1.24)

Input,	lb/hr	% Total	Output,	lb/hr	% Total
Coal	= 2257.	30.1	Dry gas	= 6451.	84.9
Steam (total)	= 699.	9.3	Water in gas	= 814.	10.7
Air (calc, dry)	= 4551.	60.6	Oil and tar	= 184.	2.4
			Ash (calc, dry)	= 131.	1.7
			Dust	= 20.	0.3
Total	= 7507.		Total	= 7600.	

Energy Balance (Percent unaccounted for: 1.35)

Input,	MM BTU/hr	Output,	MM Btu/hr	% Total
Coal	= 23.7	Dry coal gas	= 17.5	72.3
Air	= 0.011	Oil and tar	= 2.98	12.3
Steam (import)	= 0.757	Sensible	= 1.93	8.0
Cooling water	= 0.059	Latent	= 0.878	3.6
		Ash	= 0.112	0.5
		Dust	= 0.216	0.9
		Cooling water	= 0.603	2.5
Total	= 24.6	Total	= 24.2	

Performance Data

Cold gas efficiency, percent = 71.3
Cold gas with tar efficiency, percent = 83.4
Hot gas without tar efficiency percent = 82.0
Hot gas with tar efficiency, percent = 94.8
Air/Coal (lb./lb.) = 2.016
Steam/Coal (lb./lb.) = 0.310
Air/Fixed Carbon (lb./lb.) = 4.750
Coal/Gasifier Area (lb./hr./sqft) = 68.0
Fixed Carbon/Area (lb./hr./sqft) = 28.9
Producer Gas/Coal (SCF/lb.) = 52.5
Producer Gas/Fixed Carbon (SCF/lb.) = 123.6
Tar Yield (lb./lb. coal) = 0.081

Table 7-7

Material Balance and Thermal Efficiency Calculation
1.54 tn/hr, 140 F

Input Data

Time period: 8/14/84 9:00 - 8/15/84 17:00 (32.0 hours)

Gasifier Operation:		Coal Data:	
Coal feed, Ton/hour	= 1.54	Type =	Kemmerer
Blast air flow (dry) , Scfm	= 1407.	Mass Fraction Carbon	% = 60.1
Saturated air temperature, F	= 140.	Mass Fraction Fixed Carbon	= 42.44
Steam/Air Ratio (lb./lb.)	= 0.15	Mass Fraction Moisture	% = 16.76
Ambient air temperature, F	= 80.	Mass Fraction nitrogen	% = 0.90
Off-take temperature, F	= 752.	Mass Percent sulfur	= 0.79
		Heating value, Btu/lb	= 10513

Tar and Water Yield (dry basis):-		Ash and Dust Data:(dry basis)	
Water yield, lb./1000 SCF	= 8.44	Ash discharge ,lb/hour	= 88.
Tar yield, lb./1000 SCF	= 2.13	Ash carbon ,percent	= 3.4
Carbon in Tar (percent)	= 82.8	Ash sulfur ,percent	= 0.18
Sulfur in Tar (percent)	= 0.55	Ash moisture (wet),percent	= 11.5
Tar HHV, thou. Btu/lb	= 16.20	Cyclone dust,lb/hour(est.)	= 31.

Gas Composition (Dry): (normalized to 99.90)			
H2	% = 16.3	CH4	% = 1.72
CO	% = 29.7	C2H4	% = 0.119
CO2	% = 4.98	C2H6	% = 0.157
N2	% = 46.1	C3H6	% = 0.041
O2	% = 0.00	C3H8	% = 0.033
Molec. Weight	= 24.24	Argon(est. %)	= 0.549
		H2S (est ppm)	= 1636
		COS (est ppm)	= 166
		CH3SH (est ppm)	= 122
		C2H5SH (est ppm)	= 16
		HHV, Btu/SCF	= 173
		LHV, Btu/SCF	= 163

Calculation Results (based on nitrogen and carbon balance)

Material Balance (Percent unaccounted for: -1.77)

Input,	lb/hr	% Total	Output,	lb/hr	% Total
Coal	= 3089.	30.6	Dry gas	= 8645.	84.1
Steam (total)	= 937.	9.3	Water in gas	= 1141.	11.1
Air(calc,dry)	= 6073.	60.1	Oil and tar	= 288.	2.8
			Ash(calc,dry)	= 173.	1.7
			Dust	= 31.	0.3
Total	= 10099.		Total	= 10278.	

Energy Balance (Percent unaccounted for: 2.22)

Input,	MM BTU/hr	Output,	MM Btu/hr	% Total
Coal	= 32.5	Dry coal gas	= 23.4	71.9
Air	= 0.036	Oil and tar	= 4.67	14.3
Steam(import)	= 0.765	Sensible	= 2.25	6.9
Cooling water	= 0.055	Latent	= 1.234	3.8
		Ash	= 0.087	0.3
		Dust	= 0.330	1.0
		Cooling water	= 0.592	1.8
Total	= 33.3	Total	= 32.6	

Performance Data

Cold gas efficiency,	percent = 70.3
Cold gas with tar efficiency,	percent = 84.3
Hot gas without tar efficiency	percent = 80.0
Hot gas with tar efficiency,	percent = 94.6
Air/Coal	(lb./lb.) = 1.966
Steam/Coal	(lb./lb.) = 0.304
Air/Fixed Carbon	(lb./lb.) = 4.633
Coal/Gasifier Area	(lb./hr./sqft) = 93.1
Fixed Carbon/Area	(lb./hr./sqft) = 39.5
Producer Gas/Coal	(SCF/lb.) = 51.7
Producer Gas/Fixed Carbon	(SCF/lb.) = 121.9
Tar Yield	(lb./lb. coal) = 0.093

Table 7-8

Material Balance and Thermal Efficiency Calculation
Kemmerer Overall Average

Input Data

Time period: Overall Average (87.0 hours)

Gasifier Operation:

Coal feed, Ton/hour = 1.17
 Blast air flow (dry) , Scfm = 1124.
 Saturated air temperature, F = 139.
 Steam/Air Ratio (lb./lb.) = 0.15
 Ambient air temperature, F = 75.
 Off-take temperature, F = 704.

Coal Data:

Type = Kemmerer
 Mass Fraction Carbon % = 60.1
 Mass Fraction Fixed Carbon = 42.44
 Mass Fraction Moisture % = 16.76
 Mass Fraction nitrogen % = 0.90
 Mass Percent sulfur = 0.79
 Heating value, Btu/lb = 10513

Tar and Water Yield (dry basis):

Water yield, lb./1000 SCF = 8.38
 Tar yield, lb/1000 SCF = 2.02
 Carbon in Tar (percent) = 82.8
 Sulfur in Tar (percent) = 0.55
 Tar HHV, thou. Btu/lb = 16.20

Ash and Dust Data:(dry basis)

Ash discharge ,lb/hour = 45.
 Ash carbon ,percent = 4.5
 Ash sulfur ,percent = 0.19
 Ash moisture (wet),percent = 13.1
 Cyclone dust,lb/hour(est.) = 17.

Gas Composition (Dry): (normalized to 99.90)

H2 % = 16.4	CH4 % = 1.77	H2S (est ppm) = 1629
CO % = 29.5	C2H4 % = 0.094	COS (est ppm) = 166
CO2 % = 5.11	C2H6 % = 0.155	CH3SH (est ppm) = 122
N2 % = 46.1	C3H6 % = 0.038	C2H5SH (est ppm) = 15
O2 % = 0.00	C3H8 % = 0.037	HHV, Btu/SCF = 173
Molec. Weight = 24.24	Argon(est. %) = 0.549	LHV, Btu/SCF = 163

Calculation Results (based on nitrogen and carbon balance)

Material Balance (Percent unaccounted for: -1.93)

Input,	lb/hr	% Total	Output,	lb/hr	% Total
Coal	= 2345.	30.4	Dry gas	= 6624.	84.3
Steam (total)	= 712.	9.2	Water in gas	= 869.	11.1
Air(calc,dry)	= 4649.	60.3	Oil and tar	= 210.	2.7
			Ash(calc,dry)	= 134.	1.7
			Dust	= 17.	0.2
Total	= 7705.		Total	= 7854.	

Energy Balance (Percent unaccounted for: 2.80)

Input,	MM BTU/hr	Output,	MM Btu/hr	% Total
Coal	= 24.6	Dry coal gas	= 17.9	72.4
Air	= 0.016	Oil and tar	= 3.40	13.7
Steam(import)	= 0.762	Sensible	= 1.59	6.4
Cooling water	= 0.056	Latent	= 0.939	3.8
		Ash	= 0.088	0.4
		Dust	= 0.185	0.7
		Cooling water	= 0.649	2.6
Total	= 25.5	Total	= 24.8	

Performance Data

Cold gas efficiency, percent = 70.3
 Cold gas with tar efficiency, percent = 83.7
 Hot gas without tar efficiency percent = 79.6
 Hot gas with tar efficiency, percent = 93.5
 Air/Coal (lb./lb.) = 1.983
 Steam/Coal (lb./lb.) = 0.304
 Air/Fixed Carbon (lb./lb.) = 4.671
 Coal/Gasifier Area (lb./hr./sqft) = 70.7
 Fixed Carbon/Area (lb./hr./sqft) = 30.0
 Producer Gas/Coal (SCF/lb.) = 52.1
 Producer Gas/Fixed Carbon (SCF/lb.) = 122.9
 Tar Yield (lb./lb. coal) = 0.089

Figure 7-12 shows the experimental data points and the theoretical prediction. The model underpredicts performance of the grate in this test, but the data shows considerable scatter.

Some of the scatter is due to intermittent operation of the grate, and operation of the grate at low speed. (These operational procedures were necessary due to the wider grate spacings used during gasification of the Blind Canyon bituminous coal immediately prior to this test (Volume 13, Thimsen, Maurer et al, 1985). The Blind Canyon coal has a relatively higher ash content.)

7.4 Tar Yield Correlations

The overall tar yield measured during the gasification of Kemmerer subbituminous averaged 8.9 lb/100 lb wet feed coal. This value ranged from 8.1 to 9.3 lb/100 lb. The Fischer-Schrader Assay tar/oil yield correlations described by Ode and Selvig (1944) and Gomez et al (1958) have predicted tar/oil yields from past gasification tests in this series within acceptable error bounds.

There is no Fischer-Schrader Assay available for the Kemmerer sub-bituminous coal gasified during this test. As can be seen from Figures 7-13 and 7-14, the correlations of Fischer Assay tar/oil yields of similar coals predict a tar/oil yield of 9.2 to 10.0 lb/100 lb coal (as gasified). The tar/oil yield measured during the gasification of Kemmerer subbituminous coal is well within the scatter of the correlations.

7.5 Retort Sampling

Total particle mass loadings leaving the retort were measured twice during the test. The procedures are described in Volume 1 of this series (Thimsen, Maurer et al, 1984).

A total of 9 sampling runs at two different sets of gasifier operating conditions were made. Six sets of valid data were collected. Some tar was collected along with the dust. The total solid dust yield is taken as the acetone insoluble portion of the filtrate. The data are shown in Appendix G.

Figure 7-15 shows the total particle mass as a function of face velocity and gas flow. The face velocity is calculated by dividing the actual gas flow by the area of the annulus, through which the gas must flow at the top of the retort. The data are somewhat anomalous, and not like similar data sets taken during previous tests. They indicate a decrease in dust yield as gas flow increases. This is counter intuitive. However, the resolution in the data is not adequate to draw conclusions. The average dust yield was 1.8 lb/100 lb coal (as gasified). This is the yield used in the material and energy balance

Figure 7-12

Comparison of the Geometrical Grate Performance Model
with Ash Removal Rates

Figure 7-13

Tar/Oil Yield Correlation with Volatile Matter, Oxygen.

Reference: Ode and Selvig (1944)

Figure 7-14

Tar/Oil Yield Correlation with Volatile BTU.

Reference: Gomez et al (1958)

Figure 7-15

Dust Carryover vs. Gas Face Velocity.

calculations.

Two of the dust samplings representing blast air flow rates of 790 and 1500 dscfm respectively were analyzed for cumulative particle size distribution. These data are shown in Appendix G. The two samples show nearly identical size distributions with mass median diameters near 100 um. The seive data were shifted to account for the square screen mesh holes. The shifted size distributions were fitted well by bimodal size distribution functions. The larger mode was 150-200 um. The smaller mode was 13-30 um.

7.6 Enlarged Gas Cooler/Tar Separator

A single tar sample composited over all of the tar collected by the gas cooler/tar separator was submitted for the same analyses performed on the tar sample from the gas sampling and conditioning system. The results of these analyses are shown in Table 7-4.

The analyses obtained from this sample are similar to those obtained from the gas sampling and conditioning system tar sample, but significant differences are present. The gas cooler/tar separator tar is slightly higher in dry basis heating value and dry basis ultimate hydrogen and carbon, while being correspondingly lower in dry basis ultimate oxygen. The specific gravity was also less than 1, whereas the tar collected in the gas sampling and conditioning system has specific gravity greater than 1. It is not possible to estimate the significance of these differences, based on these single analyses.

A fresh tar sample from the gas sampling and conditioning system was collected on August 14, frozen in dry ice, and sent on behalf of EPRI to:

Biomaterials Profiling Center
University of Utah
Salt Lake City, Utah

The tar collected by the gas cooler/tar separator was sent on behalf of EPRI to:

Alberta Research Council
Nisku, Alberta

SRI, International
Menlo Park, California

SECTION 8

CONCLUSIONS

1. The highest throughput observed during this test was 1.54 tons/hour (92.8 lb/hr/sq ft grate) for a period of 30 hours. The throughput was limited by the ability of the induced draft fan to keep the gas duct pressure just upstream of the gas burner below atmospheric pressure. Attempts to raise throughput beyond this level resulted in unacceptable gas emissions from a leak in the gas duct at this point. There were no indications that excessive gas channeling, ash clinkering or degradation of product gas quality were occurring at this throughput.
2. At the 1.54 tons/hour throughput and a blast saturation temperature of 140 F (60 C), the following material and energy flows can be expected:

Material In (lb/lb coal)		Energy In (million Btu/hour)	
Air.....	1.97	Coal.....	32.5
Steam.....	0.304	Steam (Import).....	0.765

Material Out (lb/lb coal)		Energy Out (million Btu/hour)	
Dry Gas.....	2.80	Dry Gas.....	23.4
Tar/Oil.....	0.093	Tar/Oil.....	4.6
Water Vapor.....	0.369	Sensible/Latent (gas)	3.5
Dust.....	0.010	Dust.....	0.33
Ash.....	0.056	Ash.....	0.09
		Cooling Water.....	0.59
		Unaccounted for.....	0.7

3. The average tar/oil yield over the entire test period was 8.9 lb/100 lb coal (as gasified). This represents 14% of the energy in the coal.
4. A blast saturation temperature of 60 C (140 F) was used successfully throughout the test.
5. Use of the agitator was not required except to occasionally level the bed.
6. Measurements of dust loading in the product gas averaged approximately 1.8 lb/100 lb coal (as gasified).
7. The gas cooler/tar separator, which was scaled up from the gas sampling and conditioning system, performed according to design. The slipstream sampling nozzle leading to the gas cooler/tar separator clogged with dust during the test.

8. The tar collected by the gas cooler/tar separator was of slightly higher quality than that collected by the gas sampling and conditioning system, based on a single analysis of each tar.
9. Further testing should seek to identify the maximum throughput allowable, based on the gasification process limitations and investigate the limits to blast saturation temperature.
10. Based on this test, the Kemmerer subbituminous coal can be recommended as a fixed-bed gasifier fuel. Acceptably high throughputs were achieved with high gas quality and conversion efficiency.

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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.

Note: Grate speeds are referred to as:

"gear teeth engaged per stroke/Grate RPD
Day per gear tooth engaged"

Grate speed is the multiple of these two numbers.

TESTLOG

BOM/FGT 015 KEMMERER

AUGUST 11, 1984

- 1600 Kemmerer coal has been dropped into the retort. Fire test ash average is 11.6 inches. Double zones were evident on hole number 7.
- 1615 Increased the saturation air flow to 800 cfm. Gas supply pressure is .9 inch wc. No obvious leaks are noticeable. The secondary air flow is at 20%. The primary air flow is 3900 cfm. Furnace pressure is at 50%.
- 1635 Increased the grate speed to 4/0.60. The ESP unit is back on line.
- 1700 Increased the grate speed to 4/0.75.
- 1715 The offtake temperature is 140 C.
- 1720 Cyclone dump.
- 1740 The pH is 5.0 or slightly less. Increased the caustic pumps to 40/40 and will check it again soon. The Kemmerer appears to be 50% fines, we may need additional screening on this coal.
- 1800 Fire test ash average is 16.1 inches. Leaving the grate at 4/0.75.
- 1810 Started loading coal into the weigh bin at 4.8 tons.
- 1820 Cyclone dump produced one scoop of fine material.
- 1825 CO is 28% and CO2 is 6.5%. The offtake temperature is 136 C. The gas supply pressure is .6 inch wc. Higher heating value is 178 BTU/ft³.
- 1830 Dropped another 1.24 tons.
- 1845 The pH is back to 6.5.
- 1900 Keeping the grate speed at 4/0.75, since checking the number 2 & 5 holes got readings of 11" and 14" respectively.
- 2000 Fire test ash average is 11 inches. All bars came out wet. Bars number 1 & 6 needed to be pounded in about 3/4 the way down. Slowed the grate to 4/0.6.
- 2010 Dumped 906 pounds of dry ash. There were a few softball size clinkers.
- 2035 Started loading coal into the weigh bin again at 6.47 tons.

- 2100 Checked the ash level by putting in bars number 1 & 4 and got readings of 10" and 16" respectively.
- 2130 Dropped 1.03 tons during this coal feed. Cycled the coal valve twice.
- 2200 Fire test ash average is 9.6 inches. Had to use the sledge on bars number 3 & 5. Slowed the grate to 4/0.45.
- 2235 The offtake temperature is up to 160 C. Gas supply pressure is 0.7 inch wc. Higher heating value is 177 BTU/ft³.
- 2300 Saturation air flow is 800 cfm. Saturation temperature is 60 C. The grate speed is 4/0.45. The fines pile is growing.

August 12, 1984

- 0000 Fire test ash average is 6.4 inches. This time we got 3 zero readings! The rods went in easily except for numbers 1 & 6. These had to be persuaded with a sledge hammer from the 3 foot level.
- 0015 Decided to turn off the grate and recheck the holes which had measured 0 in an hour. The pH is 6.0 with the smaller pump shut off and the larger pump running at 40/40. Dumped 573 pounds of ash. The ash seems somewhat damp and light gray in color. The size is generally 1" or smaller with a few clinkers 4 inches in diameter. The ESP operator has just informed me that they are back on line after a period of shut down. Gas supply pressure is 0.8 inch wc. During fire testing it rises to 1.4 inches wc. The leakage only appears to be a problem when the gas supply pressure rises to over 1.0 inch wc.
- 0100 Rechecked the 3 zero holes from the earlier fire test. Now they are reading between 8 & 9 inches. Will leave the grate off for about another 45 minutes.
- 0145 Restarted the grate and set it at 4/0.40. Higher heating value is 174 BTU/ft³. CO is 29% and CO₂ is 4.7%.
- 0200 Fire test ash average is 10.4 inches. This time there were no zero holes. There were no multiple zones. Leaving the grate speed at 4/0.4 until the 0400 fire test. The grate had been off for 1.5 hours.
- 0250 Happened to glance at the ash weight indicator and noticed that there had been no climb in the cone weight. Went to investigate and found the upper valve to be closed. Corrected the situation. The ash weight jumped from 134 pounds to 193 pounds. The lights on the control panel did not give any indication that any of the valves were in the

wrong position. Ran the grate at 4/0.80 for 10 minutes.

0300 Returned the grate speed to 4/0.40. No significant addition to the ash weight was noticed.

0330 The ash weight is now reading 260 pounds. Have averaged 0.98 tons per hour on the last 5 coal drops.

0400 The gas supply pressure is 0.5 inches. This fire test shows the bed to be more even. The ash average is 8.6 inches. All bars went in easily this time. Leaving the grate speed at 4/0.4.

0410 Flushed the cyclone and got 1-2 scoops from the bottom and there was almost no particulate floating. The pH is 6.5. Dumped 315 pounds of ash. The size was mostly 1" or smaller with a few pieces 3-4 inches in diameter.

0415 Started loading coal into the weigh bin at 3.37 tons.

0430 It has taken 15 minutes to load 1.25 tons of coal into the weigh bin as the fines to top coal ratio is 5 to 1.

0440 High coal leg temperature alarm has sounded. The coal leg temperature is 51 C. The coal legs are not warm to the touch and they do not sound hollow. The upper bins are filling normally. There is coal under both slide gate valves. The offtake and agitator outlet temperatures are reading normally. The jacket outlet temperature is 87 C. This is also normal. Cannot see the problem.

0500 The coal leg temperature is now 40 C. The temperature came down gradually.

0530 We are not gaining much head way on loading coal into the upper bin. In the last 75 minutes 3.17 tons has been loaded into the weigh bin. The coal leg temperature is 33 C.

0537 The high coal leg alarm has sounded again. The coal leg temperature reads 67 C.

0545 The coal leg temperature now reads 74 C. Still have not been able to identify what is causing this.

0550 Checked the pH and found it 5.5 to 5.0. Increased the larger pump to 50/50 and started the smaller caustic pump at 30/30.

0600 We have now put 4.84 tons into the weigh bin. The fines are unbelievable with this coal. The crew is repairing a fence in the coal storage area. Fire test ash average is 4.6 inches of ash. This may indicate part of the reason the coal legs are registering so hot. The rods went in easily and there was no sign of multiple zones. Shut off the grate to allow the ash level to build. Still loading

coal and trying to clean up the coal storage area.

0655 In 3 hours the operator has loaded 7 tons of coal.

0700 The pH is 7.0. Reducing the pump speed to 40/40 on the big pump only. The smaller caustic pump is off. Finished filling the weigh bin to 10 tons. Changing the screen back to 1/4 inch.

0800 Fire test ash average is 4.6 inches with the grate off. Still have not gained any noticeable amount on the ash depth.

0825 Put the grate on at the slowest speed 1/0.40 to aid in keeping the bed even. Adjusted the retort access ports for proper steam.

0835 The grate motor is smoking. One of the dog springs came off and was jamming the tooth bar. Replaced the bar and repaired the dog and spring.

0900 Started the grate back up at 1/0.60.

0910 Cyclone flush produced very little carryover. What was there looked like a fine brown powder.

1000 Fire test ash average is 6.3 inches.

1020 Flushed the cyclone and very little carryover was evident.

1100 Changed the caustic soda barrels.

1200 Fire test ash average is 5.14 inches. The bed appears to be very soft.

1215 Slowed the grate to 1/0.45.

1330 Finished putting on the 1/4 inch screen and completed the outside clean up. Once the last of the coal currently in the weigh bin has been dropped, we will start loading over this 1/4" screen.

1400 Fire test ash average is 5.1 inches. All bars went down easily.

1420 Started the temperature and pressure probe test.

1435 Flushed the cyclone and very little particulate resulted.

1445 Checked with the ESP operator. The oxygen levels have been very good since adjusting the retort access ports. They were open too far and this admitted too much air.

1530 There are 3.59 tons up in the weigh bin. We will empty that before coaling up any more.

1600 Fire test ash average is 5.3 inches. There was a double zone on bar number 6.

1615 Cyclone dump produced 1.5 scoopful.

1630 Shut off the grate for 1/2 hour.

1700 Started the grate drive.

1800 Fire test ash average is 7.4 inches. The offtake temperature is 258 C.

1815 Shut off the grate again for 1/2 hour. There are still 2.02 tons of Kemmerer up on top.

1820 The pH is 7.0 and the caustic pumps are at 35/40.

1845 Started the grate drive at 1/0.45.

1930 There are 0.93 tons left up on top after the drop. All is on the south side.

2000 Fire test ash average is 7 inches. Turning off the grate for 1/2 hour seems to be helping. All bars were hot and came out easily. There were no multiple zones this fire test.

2010 Started loading the +1/4 inch coal into the weigh bin. Cycled the coal valves and pounded the pipes. Could not hear any coal drop; turned the slide gates off.

2020 Turned off the grate drive.

2030 Cycled the coal valves. Could not hear any coal dropping. The coal leg temperature is 32 C. There is now 2.05 tons of coal up on top. There appears to be less fines going over the screen. We are constantly checking for build up and blinding over.

2130 Cycled the coal valves again. Have not heard any drop down the pipe. The pipes are cool to the touch. The coal leg temperature is still at 32 C. Turned the grate on to 1/0.45.

2200 Fire test ash average is 8.7 inches. Still waiting for signs of empty pipes. Ran the vibrator for about 5 seconds. Still could not hear anything fall. The pipes are still cool to the touch (32 C). The offtake temperature is 250 C. Finished coaling up at 10.28 tons.

2230 Finished cleaning around the pad, hosed the drain and scraped the screen.

2235 Dumped the cyclone.

- 2240 Turned the grate off. Cycled the coal valves. Nothing fell. Coal leg temperature is still 32 C.
- 2300 Higher heating value is 164 BTU/ft³. CO is 27% and CO₂ is 6.7%. The coal leg temperature is now 30 C. The offtake temperature is 230 C.
- 2330 Cycled the lower coal valves. The south leg is full and the north leg is emptying out. The coal leg temperature is 30 C. The offtake temperature is 249 C.
- 2345 The coal leg temperature is still 30 C. The offtake temperature is 273 C.

August 13, 1984

- 0000 The coal leg temperature is 29 C and the offtake temperature is 283 C. Cycled the lower coal valves again. Fire test ash average is 17.1 inches. The rods went down easily with no multiple zones appearing. Restarting the grate at 1/1.0.
- 0015 Flushed the cyclone and obtained two scoopsful from the bottom. The pH is 6.5 with the pump at 45/45. Dumped 410 pounds of small damp ash. The coal leg temperature is 29 C and the offtake temperature is 286 C.
- 0030 Cycled the coal valves once more. Can hear the coal running down the north leg. The pipes are still not hot. Freeboard average is 38 inches. The agitator is resting 40 inches down. The coal leg temperature is 30 C. The offtake temperature is down slightly to 275 C.
- 0045 The coal leg temperature is 27 C and the offtake temperature is 231 C. Continue to hear coal trickling down the north coal leg.
- 0100 Cycled the lower coal bin valves. The north coal leg is empty. The coal leg temperature is 28 C and the offtake temperature is 280 C.
- 0105 Finally got the high coal leg temperature alarm. The coal leg temperature is 58 C and the offtake temperature is 326 C. Will drop the +1/4 inch coal.
- 0108 Dropped 4.68 tons of coal. Cycled all the valves twice.
- 0110 Ran the agitator 360 degrees to distribute the coal evenly.
- 0113 Hearing strange noises from the grate drive. Checked and found the bottom pin holding the stroke bar all the way out. Retightened it. The grate is running 1/1.25.
- 0130 Dropped 0.53 ton of coal.

- 0135 We are now getting the low saturation temperature alarm. Saturation temperature is 58.5 C. Offtake temperature is 80 C. Reduced the jacket water flow to 9 gpm from 12 gpm to increase the saturation temperature.
- 0200 Saturation temperature is back to 60 C. Ash weight is 290 pounds. Fire test ash average is 10.9 inches. The bed is more level. Reduced the grate speed to 1/0.50.
- 0225 Saturation temperature has increased to 61.5 C. Increased the jacket water flow to 11 gpm to bring the saturation temperature back to 60 C.
- 0230 Dropped 0.76 ton this coal feed. Continue loading coal into the weigh bin.
- 0300 CO is 25% and CO₂ is 7%. Higher heating value is 154 BTU/ft³. The offtake temperature is 280 C. Jacket water flow is 12 gpm.
- 0400 Ash weight is 341 pounds. Reduced the jacket water flow to 10.5 gpm. Saturation temperature is 58.5 C. CO is 26.8% and CO₂ is 4.6%. Higher heating value is 154 BTU/ft³. There are 12 tons of coal in the weigh bin. Fire test ash average is 8 inches. There were multiple zones on bars number 3,4,6 & 7.
- 0410 Will turn the grate off for 1/2 hour and then restart it at the slowest reading. Dumped 348 pounds of ash. Flushed the cyclone and found it very clean. The pH is 7.0. Reducing the caustic pump to 30/40. The offtake temperature is 269 C.
- 0430 Decreased the jacket water to 10 gpm.
- 0530 Reduced the jacket water flow to 9 gpm. We are having trouble getting the saturation temperature to and maintaining at 60 C.
- 0600 Fire test ash average is 11.1 inches. Leaving the grate at 1/0.45.
- 0610 Resume filling the weigh bin.
- 0700 Starting the temperature and pressure probe test. Cleaned up the coal storage area.
- 0800 Fire test ash average is 5.7 inches. All bars went down easily, but the east side seems colder than the west side. Leaving the grate speed at 1/0.45.
- 0850 Increased the saturation air flow to 1200 cfm. Saturation temperature is 60 C.
- 0945 Increased the offtake alarm from 300 C to 400 C. Increased

the jacket water flow to 12 gpm.

0955 CO is 31% and CO2 is 5%.

1000 Fire test ash average is 6.9 inches. All rods went down easily. The grate speed will remain the same.

1020 Cyclone dump produced 8 scoopsful (mud).

1200 Fire test ash average is 9 inches. Leaving the grate unchanged.

1300 Cleaning out the drain trough on the coal pad.

1400 Fire test ash average is 9.3 inches.

1525 The offtake temperature appears to be holding at 440 C.

1530 Cyclone dump produced 1.5 scoopsful.

1600 Fire test ash average is 8.2 inches. Holes number 5 & 6 are glowing. Will check them again in a short while.

1615 Started loading coal into the weigh bin.

1740 The offtake temperature is 406 C. The cyclone outlet pressure has gone from 0.8 inch wc to 1.1 inches wc.

1800 Fire test ash average is 9.7 inches. All bars were hot this time. Number 6 showed a double zone. Leaving the grate at 1/0.45.

1850 The offtake temperature is 380 C. We are rodding the number 6 hole. Time will tell if it helps.

1940 Dumped the cyclone and got 1.5 scoopsful.

2000 All bars during this fire test showed multiple zones. Holes number 5 & 6 are still glowing. The ash average is 10 inches. The offtake temperature is 379 C.

2120 The offtake temperature is 410 C. Poked holes number 5 & 6 and the offtake temperature came down to 385, but suspect it is a temporary adjustment.

2200 Fire test ash average is 12 inches. Increased the grate speed to 0.60. The offtake temperature is holding at 381 C.

2230 Finished coaling up.

2240 Changed the caustic soda barrel.

2255 Hosed the screen and shaker area.

2256 Dumped the cyclone.

2300 Higher heating value is 174 BTU/ft³. CO is 29.8% and CO₂ is 5%. The offtake temperature is 425 C.

2330 Flushed the cyclone and got mud (2 scoopsful).

August 14, 1984

0000 Fire test ash average is 17.6 inches. Increased the grate speed to 1/0.65.

0030 Holes 5 & 6 are glowing again. Holes 1 & 4 are starting to glow orange. Offtake temperature has dropped to 405 C.

0110 The offtake temperature is back to 434 C.

0130 Holes 5 & 6 continue to be bright orange. The offtake temperature is 445 C. Currently we are using 1.2 tons of coal each drop. Gas supply pressure is 1.6 inches wc.

0200 Fire test ash average is 14.6 inches. The offtake temperature is 460 C.

0250 Started loading coal into the weigh bin .

0330 The offtake temperature is 490 C. The bed is showing bright orange in the region of holes 1,2,4,5 & 6. We will poke and use the agitator to get control back.

0345 The gas supply pressure is 2 inches wc. Increasing the furnace pressure to 100% to bring the gas supply pressure to 1.3 inches wc.

0400 Fire test ash average is 18.1 inches. Increase the grate speed to 1/1.00. Some bottom crust is developing. The bars are still going in fairly well.

0508 The offtake temperature peaked at 503 C and then returned to 490 C. Gas supply pressure is 1.6 inches after opening the vane valve all the way.

0600 Fire test ash average is 20 inches. Holes number 2,3 & 6 have multiple zones. Grate speed is set at 2/1.20.

0615 Loading coal into the weigh bin. Flushed the cyclone (3-4 scoopsful). Dumped 450 pounds of ash.

0630 Finished loading coal at 7.96 tons. Letting this run out of the weigh bin before we introduce the double screened coal.

0700 The pH is 6.0 and the caustic pump is at 40/40. The offtake temperature is 474 C.

0730 Starting the temperature and pressure probe test.

0750 Flushed the cyclone. The result was 3 scoopfuls of particulate on the bottom and a fine silt floating.

0800 Fire test ash average is 6.1 inches. All bars went in with ease.

0830 Increased the saturation air flow to 1400 cfm and checked on the combustor inlet leakage problem. There was very little so the saturation flow was increased to 1500 cfm. At this saturation air flow there was a fair amount of leaking gas. We will hold at 1500 cfm for now.

0855 Decreased the secondary air flow to 3% open. This has helped some. Dropped the outlet pressure to 3.4 inches wc.

0900 The leakage seems to have subsided. The cyclone outlet pressure is 5.4 inches wc.

0910 Decrease the grate speed to 2/0.75.

1000 Fire test ash average is 7.7 inches. Leaving the grate at 2/0.75.

1200 Fire test ash average is 9.1 inches.

1330 Dropped 1.74 tons during this coal feed. Flushed the cyclone. Filled the cyclone until the water seal was almost made. When the gas supply pressure started jumping around and the ash pit pressure started increasing, put the cyclone on drain mode for two minutes and then opened it.

1400 Fire test ash average is 10.6 inches. All bars went in easily.

1530 Dumped the cyclone and 2 scoopful resulted.

1600 Fire test ash average is 10 inches. There were double zones on 1 & 6. Glowing is visible in the number 6 hole.

1625 Cycled the cyclone and dumped it (1 scoopful).

1730 Loaded one coal truck with fines.

1740 Dumped the cyclone.

1800 Fire test ash average is 9.6 inches. The offtake temperature is 425 C.

1840 Cyclone dump.

1900 Dumped 780 pounds of ash.

1940 Cyclone dump.

1945 Filled the second truck with fines.

2000 Fire test ash average is 12.1 inches. Had to use the sledge hammer on bar number 3. Increased the grate speed to 2/0.55. The offtake temperature is 419 C.

2040 Dumped the cyclone.

2045 Poked the number 6 hole, but it does not appear to have helped. The offtake temperature is 429 C. Gas supply pressure is rising.

2100 Start loading coal into the weigh bin.

2135 The offtake temperature is 459 C. Gas supply pressure is 6.6 inches wc.

2150 Changed paper in the Chessel recorders.

2205 Gas supply pressure now reads 7.8 inches wc on fire tests.

2206 Fire test ash average is 12.4 inches. Double zones were visible on bars number 1,3,5 & 6. Had to use the sledge on number 5 hole. Gas supply pressure came down to 6.9 inches wc.

2215 Cleaned up the coal storage pad.

2220 Poked hole number 6 once again. Gas supply pressure is 6.8 inches wc.

2225 Dumped the cyclone.

2300 Gas supply pressure is 7.1 inches wc and the ashpit pressure is 20.3 inches. Higher heating value is 169 BTU/ft³. CO is 29.2% and CO₂ is 4.4%.

August 15, 1984

0000 Fire test ash average is 19.4 inches. Ashpit pressure is 20.8 inches wc and the gas supply pressure is 8 inches wc. There is very little leakage from the transition piece. Increased the grate speed to 2/1.0.

0015 Flushed the cyclone. This time there were 12-14 scoopsful. Dumped 600 pounds of ash. The ash was dry and gray. The size was 1.5 inches and smaller. The pH has been staying between 6.5 and 7.0. Reduced the caustic pump to 40/40. Stuck a rod into the elbow of the burner inlet. Gas supply pressure went down to 6.7 inches wc.

0020 ESP has shut down due to plugging upstream of the condenser. Gas supply pressure is 7.6 inches wc.

0200 Fire test ash average is 17.7 inches. a slight bottom crust is forming in the region of holes number 2,3 & 4. Leaving the grate speed at 2/1.00.

0215 Started loading coal into the weigh bin at 3.87 tons.

0223 Advised the University of Minnesota that their O2 alarm had gone off.

0230 University of Minnesota started their particle testing.

0255 Stopped coaling up at 12 tons. This batch of coal had very little fines in it. The pH is 6.0 and we changed the caustic barrel as it was just about empty.

0400 The offtake temperature is 397 C. The offtake temperature and the CO2 have been slowly decreasing all night. The CO has remained the same. Fire test ash average is 14 inches. Number 6 bar showed multiple zones. Had to adjust the orifices on holes number 1,4 & 6 as the offtake pressure is up and there is not enough steam to hold the gas in. Reduced the grate speed to 2/0.75.

0415 Dumped 620 pounds of ash.

0500 Higher heating value is 171 BTU/ft3. The CO is 29.4% and the CO2 is 4.3%

0600 Fire test shows a much more even bed. The bed is now looser and there were no multiple zones this test. Grate speed is 2/0.70.

0610 Rodded the combustor again. Gas supply pressure fell from 8.1 inches wc to 7.8 inches wc, but then went back up after 5 minutes to 8.0 inches wc.

0615 Resumed loading coal into the weigh bin and cleaning up outside.

0620 Gas supply pressure is now down to 7.3 inches wc. The offtake temperature has been under 400 C for 1/2 hour.

0700 Started the temperature and pressure probe test.

0730 The discharge lines are becoming severely plugged. The ashpit pressure is 21.2 inches wc. The gas offtake pressure is 8.7 inches wc.

0800 Fire test ash average is 10 inches. All bars went in easily.

0820 Rodding out the combustion inlet to attempt to reduce the high cyclone pressure. Flushed the cyclone until just before the water seal is made.

0825 Cyclone outlet pressure is 7.2 inches.

0830 Starting load swings. Decreasing the load to 600 cfm. Reduced the furnace pressure to 55% open and the grate drive speed to 1/0.70.

0855 Reduced the grate drive to 1/0.45.

0930 Increased the saturation air flow to 1500 cfm. Increased the grate drive to 1/1.25. CO is 24% and CO2 is 4%. Increased the furnace pressure 100% open.

1000 Fire test ash average is 12.3 inches. Number 6 hole showed double zones.

1030 Reduced the saturation air flow to 600 cfm. Reduced the furnace pressure to 55% open.

1040 Reduced the grate speed to 1/0.60.

1130 Increased the saturation air flow to 1500 cfm. Furnace pressure 100% open. Increased the grate speed to 1/1.25.

1135 Flushed the cyclone and got 1.5 scoopsful. There was a small amount floating on top.

1145 Dumped 815 pounds of ash (1/2 - 1 inch in size). The color was gray and no clinkers were evident.

1200 Fire test ash average is 10 inches.

1215 Increased the saturation air flow to 1600 cfm. Cyclone outlet pressure is 8.6 inches wc. Decreased the saturation air flow to 1575 cfm and the cyclone outlet pressure went to 8.1 inch wc.

1300 Decreased the saturation air flow to 1525 cfm due to excess pressure.

1400 Fire test ash average is 10.3 inches.

1430 This cyclone dump produced a considerable amount of floating particulate.

1545 Dumped the cyclone.

1600 Fire test ash average is 13.6 inches. Bar number 6 had a double zone. Number 5 bar had to be persuaded with a sledge to go down. All bars came out hot.

1625 We are not going to load any more coal into the weigh bin, as there is too much pressure building up and we anticipate shutting down at 2000.

1630 Dumped the cyclone (1 scoopful).

1730 The north side of the upper coal hopper is empty. The south side has.77 tons.

1740 Cyclone dump.

1800 Fire test ash average is 10 inches. Multiple zones showed on bars 7 & 8. Slowed the grate speed to 1.26. Had to pound in the number 5 bar.

1815 Dumped 845 pounds of ash.

1910 Dumped the cyclone twice.

1915 Put a barrel under the downcomer tee.

1920 Due to high back pressure from gas duct plugging (9.8 inches wc - offtake pressure), we will shut down the gasifier.

1950 ESP has been purged.

1955 Cut back the saturation air flow to 800 cfm.

1956 Esp has been shut down.

2010 Shut down

2020 Lit the vent flare.

2045 Opened the downcomer and found it plugged solid. Opened the 4 inch valve above it instead. The line is visibly plugged 2/3 of the way up the pipe by the safety shut off valve and burning.

2330 Horizontal pipe from the venturi down is burning well. The other transition piece just before the combustor is also starting to burn through. The venturi gas discharge temperature is 533 C.

2350 Started cranking the grate at 10/2.20 to empty the gasifier.

2358 Grate stopped dead center while running at full speed.

August 16, 1984

0004 Have the grate running full blast again. Started piling ash on the ground north of the ash bunker.

END OF BOM/FGT-015

KEMMERER

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: August 11, 1984

HOURLY	TEMP	RELATIVE HUMIDITY	BAROMET PRESS	RAIN SNOW
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0100	66	73	29.255	
0200	64	75	29.260	
0300	64	75	29.260	
0400	62	81	29.270	
0500	61	81	29.270	
0600	61	81	29.280	
0700	63	72	29.280	
0800	65	73	29.280	
0900	67	73	29.290	
1000	70	70	29.290	
1100	71	70	29.280	
1200	72	68	29.280	
1300	73	66	29.270	
1400	75	60	29.250	
1500	75	60	29.250	
1600	76	56	29.240	
1700	75	58	29.230	
1800	76	56	29.220	
1900	74	60	29.220	
2000	70	71	29.230	
2100	69	73	29.240	
2200	67	78	29.250	
2300	66	81	29.250	
2400	65	82	29.250	

General Conditions: Clear sunrise and hazy sunset. 802 minutes of sunshine (94%). Maximum wind speed was 14 mph.

DATE: August 12, 1984

HOURLY	TEMP	RELATIVE HUMIDITY	BAROMET PRESS	RAIN SNOW
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0100	64	84	29.250	
0200	64	84	29.250	
0300	64	87	29.255	
0400	64	87	29.255	
0500	65	84	29.265	
0600	64	87	29.270	
0700	66	84	29.270	
0800	69	76	29.285	
0900	71	73	29.280	
1000	73	71	29.280	
1100	76	66	29.270	
1200	79	62	29.260	
1300	81	56	29.240	
1400	83	49	29.230	
1500	84	49	29.210	
1600	83	53	29.200	
1700	83	49	29.190	
1800	82	51	29.190	
1900	78	64	29.180	
2000	76	69	29.200	
2100	74	71	29.200	
2200	72	76	29.200	
2300	71	76	29.200	
2400	71	73	29.205	

General Conditions: Cloudy sunrise and sunset. 755 minutes of sunshine (88%). Maximum wind speed was 15 mph.

DATE: August 13, 1984

HOUR	TEMP	RELATIVE HUMIDITY	BAROMET PRESS	RAIN SNOW
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0100	71	71	29.210	
0200	71	71	29.215	
0300	70	73	29.210	
0400	70	76	29.215	
0500	70	73	29.210	
0600	70	73	29.210	
0700	72	68	29.215	
0800	73	66	29.220	
0900	72	71	29.220	
1000	74	66	29.215	
1100	77	64	29.205	
1200	81	56	29.200	
1300	84	55	29.170	
1400	86	52	29.160	
1500	86	52	29.140	
1600	86	53	29.140	
1700	85	55	29.130	
1800	84	57	29.125	
1900	81	65	29.125	
2000	77	71	29.130	
2100	77	71	29.130	
2200	76	71	29.140	
2300	74	76	29.140	
2400	72	76	29.140	

General Conditions: Cloudy sunrise and clear sunset. 700 minutes of sunshine (82%). Maximum wind speed was 18 mph.

DATE: August 14, 1984

HOUR	TEMP	RELATIVE HUMIDITY	BAROMET PRESS	RAIN SNOW
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0100	73	74	29.145	
0200	71	76	29.140	
0300	70	76	29.140	
0400	70	73	29.140	
0500	69	73	29.150	
0600	67	78	29.145	
0700	71	66	29.155	
0800	74	59	29.160	
0900	78	54	29.160	
1000	81	53	29.160	
1100	83	51	29.160	
1200	85	50	29.150	
1300	86	48	29.140	
1400	87	48	29.130	
1500	87	45	29.125	
1600	86	46	29.105	
1700	85	50	29.095	
1800	84	50	29.100	
1900	80	58	29.100	
2000	78	64	29.100	
2100	77	64	29.115	
2200	77	64	29.110	
2300	76	64	29.100	
2400	75	66	209.105	

General Conditions: Clear sunrise and sunset. 841 minutes of sunshine (99%). Maximum wind speed was 20 mph.

DATE: AUGUST 15, 1984

HOUR	TEMP	RELATIVE HUMIDITY	BAROMET PRESS	RAIN SNOW
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0100	76	62	29.105	
0200	75	64	29.105	
0300	75	64	29.115	T
0400	73	74	29.120	T
0500	73	71	29.145	0.01
0600	71	79	29.150	0.01
0700	72	73	29.150	
0800	73	73	29.160	
0900	76	66	29.150	
1000	80	60	29.160	
1100	82	57	29.150	
1200	84	54	29.150	
1300	85	55	29.140	
1400	86	53	29.130	
1500	87	50	29.125	
1600	87	45	29.125	
1700	86	52	29.115	
1800	85	51	29.115	
1900	82	57	29.115	
2000	80	60	29.130	
2100	78	65	29.140	
2200	80	56	29.160	
2300	77	60	29.170	
2400	76	58	29.170	

General Conditions: Cloudy sunrise and sunset. 697 minutes of sunshine (82%). Maximum wind speed was 15 mph.

APPENDIX C
Coal Sizing Data

Feed Coal Size Distribution for BOM/FGT-015

Sample Number	Date	Shift Start Time	Screen Mesh Size inch	Cumulative Mass Fraction, % <u>less than stated mesh size, inch</u>				
				1/4	1/2	3/4	1	1 1/2
1	8/11/84	16:00	+1/2	9.4	54.6	82.2	95.5	100.0
2	8/12/84	0:00	+1/2	3.1	15.3	62.3	88.2	100.0
3	8/12/84	8:00	+1/2	4.6	32.0	78.2	95.6	100.0
4	8/12/84	16:00	+1/2	2.9	18.8	36.4	50.7	86.2
5	8/13/84	0:00	+1/4	6.1	43.2	69.3	90.1	98.5
6	8/13/84	8:00	+1/4	4.5	33.9	64.6	86.9	97.7
7	8/13/84	16:00	+1/4	5.9	45.6	78.4	93.3	100.0
8	8/14/84	0:00	+1/4	6.0	50.7	77.4	93.3	100.0
9	8/14/84	8:00	+1/4	6.6	46.2	75.2	94.2	100.0
10	8/14/84	16:00	+1/4	5.7	47.0	82.8	93.9	100.0
11	8/15/84	0:00	+1/4	8.0	54.3	83.4	95.6	100.0
12	8/15/84	8:00	+1/4	8.6	53.8	84.0	95.1	100.0
1 - 12 AVERAGES				5.9	41.0	71.9	89.0	98.5

APPENDIX D

Coal Addition Log

Coal weights are given in short tons.

DATE	TIME	SAMPLE #	START WT (T)	STOP WT (T)	NET WT (T)	SCREEN (IN)	WASH ?	FUEL
8/11	1600	C1	5.11	1.30	3.81	0.50	NO	KEMMERER
8/11	1630	C1	3.80	2.24	1.56	0.50	NO	KEMMERER
8/11	1730	C1	6.04	4.80	1.24	0.50	NO	KEMMERER
8/11	1830	C1	6.58	5.34	1.24	0.50	NO	KEMMERER
8/11	1930	C1	9.02	7.80	1.22	0.50	NO	KEMMERER
8/11	2030	C1	7.80	6.47	1.33	0.50	NO	KEMMERER
8/11	2130	C1	9.29	8.25	1.04	0.50	NO	KEMMERER
8/11	2230	C1	9.33	8.25	1.08	0.50	NO	KEMMERER
8/11	2330	C2	8.25	7.25	1.00	0.50	NO	KEMMERER
8/12	30	C2	7.25	6.27	0.98	0.50	NO	KEMMERER
8/12	130	C2	6.27	5.28	0.99	0.50	NO	KEMMERER
8/12	230	C2	5.28	4.32	0.96	0.50	NO	KEMMERER
8/12	330	C2	4.32	3.37	0.95	0.50	NO	KEMMERER
8/12	430	C2	4.63	3.68	0.95	0.50	NO	KEMMERER
8/12	530	C2	5.59	4.71	0.88	0.50	NO	KEMMERER
8/12	630	C2	6.74	5.90	0.84	0.50	NO	KEMMERER
8/12	730	C3	10.79	9.72	1.07	0.50	NO	KEMMERER
8/12	830	C3	9.90	9.16	0.74	0.50	NO	KEMMERER
8/12	930	C3	9.16	8.39	0.77	0.50	NO	KEMMERER
8/12	1030	C3	8.39	7.64	0.75	0.50	NO	KEMMERER
8/12	1130	C3	7.64	6.89	0.75	0.50	NO	KEMMERER
8/12	1230	C3	6.89	6.06	0.83	0.50	NO	KEMMERER
8/12	1330	C3	6.06	5.27	0.79	0.50	NO	KEMMERER
8/12	1430	C3	5.27	4.39	0.88	0.50	NO	KEMMERER
8/12	1530	C4	4.38	3.59	0.79	0.50	NO	KEMMERER
8/12	1630	C4	3.59	2.79	0.80	0.50	NO	KEMMERER
8/12	1730	C4	2.79	2.03	0.76	0.50	NO	KEMMERER
8/12	1830	C4	2.01	1.32	0.69	0.50	NO	KEMMERER
8/12	1930	C4	1.32	0.93	0.39	0.50	NO	KEMMERER
8/13	108	C5	10.28	5.60	4.68	0.25	NO	KEMMERER
8/13	130	C5	5.60	5.07	0.53	0.25	NO	KEMMERER
8/13	230	C5	5.53	4.77	0.76	0.25	NO	KEMMERER
8/13	330	C5	10.44	9.70	0.74	0.25	NO	KEMMERER
8/13	430	C5	11.99	11.21	0.78	0.25	NO	KEMMERER
8/13	530	C5	11.21	10.39	0.82	0.25	NO	KEMMERER
8/13	630	C5	11.99	11.18	0.81	0.25	NO	KEMMERER
8/13	730	C6	11.60	10.66	0.94	0.25	NO	KEMMERER
8/13	930	C6	10.66	8.84	1.82	0.25	NO	KEMMERER
8/13	1030	C6	10.98	9.87	1.11	0.25	NO	KEMMERER
8/13	1130	C6	9.87	8.72	1.15	0.25	NO	KEMMERER
8/13	1230	C6	8.72	7.55	1.17	0.25	NO	KEMMERER
8/13	1330	C6	7.55	6.54	1.01	0.25	NO	KEMMERER
8/13	1430	C6	6.54	5.58	0.96	0.25	NO	KEMMERER
8/13	1530	C7	5.58	4.60	0.98	0.25	NO	KEMMERER
8/13	1630	C7	5.67	4.67	1.00	0.25	NO	KEMMERER
8/13	1730	C7	9.85	8.81	1.04	0.25	NO	KEMMERER
8/13	1830	C7	8.82	7.57	1.25	0.25	NO	KEMMERER
8/13	1930	C7	7.58	6.38	1.20	0.25	NO	KEMMERER
8/13	2030	C7	6.39	5.23	1.16	0.25	NO	KEMMERER
8/13	2130	C7	5.24	4.01	1.23	0.25	NO	KEMMERER
8/13	2230	C7	9.96	8.74	1.22	0.25	NO	KEMMERER

DATE	TIME	SAMPLE #	START WT (T)	STOP WT (T)	NET WT (T)	SCREEN (IN)	WASH ?	FUEL
8/13	2330	C8	9.78	8.59	1.19	0.25	NO	KEMMERER
8/14	30	C8	8.59	7.35	1.24	0.25	NO	KEMMERER
8/14	130	C8	7.35	6.16	1.19	0.25	NO	KEMMERER
8/14	230	C8	6.16	5.02	1.14	0.25	NO	KEMMERER
8/14	330	C8	9.14	8.04	1.10	0.25	NO	KEMMERER
8/14	430	C8	10.13	9.02	1.11	0.25	NO	KEMMERER
8/14	530	C8	9.02	7.88	1.14	0.25	NO	KEMMERER
8/14	630	C8	9.11	7.96	1.15	0.25	NO	KEMMERER
8/14	730	C9	7.96	6.72	1.24	0.25	NO	KEMMERER
8/14	830	C9	6.72	5.59	1.13	0.25	NO	KEMMERER
8/14	930	C9	5.59	4.07	1.52	0.25	NO	KEMMERER
8/14	1030	C9	4.06	2.58	1.48	0.25	NO	KEMMERER
8/14	1130	C9	2.57	1.12	1.45	0.25	NO	KEMMERER
8/14	1230	C9	1.12	0.55	0.57	0.25	NO	KEMMERER
8/14	1330	C9	5.62	3.10	2.52	0.25	NO	DS KEMMERER
8/14	1430	C9	7.66	5.92	1.74	0.25	NO	DS KEMMERER
8/14	1530	C10	9.85	8.21	1.64	0.25	NO	DS KEMMERER
8/14	1630	C10	8.21	6.52	1.69	0.25	NO	DS KEMMERER
8/14	1730	C10	6.52	4.81	1.71	0.25	NO	DS KEMMERER
8/14	1830	C10	4.81	3.50	1.31	0.25	NO	DS KEMMERER
8/14	1930	C10	6.70	5.24	1.46	0.25	NO	DS KEMMERER
8/14	2030	C10	7.62	6.00	1.62	0.25	NO	DS KEMMERER
8/14	2130	C10	11.38	10.00	1.38	0.25	NO	DS KEMMERER
8/14	2230	C10	10.00	8.46	1.54	0.25	NO	DS KEMMERER
8/14	2330	C11	8.46	6.97	1.49	0.25	NO	DS KEMMERER
8/15	30	C11	6.97	5.27	1.70	0.25	NO	DS KEMMERER
8/15	130	C11	5.27	3.87	1.40	0.25	NO	DS KEMMERER
8/15	230	C11	7.76	6.15	1.61	0.25	NO	DS KEMMERER
8/15	330	C11	12.09	10.52	1.57	0.25	NO	DS KEMMERER
8/15	430	C11	10.52	8.75	1.77	0.25	NO	DS KEMMERER
8/15	530	C11	8.75	7.28	1.47	0.25	NO	DS KEMMERER
8/15	630	C11	11.60	9.92	1.68	0.25	NO	DS KEMMERER
8/15	730	C12	10.61	9.30	1.31	0.25	NO	DS KEMMERER
8/15	830	C12	9.30	7.71	1.59	0.25	NO	KEMMERER
8/15	930	C12	7.71	7.04	0.67	0.25	NO	KEMMERER
8/15	1030	C12	7.04	5.45	1.59	0.25	NO	KEMMERER
8/15	1130	C12	5.45	4.73	0.72	0.25	NO	KEMMERER
8/15	1230	C12	4.73	3.09	1.64	0.25	NO	KEMMERER
8/15	1330	C12	7.79	6.06	1.73	0.25	NO	KEMMERER
8/15	1430	C12	7.79	6.06	1.73	0.25	NO	KEMMERER
8/15	1530	C13	4.54	3.03	1.51	0.25	NO	KEMMERER
8/15	1630	C13	3.03	1.63	1.40	0.25	NO	KEMMERER
8/15	1730	C13	1.63	0.75	0.88	0.25	NO	KEMMERER
8/15	1830	C13	0.76	0.35	0.41	0.25	NO	KEMMERER

APPENDIX E
Ash Analysis Data

ASH ANALYSIS FOR BOM/FGT-015

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	8/11/84	20:10	3.4	12.8	33.4	53.3	84.0	0.69	3	10.8	0.20
2	8/12/84	0:10	17.9	44.2	63.6	74.3	87.9	0.71	17	10.5	0.25
3	8/12/84	4:09	12.9	29.6	41.7	50.2	66.0	0.79	33	12.6	0.23
4	8/13/84	0:15	25.2	49.4	63.2	68.9	81.2	0.76	27	9.1	0.21
5	8/13/84	4:09	17.8	35.8	50.5	62.7	81.5	0.75	17	5.4	0.19
6	8/14/84	6:15	11.1	23.8	35.6	44.6	69.5	0.73	9	6.4	0.18
7	8/14/84	11:25	22.2	44.5	61.0	71.8	93.3	0.78	14	5.9	0.30
8	8/14/84	19:00	16.3	35.7	54.8	70.4	96.1	0.80	13	3.4	0.16
9	8/15/84	0:20	15.5	36.1	54.3	67.7	95.4	0.80	14	2.6	0.18
10	8/15/84	4:09	13.3	29.4	45.1	57.3	79.9	0.89	10	1.9	0.16
11	8/15/84	11:35	17.6	43.5	61.7	76.1	96.2	0.94	12	2.0	0.13
12	8/15/84	18:10	15.2	37.0	59.2	73.3	96.1	0.85	9	1.7	0.12
5 - 12 AVERAGES			16.1	35.7	52.8	65.5	88.5	0.819	12.2	3.7	0.18

APPENDIX F

Ash Removal Log

Ash weights are given in pounds.

Flush water is given in gallons.

DATE	TIME	SAMPLE #	INITIAL DRY WT.	FINAL DRY WT.	NET DRY WT.	INITIAL WET WT.	FINAL WET WT.	NET WET WT.	NET WET & NET DRY	FLUSH (GAL)
8/11	2010	A1	917	119	798	362	96	266	1064	30
8/12	10	A2	574	103	471	388	127	261	732	30
8/12	410	A3	315	102	213	386	99	287	500	30
8/13	15	A4	403	108	295	375	134	241	536	30
8/13	410	A5	340	100	240	380	98	282	522	30
8/13	615	A6	454	96	358	383	163	220	578	30
8/13	1125	A7	685	105	580	475	98	377	957	30
8/13	1900	A8	806	94	712	479	92	387	1099	30
8/15	20	A9	603	93	510	465	96	369	879	30
8/15	410	A10	667	89	578	473	92	381	959	30
8/15	1145	A11	822	101	721	500	93	407	1128	30
8/15	1610	A12	850	92	758	515	94	421	1179	30

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 (4 included)
- G-4. Dust Size Distribution Modal Analysis (4 included)
- G-5. Explanation of Modal Fitting Parameters

Grand Average Gas/Air Ratio	Estimated Offtake Elbow Area/ Sampler Inlet Area	Retort Area Less Draft Shroud Area
1.92	7678	28.75 square feet

RUN #	DATE TIME	TEST	MASS	COAL	FEED			GAS FLOW		DUST	RT/	PROBE	AGITATOR	AGITATOR
		LENGTH (min)	PARTICLES (milligram)	RATE (lb/hr)	T- 705 (deg. K)	P-705 ("hg abs)	F-701 (scfm)	RATE (acfm)	COAL (%)	RT	DEPTH (inch)	ANGLE (deg)	RATE (sw/hr)	BOARD (inch)
1	13-AUG-84 07:05	4.0	161.90	1793	525	29.41	794	2723	2.29	34	X		0	39.0
2	13-AUG-84 07:24	6.0	261.30	1793	520	29.42	793	2691	2.47	34	X		0	39.5
3	13-AUG-84 07:50	6.0	225.50	1793	523	29.41	794	2713	2.13	34	X		0	39.5
4	14-AUG-84	No particles were collected because the glass fiber filters melted.												
5	14-AUG-84													
6	14-AUG-84													
7	15-AUG-84 02:57	2.5	124.40	3167	678	29.82	1507	6455	1.60	34	X		0	36.5
8	15-AUG-84 03:10	5.0	170.99	3167	675	29.83	1508	6447	1.10	34	X		0	36.5
9	15-AUG-84 03:34	2.5	119.80	3167	668	29.82	1505	6363	1.54	34	X		0	38.5

CUMULATIVE SIZE DISTRIBUTION DATA

SIEVING	ASTM SIEVE NUM.	SIEVE SIZE (um)	SHIFT SIZE (um)	Sample #	
				015-02	015-07
				Percent Less Than	Percent Less Than
				Stated Size	Stated Size
8		2360	3189.2	--	100.0
14		1400	1891.9	100.0	97.0
20		841	1136.5	98.0	91.6
30		595	804.1	95.0	88.0
40		420	567.5	89.3	81.9
60		250	337.8	76.8	71.4
100		149	201.4	61.6	60.3
200		74	100.0	37.9	38.9

MICROSCOPY

PARTICLE DIAMETER (um)	Percent Less Than Stated Size	
	(%)	(%)
178.0	--	38.9
100.0	37.9	37.2
56.0	26.1	21.7
32.0	14.5	11.5
17.8	7.83	5.75
10.0	3.20	2.86
5.60	0.904	0.996
3.20	0.220	0.221

Figure G-3a

Figure G-3b

Figure G-4a

Figure G-4b

Table G-5

Description of Modal Fitting Parameters
(Associated with Figures G-4(a,b))

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

W - Wet bar

D - Multiple incandescent zones

H - Relatively hot incandescent zone

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

FREBOARD DATA

DATE TIME	#1	#2	#3	#4	#5	#6	AVERAGE
8/11 1330		42.0			48.0		45.0
8/11 1430			48.0			50.0	49.0
8/11 1530	41.0			54.0			47.5
8/11 1630		40.0			40.0		40.0
8/11 1730			37.0			40.0	38.5
8/11 1830	37.0			37.0			37.0
8/11 1930		37.0			37.0		37.0
8/11 2030			37.0			39.0	38.0
8/11 2130	37.0			38.0			37.5
8/11 2230		38.0			39.0		38.5
8/11 2330	34.0			35.0			34.5
8/12 30		38.0			38.0		38.0
8/12 130			36.0			38.0	37.0
8/12 230	35.0			34.0			34.5
8/12 330		37.0			37.0		37.0
8/12 430			37.0			38.0	37.5
8/12 530	35.0			35.0			35.0
8/12 630		38.0			38.0		38.0
8/12 730			40.0			41.0	40.5
8/12 830	37.0			36.0			36.5
8/12 930		40.0			39.0		39.5
8/12 1030			39.0			39.0	39.0
8/12 1140	36.0			36.0			36.0
8/12 1230		42.0			40.0		41.0
8/12 1330			40.0			42.0	41.0
8/12 1430	37.0			37.0			37.0
8/12 1530		39.0			40.0		39.5
8/12 1630			40.0			39.0	39.5
8/12 1730	38.0			39.0			38.5
8/12 1830		41.0			39.0		40.0
8/12 1930			40.0			42.0	41.0
8/12 2030	38.0			36.0			37.0
8/12 2130		39.0			40.0		39.5
8/12 2230			39.0			41.0	40.0
8/12 2330	34.0			39.0			36.5
8/13 30		38.0			43.0		40.5
8/13 130			34.0			34.0	34.0
8/13 230	35.0			35.0			35.0
8/13 330		39.0			37.0		38.0
8/13 430			36.0			39.0	37.5
8/13 530	35.0			35.0			35.0
8/13 630		38.0			38.0		38.0
8/13 730			40.0			39.0	39.5
8/13 830	36.0			38.0			37.0
8/13 930		39.0			38.0		38.5
8/13 1030			39.0			40.0	39.5
8/13 1130	37.0			37.0			37.0
8/13 1230		38.0			38.0		38.0
8/13 1330			39.0			39.0	39.0

DATE	TIME	#1	#2	#3	#4	#5	#6	AVERAGE
8/13	1430	37.0			39.0			38.0
8/13	1530		38.0			39.0		38.5
8/13	1630			39.0			39.0	39.0
8/13	1730	36.0			37.0			36.5
8/13	1830		40.0			39.0		39.5
8/13	1930			40.0			39.0	39.5
8/13	2030	38.0			38.0			38.0
8/13	2130		40.0			39.0		39.5
8/13	2230			39.0			39.0	39.0
8/13	2330	35.0			34.0			34.5
8/14	30		39.0			38.0		38.5
8/14	130			37.0			39.0	38.0
8/14	230	35.0			35.0			35.0
8/14	330		37.0			38.0		37.5
8/14	430			36.0			39.0	37.5
8/14	530	34.0			34.0			34.0
8/14	630		38.0			38.0		38.0
8/14	730			38.0			39.0	38.5
8/14	830	36.0			38.0			37.0
8/14	930		38.0			38.0		38.0
8/14	1030			39.0			40.0	39.5
8/14	1130	34.0			35.0			34.5
8/14	1230		37.0			37.0		37.0
8/14	1330			38.0			40.0	39.0
8/14	1430	35.0			37.0			36.0
8/14	1530		39.0			38.0		38.5
8/14	1630			38.0			39.0	38.5
8/14	1730	37.0			38.0			37.5
8/14	1830		38.0			37.0		37.5
8/14	1930			39.0			40.0	39.5
8/14	2030	37.0			35.0			36.0
8/14	2130		37.0			38.0		37.5
8/14	2230			38.0			42.0	40.0
8/14	2330	35.0			35.0			35.0
8/15	30		38.0			38.0		38.0
8/15	130			36.0			38.0	37.0
8/15	230	34.0			35.0			34.5
8/15	330		38.0			39.0		38.5
8/15	430			36.0			39.0	37.5
8/15	530	35.0			35.0			35.0
8/15	630		38.0			39.0		38.5
8/15	730			38.0			38.0	38.0
8/15	830	37.0			36.0			36.5
8/15	830	37.0			36.0			36.5
8/15	930		39.0			38.0		38.5
8/15	1030			38.0			38.0	38.0
8/15	1130	36.0			36.0			36.0
8/15	1230		39.0			38.0		38.5
8/15	1330			38.0			39.0	38.5
8/15	1430	36.0			36.0			36.0
8/15	1530		39.0			39.0		39.0
8/15	1630			38.0			40.0	39.0
8/15	1730	36.0			36.0			36.0

TABLE H-2

FIRETEST DATA

Date	Time	Insertion Time (min)	#1	#2	#3	#4	#5	#6	#7	Average
811	1600	5	7	11	1D	21	20	20	1D	11.6
811	1800	4	23	22	14	11	15	16	12	16.1
811	2000	4	19W	9W	5W	11W	16W	4W	13W	11
811	2200	4	13W	12W	9	10C	5	11	7C	9.6
812	0000	4	19	0	0	7C	14	5	0	6.4
812	0200	4	23	4	18C	4	11	10	3	10.4
812	0400	4	7	5	8	12	9	11	8	8.6
812	0600	4	4	5	2	11	4	4	2	4.6
812	0800	4	4H	4H	8H	3H	4H	4D	5H	4.6
812	1000	5	3	7	7	8	3	10	6	6.3
812	1200	5-6	8C	3H	4H	3H	8H	7D	3H	5.1
812	1400	5-6	6C	7H	6C	3H	8H	4D	2H	5.1
812	1600	5-6	5H	6	6	6H	6	6D	2	5.3
812	1800	5	9C	6C	9H	5H	8D	8HD	7H	7.4
812	2000	6	6H	6H	11H	6	7H	7H	6H	7
812	2200	6	6H	6H	11H	6	7H	7H	6H	8.7
813	0000	4	11	14C	11	19C	21C	23	11	15.7
813	0200	5	9	11	14	14	15	10	3	10.9
813	0400	5-7	5	10	0D	4D	21	7D	9D	8
813	0600	6	0D	13	14	8D	16	19D	8	11.1
813	0800	6	3H	6C	7	5	5	3	11	5.7
813	1000	6	5H	6C	6C	7D	9H	6H	9H	6.9
813	1200	6	9C	5C	10H	7H	9D	5H	11H	8
813	1400	5-6	6C	5C	11C	12H	11H	6C	14H	9.3
813	1600	5-6	9C	9C	10H	9H	10D	6C	5H	8.3
813	1800	5-6	6H	6	7	16H	11H	10D	12	9.7
813	2000	5-6	14H	5H	17H	14H	12D	7D	1H	10
813	2200	5-6	7H	10H	10H	14H	24H	14H	8H	12.4
814	0000	5	7	6D	10	28	46	15	11	17.6
814	0200	5	7	7	15D	29	22	10	12	14.6
814	0400	5	9D	15D	14	30	21	14C	13	16.7
814	0600	6	23	11D	32D	29	19	12D	14	20
814	0800	5-6	9H	6H	7H	8H	4H	4H	5H	6.1
814	1000	6-7	12H	4H	4H	12H	8H	10H	4H	7.7
814	1200	6	3H	6C	7C	21H	11H	10H	6D	9.1
814	1400	6	12H	6H	9H	22H	6	7C	11H	10.6
814	1600	6	5D	5H	9H	27H	2H	6D	16H	10
814	1800	5-6	10H	9C	10C	17H	2H	9D	10H	9.6
814	2000	5-6	33H	7H	4H	16H	7H	8D	10	12.1
814	2200	5-6	9H	10H	35D	10H	7D	9D	7H	12.4
815	0000	5-6	6	30D	39	26	12	15	8	19.4
815	0200	6-7	17	5	9	26	32	32	3	17.7
815	0400	6	6	10	3	23	48	8D	0	14
815	0600	6	8	15	7	21	9	9	9	11.1
815	0800	5	3H	5D	7H	22H	10H	14D	9H	10
815	1000	5-6	4C	5	4	42H	11H	10D	10	12.3
815	1200	4-5	3H	6H	2H	25H	19H	4D	11H	10
815	1400	4-5	6D	9H	14H	13H	14H	6H	10	10.3

Date	Time	Insertion Time (min)	#1	#2	#3	#4	#5	#6	#7	Average
815	1600	4-5	12H	7H	10H	25H	6H	6D	29H	13.6
815	1800	4-5	4H	7D	9H	8D	22H	6H	14H	10

TABLE H-3

OPERATOR LOGGED DATA I

DATE	TIME	AGIT. WATER FLOW	JACKET WATER FLOW	JACKET W. F. TOTAL	JACKET WATER HRLY USE	METER INLET PRESS.	REG. STEAM PRESS.	STEAM TEMP. F.	ORIFICE DELTA P	VALVE POSIT.
811	1530	3.0	12	32116	600	82	39.9	285	3	16
811	1630	3.0	12	32123	700	85	40	285	3	20
811	1730	3.0	12	32131	800	85	40	285	3	24
811	1830	3.0	12	32138	700	85	40	285	3	20
811	1930	3.0	12	32144	600	85	40	285	3	20
811	2030	3.0	12	32151	700	85	40	285	2.5	22
811	2130	3.0	12	32159	800	85	40	285	2.5	22
811	2230	3.0	12	32165	600	85	40	285	2	20
811	2330	3.0	12	32172	700	74	39.5	288	2	21
812	0030	3.0	12	32179	700	82	37.7	288	2.0	19
812	0130	3.0	12	32186	700	82	39.5	289	2	21
812	0230	3.0	12	32193	700	82	39.5	290	1.5	22
812	0330	3.0	12	32200	700	81	39.1	289	2	19
812	0430	3.0	12	32207	700	80	39.5	285	1.7	18
812	0530	3.0	12	32214	700	83	39.4	282	2	16
812	0630	3.0	12	32220	600	82	39.5	285	2	16
812	0730	3.0	12	32227	700	80	39.5	285	2.5	18
812	0830	3.0	12	32234	700	85	39.8	280	2	16
812	0930	3.0	12	32241	700	85	40	285	2.5	18
812	1030	3.0	12	32248	700	85	39.8	280	2	15
812	1130	3.0	12	32255	700	85	40	290	3.5	18
812	1230	3.0	12	32261	600	82	39.6	280	2	16
812	1330	3.0	12	32268	700	85	40	285	3	18
812	1430	3.0	12	32274	600	80	39.5	285	2.5	14
812	1530	3.0	12	32282	800	80	39.5	285	2.5	14
812	1630	3.0	12	32289	700	80	39.7	285	2.5	14
812	1730	3.0	12	32295	600	80	39.8	285	2.5	12
812	1830	3.0	12	32302	700	80	39.9	285	2.5	12
812	1930	3.0	12	32310	800	80	39.9	285	2.5	12
812	2030	3.0	12	32315	500	80	39.8	285	2.5	12
812	2130	3.0	12	32324	900	80	39.9	285	2.5	16
812	2230	3.0	12	32329	500	80	39.9	285	2.5	14
812	2330	3.0	12	32335	600	82	39.7	285	1.5	14
813	0030	3.0	12	32342	700	82	39.3	283	1.7	15
813	0130	3.0	12	32350	800	84	39.5	282	1.5	15
813	0230	3.0	9	32354	400	83	39.4	284	1.5	16
813	0330	3.0	12	32360	600	84	39.5	284	2	15
813	0430	3.0	10.5	32367	700	83	39.7	285	1.7	15
813	0530	3.0	9.5	32373	600	83	39.8	285	2	15
813	0630	3.0	9	32377	400	84	39.5	285	1.5	14
813	0730	3.0	10	32382	500	84	39.5	285	2	15
813	0830	3.0	10	32387	500	84	39.5	285	2	15
813	0930	3.0	12	32393	600	85	39.8	285	2	10
813	1030	3.0	12	32400	700	82	39.5	285	2.5	18
813	1130	3.0	12	32406	600	82	39.5	285	2.5	16
813	1230	3.0	12	32413	700	82	39.8	285	3	18
813	1330	3.0	12	32420	700	82	39.8	285	3	20

DATE	TIME	AGIT. WATER FLOW	JACKET WATER FLOW	JACKET W. F. TOTAL	JACKET WATER HRLY USE	METER INLET PRESS.	REG. STEAM PRESS.	STEAM TEMP. F.	ORIFICE DELTA P	VALVE POSIT.
813	1430	3.0	12	32426	600	84	39.8	285	3	18
813	1530	3.0	12	32433	700	84	39.8	285	3	16
813	1630	3.0	12	32440	700	84	39.8	285	3	20
813	1730	3.0	12	32447	700	84	40	285	3	22
813	1830	3.0	12	32453	600	90	40	285	3	22
813	1930	3.0	12	32460	700	90	40	285	3	22
813	2030	3.0	12	32466	600	90	40	285	3	22
813	2130	3.0	12	32473	700	84	40	285	3	24
813	2230	3.0	12	32480	700	84	40	285	3	26
813	2330	3.0	12	32487	700	81	39.5	286	3.8	24
814	0030	3.0	12	32494	700	82	39.1	283	4	24
814	0130	3.0	12	32500	600	82	39.3	284	4.2	24
814	0230	3.0	12	32507	700	81	39.3	285	4	26
814	0330	3.0	12	32513	600	80	39.5	287	4	26
814	0430	3.0	12	32520	700	80	39.3	285	3.5	27
814	0530	3.0	12	32527	700	82	39.5	286	3.8	26
814	0630	3.0	12	32533	600	80	39.3	287	4	26
814	0730	3.0	12	32541	800	82	39.5	285	4.5	26
814	0830	3.0	12	32546	500	84	39.8	285	3.5	26
814	0930	3.0	12	32553	700	84	39.6	285	4	26
814	1030	3.0	12	32560	700	82	39.8	288	4	28
814	1130	3.0	12	32566	600	80	39.8	288	4	28
814	1230	3.0	12	32572	600	82	39.8	280	4	28
814	1330	3.0	12	32579	700	82	39.8	290	4	24
814	1430	3.0	12	32586	700	85	39.8	290	3.5	21
814	1530	3.0	12	32593	700	85	39.9	290	3.5	26
814	1630	3.0	12	32599	600	85	45	290	3.5	24
814	1730	3.0	12	32607	800	85	40	290	3.5	26
814	1830	3.0	12	32613	600	85	40	290	3.5	24
814	1930	3.0	12	32620	700	85	40	285	3	26
814	2030	3.0	12	32626	600	85	40	285	3	28
814	2130	3.0	12	32632	600	85	40	285	3	28
814	2230	3.0	12	32639	700	85	40	285	3	30
814	2330	3.0	12	32646	700	82	39.8	288	5	29
815	0030	3.0	12	32654	800	81	39.5	289	4	29
815	0130	3.0	12	32659	500	82	39.5	282	5.5	28
815	0230	3.0	12	32666	700	82	39.3	287	5	28
815	0330	3.0	12	32672	600	83	39.5	285	4.5	28
815	0430	3.0	12	32680	800	82	39.7	288	5	27
815	0530	3.0	12	32687	700	82	39.5	285	4.5	29
815	0630	3.0	12	32692	500	81	39.3	285	4	28
815	0730	3.0	12	32700	800	84	39.8	290	4	28
815	0830	3.0	12	32706	600	85	40	290	3.5	20
815	0930	3.0	12	32712	600	80	39.4	285	5.5	30
815	1030	3.0	12	32719	700	82	40	290	3	16
815	1230	3.0	12	32733	1400	84	39.8	290	4	26
815	1330	3.0	12	32740	700	80	39.8	290	4.5	26
815	1430	3.0	12	32744	400	84	39.8	290	4.5	26
815	1530	3.0	12	32752	800	84	39.8	290	4.5	28
815	1630	3.0	12	32758	600	84	39.8	290	4.5	26
815	1730	3.0	12	32765	700	84	39.8	290	4.5	28

DATE	TIME	AGIT. WATER FLOW	JACKET WATER FLOW	JACKET W. F. TOTAL	JACKET WATER HRLY USE	METER INLET PRESS.	REG. STEAM PRESS.	STEAM TEMP. F.	ORIFICE DELTA P	VALVE POSIT.
815	1830	3.0	12	32771	600	84	39.8	290	4.5	26
815	1930	3.0	12	32778	700	84	39.8	290	4.5	22

END OF BOM/FGT 015 KEMMERER

TABLE H-4

OPERATOR LOGGED DATA II

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			ANNUBAR DELTA P
								pH	REAGENT PUMP SPEED	REAGENT PUMP STROKE	
811	1530	345	0	0	23151	27	4/0.42	0	30	30	.1
811	1630	345	0	0	23171	20	4/0.43	0	30	30	.1
811	1730	345	0	0	23206	35	4/0.75	5	40	40	.1
811	1830	345	0	0	23244	38	4/0.75	6.5	40	40	.1
811	1930	345	0	0	23279	35	4/0.75	6.5	40	40	.1
811	2030	345	0	0	23312	33	4/0.6	6.5	40	40	.1
811	2130	345	0	0	23346	34	4/0.6	6.5	40	40	.1
811	2230	345	0	0	23371	25	4/0.45	6.5	40	40	.1
811	2330	345	0	0	23393	22	4/0.45	6	40	40	.11
812	0030	345	0	0	23409	16	0	6	40	40	.11
812	0130	345	0	0	23409	0	0	6	40	40	.11
812	0230	345	0	0	23426	17	4/0.4	6	40	40	.11
812	0330	345	0	0	23450	24	4/0.4	6	40	40	.11
812	0430	345	0	0	23472	22	4/0.4	6.5	40	40	.12
812	0530	345	0	0	23487	15	3/0.42	6.5	40	40	.12
812	0630	345	0	0	23495	8	0	5.5	50/30	50/30	.11
812	0730	345	0	0	23495	0	0	5.5	40	40	.11
812	0830	345	0	0	23496	1	1/0.4	5.5	40	40	.11
812	0930	345	0	0	23500	4	1/0.6	5.5	40	40	.11
812	1030	345	0	0	23508	8	1/0.6	6	40	40	.11
812	1130	345	0	0	23516	8	1/0.6	6	40	40	.11
812	1230	345	0	0	23522	6	1/0.45	6	40	40	.11
812	1330	345	0	0	23527	5	1/0.4	6	40	40	.11
812	1430	345	0	0	23533	6	1/0.45	6	40	40	.11
812	1530	345	0	0	23539	6	1/0.45	6	40	40	.1
812	1630	345	0	0	23544	5	0	6	40	40	.1
812	1730	345	0	0	23548	4	1/0.45	7	40	40	.1
812	1830	345	0	0	24552	4	0	6.5	35	40	.1
812	1930	345	0	0	24558	6	1/0.45	6.5	35	40	.1
812	2030	345	0	0	24560	2	0	6.5	35	40	.1
812	2130	345	0	0	24561	1	1/0.45	6.5	35	40	.1
812	2230	345	0	0	24566	5	1/0.45	6	35	40	.1
812	2330	345	0	0	23566	0	0	6	45	45	.11
813	0030	345	0	0	23570	4	1/1.0	6.5	45	45	.11
813	0130	347	2	0	23587	17	1/1.0	6.5	45	45	.11
813	0230	347	0	0	23601	14	1/0.5	6.5	45	45	.11
813	0330	347	0	0	23606	5	1/0.5	6.5	45	45	.11
813	0430	347	0	0	23610	4	0	7	45	45	.11
813	0530	347	0	0	23614	4	1/0.42	6.5	30	40	.11
813	0630	347	0	0	23619	5	1/0.45	6	30	40	.12
813	0730	347	0	0	23625	6	1/0.45	5.5	30	40	.12
813	0830	347	0	0	23630	5	1/0.45	6	40	40	.11
813	0930	347	0	0	23636	6	1/0.45	6	40	40	.25
813	1030	347	0	0	23642	6	1/0.45	5.5	40	40	.25
813	1130	347	0	0	23647	5	1/0.45	6	40	40	.25
813	1230	347	0	0	23653	6	1/0.45	6	40	40	.25

DATE	TIME	AGIT. COUNT	AGIT SWEEP PER HR	AGIT DRIVE SETNG	GRATE GEAR COUNTER READING	GRATE GEAR RPH	GRATE DRIVE SETNG	FLUE GAS SCRUBBER			ANNUB DELTA P
								PH	REAGENT PUMP SPEED	REAGENT PUMP STROKE	
813	1330	347	0	0	23659	6	1/0.45	6.5	40	40	.2
813	1430	347	0	0	23665	6	1/0.45	6.5	40	40	.2
813	1530	347	0	0	23671	6	1/0.45	6.5	40	40	.2
813	1630	347	0	0	23676	5	1/0.45	6	40	40	.2
813	1730	347	0	0	23682	6	1/0.45	6	40	40	.2
813	1830	347	0	0	23688	6	1/0.45	6	40	40	.2
813	1930	347	0	0	23693	5	1/0.45	6	40	40	.2
813	2030	347	0	0	23699	6	1/0.45	6	40	40	.2
813	2130	347	0	0	23704	5	1/0.45	6	40	40	.2
813	2230	347	0	0	23711	7	1/0.5	6	40	40	.2
813	2330	347	0	0	23718	7	1/0.5	6	40	40	.2
814	0030	347	0	0	23724	6	1/0.65	6	40	40	.2
814	0130	347	0	0	23732	8	1/0.65	6	40	40	.2
814	0230	347	0	0	23741	9	1/0.65	6	40	40	.2
814	0330	347	0	0	23749	8	1/0.65	6	40	40	.2
814	0430	347	0	0	23759	10	1/1.0	6.5	40	40	.2
814	0530	347	0	0	23771	12	1/1.0	6	35	40	.2
814	0630	347	0	0	23788	17	2/1.2	5	45	45	.2
814	0730	347	0	0	23816	28	2/1.2	6	40	40	.2
814	0830	347	0	0	23836	20	2/1.2	5.5	40	40	.2
814	0930	347	0	0	23860	24	2/0.75	6	40	40	.2
814	1030	347	0	0	23874	14	2/0.75	5.5	40	40	.4
814	1130	347	0	0	23890	16	2/0.75	6.5	45	45	.3
814	1230	347	0	0	23907	17	2/0.75	6.5	45	45	.4
814	1330	347	0	0	23925	18	2/0.75	6.5	45	45	.4
814	1430	347	0	0	23943	18	2/0.75	5.5	45	45	.4
814	1530	347	0	0	23961	18	2/0.75	5.5	50	50	.4
814	1630	347	0	0	23975	14	2/0.75	5.5	50	50	.4
814	1730	347	0	0	23993	18	2/0.75	5.5	50	50	.4
814	1830	347	0	0	24005	12	2/0.5	5.5	50	50	.4
814	1930	347	0	0	24016	11	2/0.5	6	50	50	.4
814	2030	347	0	0	24029	13	2/0.5	6	50	50	.4
814	2130	347	0	0	24039	10	2/0.55	6	50	50	.4
814	2230	347	0	0	24052	13	2/0.55	6	50	50	.4
814	2330	347	0	0	24066	14	2/0.54	6	50	50	.4
815	0030	347	0	0	24085	19	2/1.0	7	40	40	.4
815	0130	347	0	0	24103	18	2/0.8	6	40	40	.4
815	0230	347	0	0	24122	19	2/1.0	6	40	40	.4
815	0330	347	0	0	24142	20	2/1.0	6	40	40	.4
815	0430	347	0	0	24163	21	2/0.75	6	40	40	.4
815	0530	347	0	0	24174	11	2/0.75	6	40	40	.4
815	0630	347	0	0	24192	18	2/0.7	6	40	40	.4
815	0730	347	0	0	24208	16	2/0.7	6.5	40	40	.4
815	0830	347	0	0	24221	13	1/0.7	6.5	40	40	.06
815	0930	347	0	0	24227	6	1/1.25	6	40	40	.4
815	1030	347	0	0	24242	15	1/0.6	6	40	40	.06
815	1230	347	0	0	24269	27	1/1.27	6	40	40	.43
815	1330	347	0	0	24283	14	1/1.27	6	40	40	.4
815	1430	347	0	0	24297	14	1/1.27	6	40	40	.4
815	1530	347	0	0	24314	17	1/1.26	6	40	40	.4

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			ANNUBAR DELTA P
								pH	REAGENT PUMP SPEED	REAGENT PUMP STROKE	
815	1630	347	0	0	24330	16	1/1.35	6	40	40	.41
815	1730	347	0	0	24347	17	1/1.35	6	40	40	.41
815	1830	347	0	0	24363	16	1/1.35	6	40	40	.41
815	1930	347	0	0	24379	16	1/1.35	6	40	40	.41
END OF BOM/FGT 015						KEMMERER					

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

8/11/1984

16:38	16.896	5.040	0.088	0.247	0.000	43.11	2.729	27.13	0.041	0.051	177.4	165.6	95.33	22.81	0.787
16:56	17.926	5.031	0.093	0.255	0.000	41.70	2.878	28.31	0.015	0.051	185.6	173.2	96.25	22.78	0.786
17:15	17.434	5.211	0.091	0.254	0.000	41.71	2.854	27.85	0.031	0.051	182.7	170.5	95.48	22.73	0.784
17:33	17.529	5.141	0.090	0.252	0.000	41.73	2.307	28.03	0.041	0.050	178.2	166.5	95.17	22.67	0.782
17:51	17.928	5.331	0.096	0.261	0.000	42.17	2.437	27.87	0.032	0.051	180.3	168.3	96.18	22.86	0.789
18:10	17.831	5.585	0.105	0.249	0.000	42.62	2.371	27.57	0.017	0.047	177.8	166.0	96.38	22.99	0.794
18:28	17.966	5.346	0.086	0.239	0.000	42.70	2.279	28.42	0.016	0.046	179.6	167.8	97.09	23.13	0.798
18:46	17.736	5.285	0.083	0.242	0.000	42.29	2.279	28.45	0.039	0.046	179.5	167.8	96.45	23.00	0.794
19: 5	17.540	5.031	0.079	0.238	0.000	44.06	2.318	27.34	0.067	0.067	176.7	165.0	96.74	23.09	0.797
19:23	17.897	5.311	0.078	0.247	0.000	41.76	2.888	28.03	0.038	0.048	184.8	172.4	96.29	22.84	0.789
19:41	18.269	5.159	0.076	0.245	0.000	42.37	2.374	28.40	0.057	0.068	182.9	170.7	97.02	22.99	0.794
20: 0	18.134	5.253	0.081	0.252	0.000	42.13	2.411	28.39	0.041	0.050	182.2	170.1	96.73	22.96	0.792
20:18	17.512	4.657	0.076	0.245	0.000	42.02	2.349	28.78	0.037	0.048	180.5	168.8	95.73	22.75	0.785
20:37	17.603	4.493	0.071	0.231	0.000	40.93	2.728	29.27	0.035	0.047	185.7	173.7	95.41	22.56	0.779
20:55	17.435	4.600	0.000	0.236	0.000	40.63	2.739	29.00	0.037	0.048	183.5	171.5	94.72	22.43	0.774
21:13	17.673	4.799	0.072	0.232	0.000	41.60	2.230	28.98	0.000	0.045	179.2	167.6	95.63	22.71	0.784
21:32	17.393	4.959	0.068	0.222	0.000	41.99	2.621	28.93	0.033	0.043	182.5	170.7	96.26	22.94	0.792
21:50	16.997	4.955	0.066	0.223	0.000	41.64	2.561	28.82	0.034	0.045	180.3	168.8	95.34	22.79	0.787
22: 8	16.800	4.926	0.000	0.220	0.000	41.56	2.549	28.60	0.015	0.044	177.3	165.9	94.72	22.66	0.782
22:27	17.363	4.782	0.067	0.217	0.000	41.79	2.128	29.19	0.015	0.041	177.7	166.4	95.59	22.79	0.787
22:45	17.025	4.790	0.066	0.212	0.000	41.78	2.066	28.90	0.035	0.041	175.4	164.3	94.91	22.70	0.783
23: 4	17.004	4.815	0.063	0.205	0.000	42.26	2.008	29.03	0.032	0.040	174.9	163.9	95.46	22.87	0.789
23:23	17.515	4.622	0.062	0.198	0.000	42.93	1.989	29.72	0.052	0.056	179.3	168.1	97.14	23.18	0.800
23:42	18.062	4.460	0.060	0.192	0.000	42.91	2.175	30.03	0.048	0.053	183.7	172.0	97.99	23.23	0.802

8/12/1984

0: 0	17.897	4.700	0.058	0.191	0.000	43.41	1.970	29.81	0.051	0.055	180.4	169.0	98.14	23.38	0.807
0:18	16.771	4.470	0.059	0.197	0.000	44.91	2.132	29.94	0.052	0.056	179.0	168.0	98.59	23.74	0.819
0:37	18.167	4.460	0.058	0.190	0.000	43.07	2.145	30.25	0.050	0.051	184.3	172.6	98.44	23.33	0.805
0:55	17.940	4.415	0.058	0.183	0.000	43.45	1.888	30.44	0.050	0.056	181.6	170.3	98.48	23.42	0.809
1:14	17.064	4.400	0.057	0.179	0.000	45.38	1.799	29.03	0.048	0.055	173.2	162.4	98.01	23.53	0.812
1:32	17.450	4.710	0.058	0.185	0.000	43.35	2.188	29.93	0.029	0.038	180.5	169.2	97.95	23.41	0.808
1:50	17.165	4.667	0.057	0.180	0.000	43.20	1.843	29.69	0.028	0.036	175.2	164.3	96.86	23.21	0.801
2: 9	16.070	4.859	0.050	0.177	0.000	46.13	1.980	27.76	0.027	0.036	166.6	156.2	97.08	23.57	0.814
2:27	16.840	5.030	0.059	0.186	0.000	43.13	1.920	28.98	0.029	0.038	172.8	162.0	96.21	23.16	0.800
2:46	17.035	5.138	0.058	0.180	0.000	43.65	2.176	29.01	0.028	0.036	175.9	164.8	97.30	23.40	0.808
3: 4	16.543	5.338	0.058	0.180	0.000	43.72	2.114	28.41	0.028	0.036	171.8	161.0	96.42	23.32	0.805
3:23	16.799	5.410	0.057	0.178	0.000	44.21	1.860	28.62	0.026	0.035	170.6	159.9	97.19	23.52	0.812
3:41	16.128	5.810	0.049	0.175	0.000	44.14	1.698	27.82	0.017	0.035	163.9	153.7	95.87	23.40	0.808
4: 0	16.354	5.528	0.053	0.170	0.000	44.16	1.974	28.36	0.027	0.034	169.3	158.7	96.66	23.49	0.811
4:18	15.184	5.399	0.048	0.175	0.000	45.37	1.738	27.59	0.027	0.036	160.7	150.9	95.56	23.49	0.811
4:37	16.130	5.379	0.047	0.169	0.000	43.72	1.691	28.33	0.028	0.035	165.5	155.4	95.53	23.24	0.802
4:55	16.293	5.374	0.047	0.170	0.000	43.64	1.753	28.43	0.026	0.034	167.0	156.7	95.78	23.26	0.803
5:14	16.117	5.543	0.049	0.176	0.000	43.66	1.757	28.28	0.027	0.036	166.2	155.9	95.65	23.30	0.804
5:32	16.361	5.657	0.050	0.180	0.000	43.90	1.757	28.28	0.030	0.038	167.1	156.8	96.25	23.42	0.808
6:28	16.004	5.682	0.053	0.189	0.000	43.39	1.917	27.86	0.025	0.039	166.4	156.0	95.16	23.19	0.800

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

8/12/1984															
6:46	16.469	5.435	0.051	0.178	0.000	43.82	1.774	28.56	0.020	0.037	168.3	157.9	96.34	23.38	0.807
7:34	16.174	5.351	0.050	0.176	0.000	43.75	1.966	28.78	0.026	0.028	169.9	159.4	96.30	23.41	0.808
7:52	16.503	5.137	0.046	0.160	0.000	44.05	1.939	29.06	0.025	0.032	171.3	160.7	96.95	23.47	0.810
8:10	14.965	4.763	0.042	0.146	0.000	47.72	1.483	26.71	0.028	0.030	153.8	144.5	95.88	23.57	0.813
8:29	16.478	5.015	0.050	0.153	0.000	44.35	1.899	29.36	0.023	0.030	171.6	161.1	97.35	23.57	0.814
8:47	16.170	5.024	0.042	0.144	0.000	43.98	1.700	29.07	0.021	0.029	167.3	157.2	96.18	23.35	0.806
9: 5	15.906	5.027	0.000	0.142	0.000	43.84	1.443	28.97	0.030	0.029	163.0	153.3	95.38	23.23	0.802
9:23	16.177	5.020	0.042	0.145	0.000	44.45	1.796	29.24	0.031	0.029	169.1	158.8	96.93	23.55	0.813
9:41	16.044	5.211	0.043	0.148	0.000	44.46	1.504	29.02	0.029	0.029	165.0	155.2	96.49	23.53	0.812
9:59	15.781	5.229	0.045	0.137	0.000	44.55	1.675	28.88	0.021	0.028	165.1	155.2	96.34	23.53	0.812
10:18	15.365	5.108	0.039	0.138	0.000	46.36	1.651	28.19	0.035	0.028	161.5	151.8	96.91	23.79	0.821
10:36	16.588	5.107	0.046	0.144	0.000	45.66	1.498	29.66	0.041	0.026	168.9	158.8	98.77	24.01	0.829
10:54	16.001	5.073	0.046	0.145	0.000	44.71	1.801	29.30	0.021	0.029	168.6	158.4	97.12	23.66	0.817
11:12	16.039	5.088	0.041	0.146	0.000	44.65	1.677	29.51	0.015	0.029	167.9	157.9	97.20	23.68	0.818
11:31	16.102	5.062	0.048	0.154	0.000	44.33	1.844	29.31	0.000	0.031	169.1	158.9	96.88	23.55	0.813
11:49	16.084	5.137	0.049	0.157	0.000	44.35	1.925	29.07	0.000	0.032	169.2	158.9	96.80	23.54	0.812
12: 7	15.767	5.031	0.048	0.154	0.000	46.95	1.577	28.07	0.018	0.030	161.8	152.0	97.65	23.88	0.824
12:25	16.042	5.357	0.046	0.169	0.000	44.43	2.011	28.99	0.012	0.034	170.2	159.8	97.09	23.66	0.817
12:43	15.944	5.272	0.046	0.168	0.000	43.79	1.873	28.84	0.012	0.035	168.0	157.8	95.98	23.37	0.807
13: 2	16.139	5.223	0.051	0.166	0.000	44.15	1.984	29.12	0.000	0.034	170.4	160.0	96.87	23.55	0.813
13:20	16.178	5.253	0.052	0.170	0.000	43.96	2.003	29.15	0.000	0.035	170.9	160.5	96.80	23.52	0.812
13:38	15.838	5.283	0.000	0.000	0.000	43.29	1.690	28.73	0.028	0.036	162.1	152.4	94.89	23.12	0.798
13:56	15.920	5.279	0.000	0.171	0.000	43.28	1.653	28.58	0.017	0.036	164.3	154.4	94.94	23.12	0.798
14:14	15.844	5.280	0.046	0.168	0.000	43.97	1.885	28.64	0.017	0.035	167.3	157.1	95.89	23.37	0.807
14:33	15.863	5.328	0.000	0.000	0.000	44.24	1.665	28.43	0.027	0.035	161.0	151.3	95.59	23.32	0.805
14:51	15.959	5.399	0.000	0.000	0.000	43.83	1.711	28.54	0.016	0.035	161.8	152.1	95.49	23.27	0.803
15: 9	15.910	5.440	0.045	0.163	0.000	44.13	1.899	28.48	0.015	0.034	166.9	156.7	96.12	23.44	0.809
15:28	15.872	5.547	0.050	0.162	0.000	44.26	1.942	28.34	0.016	0.033	166.9	156.6	96.23	23.50	0.811
15:47	15.800	5.541	0.043	0.158	0.000	44.28	1.862	28.30	0.023	0.033	165.7	155.5	96.03	23.47	0.810
16: 5	14.707	5.373	0.000	0.000	0.000	47.42	1.557	26.34	0.008	0.030	148.9	139.9	95.44	23.59	0.814
16:23	15.437	5.739	0.000	0.000	0.000	44.39	0.000	27.92	0.023	0.033	141.0	133.2	93.54	23.12	0.798
16:42	15.436	5.782	0.000	0.000	0.000	44.40	1.569	27.76	0.023	0.033	156.3	147.0	95.00	23.35	0.806
17: 0	15.383	5.807	0.000	0.000	0.000	44.06	1.572	27.70	0.024	0.033	156.0	146.6	94.58	23.25	0.802
17:18	15.342	5.872	0.000	0.000	0.000	44.31	1.565	27.73	0.011	0.033	155.6	146.3	94.86	23.34	0.806
17:36	15.232	5.835	0.000	0.000	0.000	43.75	0.000	27.42	0.000	0.026	138.0	130.4	92.26	22.82	0.788
17:55	15.488	5.806	0.048	0.162	0.000	44.05	2.000	27.51	0.025	0.034	163.8	153.6	95.13	23.32	0.805
18:13	15.438	5.722	0.049	0.156	0.000	45.59	1.595	27.02	0.025	0.033	157.8	148.1	95.63	23.51	0.812
18:31	15.672	5.910	0.048	0.162	0.000	45.01	2.010	27.66	0.026	0.033	164.9	154.7	96.53	23.69	0.818
18:50	15.535	5.876	0.000	0.161	0.000	44.41	2.009	27.44	0.025	0.034	163.0	152.9	95.49	23.42	0.809
19: 8	15.427	5.865	0.000	0.000	0.000	44.08	1.985	27.32	0.025	0.034	159.1	149.4	94.73	23.24	0.802
19:26	15.607	5.857	0.048	0.165	0.000	44.30	2.033	27.52	0.028	0.035	164.7	154.4	95.60	23.43	0.809
19:45	15.840	5.766	0.048	0.166	0.000	44.38	1.692	27.75	0.028	0.035	162.7	152.7	95.71	23.43	0.809
20: 3	15.418	5.619	0.048	0.160	0.000	45.91	1.999	27.00	0.027	0.034	161.9	151.8	96.22	23.62	0.815
20:21	15.697	5.772	0.048	0.163	0.000	44.49	2.027	27.73	0.028	0.035	165.5	155.2	95.99	23.50	0.811
20:40	15.812	5.770	0.048	0.165	0.000	44.49	2.055	27.69	0.028	0.035	166.1	155.7	96.09	23.50	0.811
20:58	16.018	5.589	0.050	0.161	0.000	44.84	1.655	28.12	0.026	0.034	164.0	153.9	96.49	23.58	0.814
21:17	15.809	5.681	0.051	0.162	0.000	44.55	2.008	27.92	0.023	0.035	166.2	155.9	96.24	23.53	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

8/12/1984															
21:35	16.037	5.631	0.051	0.162	0.000	45.00	1.669	28.03	0.019	0.034	163.7	153.7	96.64	23.62	0.815
21:53	15.481	5.678	0.053	0.168	0.000	43.95	1.697	27.56	0.015	0.036	160.8	151.0	94.64	23.20	0.801
22:12	15.255	5.606	0.048	0.161	0.000	46.04	1.976	26.90	0.026	0.034	160.8	150.8	96.05	23.61	0.815
22:30	15.908	5.690	0.052	0.164	0.000	44.96	1.670	27.85	0.025	0.034	163.0	153.0	96.35	23.58	0.814
22:48	15.832	5.732	0.050	0.170	0.000	44.60	1.707	27.69	0.027	0.036	162.8	152.7	95.85	23.46	0.810
8/13/1984															
18:26	15.411	5.155	0.095	0.153	0.000	44.65	1.681	28.69	0.041	0.055	165.6	155.7	95.94	23.51	0.812
18:45	16.101	4.958	0.093	0.159	0.000	45.43	1.735	29.10	0.060	0.050	170.1	159.8	97.69	23.79	0.821
19: 3	15.969	3.500	0.085	0.154	0.000	48.61	1.739	28.25	0.048	0.050	166.4	156.2	98.41	23.79	0.821
19:22	16.444	5.057	0.094	0.161	0.000	45.87	1.778	29.36	0.055	0.050	172.4	161.9	98.87	24.04	0.830
19:40	16.696	4.963	0.096	0.168	0.000	45.59	1.864	29.43	0.055	0.050	174.4	163.7	98.92	23.96	0.827
19:59	16.603	4.852	0.093	0.162	0.000	45.41	1.803	29.45	0.054	0.049	173.4	162.8	98.48	23.85	0.823
20:18	16.245	4.976	0.102	0.160	0.000	45.92	1.768	29.44	0.054	0.050	171.9	161.6	98.72	24.03	0.830
20:37	16.216	4.980	0.099	0.156	0.000	45.89	1.747	29.45	0.055	0.049	171.6	161.2	98.64	24.02	0.829
20:56	16.213	4.954	0.100	0.155	0.000	45.89	1.749	29.49	0.058	0.049	171.8	161.4	98.66	24.03	0.829
21:14	16.015	4.932	0.102	0.159	0.000	46.45	1.763	29.16	0.058	0.052	170.4	160.1	98.69	24.08	0.831
21:33	16.043	5.211	0.097	0.162	0.000	45.96	1.790	29.04	0.044	0.040	169.7	159.4	98.38	24.03	0.829
21:51	16.501	4.890	0.098	0.163	0.000	46.00	1.816	29.48	0.052	0.050	173.3	162.8	99.05	24.04	0.830
22:10	15.995	5.000	0.105	0.160	0.000	45.95	1.775	29.10	0.045	0.041	169.7	159.5	98.18	23.95	0.827
22:28	16.196	5.080	0.105	0.161	0.000	45.70	1.799	29.34	0.046	0.040	171.4	161.0	98.46	23.99	0.828
22:47	16.231	5.000	0.106	0.167	0.000	45.40	1.859	29.40	0.043	0.038	172.3	161.9	98.25	23.90	0.825
23:35	16.004	4.999	0.119	0.158	0.000	45.78	1.795	29.27	0.049	0.013	170.1	159.9	98.18	23.94	0.826
23:54	15.831	5.073	0.116	0.151	0.000	46.08	1.730	29.14	0.046	0.013	168.2	158.1	98.18	24.00	0.829
8/14/1984															
0:12	15.745	5.216	0.118	0.156	0.000	46.11	1.769	28.73	0.045	0.040	167.8	157.6	97.93	23.98	0.828
0:31	15.650	5.351	0.127	0.161	0.000	46.09	1.820	28.53	0.046	0.033	167.4	157.3	97.81	23.99	0.828
0:50	15.953	5.420	0.113	0.169	0.000	46.06	1.876	28.56	0.047	0.034	169.1	158.7	98.23	24.03	0.829
1: 8	15.572	5.400	0.112	0.150	0.000	46.21	1.715	28.65	0.042	0.034	166.0	156.0	97.88	24.05	0.830
1:27	15.616	5.183	0.118	0.149	0.000	46.02	1.701	28.94	0.043	0.036	167.1	157.1	97.81	23.98	0.828
1:46	15.696	5.171	0.120	0.155	0.000	45.85	1.764	29.06	0.045	0.036	168.5	158.5	97.90	23.98	0.828
2: 5	15.306	5.123	0.113	0.149	0.000	46.98	1.697	28.41	0.043	0.031	164.1	154.3	97.86	24.06	0.831
2:23	15.495	5.282	0.119	0.146	0.000	46.39	1.667	29.05	0.043	0.031	166.5	156.7	98.22	24.15	0.834
2:42	15.489	5.298	0.126	0.152	0.000	46.22	1.733	28.80	0.044	0.031	166.6	156.7	97.89	24.05	0.830
3: 1	15.455	5.280	0.125	0.152	0.000	46.07	1.712	28.89	0.045	0.030	166.6	156.7	97.76	24.02	0.829
3:19	15.226	5.286	0.127	0.142	0.000	46.37	1.611	28.79	0.044	0.030	164.3	154.6	97.63	24.06	0.830
3:38	15.001	5.273	0.128	0.141	0.000	46.91	1.499	28.48	0.043	0.031	161.5	152.0	97.50	24.09	0.832
3:57	15.223	5.308	0.131	0.145	0.000	46.36	1.533	28.77	0.044	0.032	163.6	154.0	97.55	24.05	0.830
4:17	15.153	5.603	0.126	0.143	0.000	46.88	1.653	28.36	0.044	0.033	163.2	153.5	97.99	24.22	0.836
4:35	14.978	5.565	0.130	0.146	0.000	46.87	1.657	28.33	0.045	0.038	162.8	153.2	97.76	24.20	0.835
4:54	15.195	5.441	0.132	0.148	0.000	46.82	1.689	28.57	0.045	0.032	164.6	154.8	98.07	24.21	0.836
5:13	15.128	5.421	0.137	0.149	0.000	46.61	1.564	28.54	0.046	0.029	163.0	153.4	97.62	24.11	0.832
5:31	15.132	5.420	0.142	0.149	0.000	46.80	1.574	28.66	0.046	0.031	163.7	154.0	97.96	24.20	0.835
5:50	15.369	5.395	0.141	0.155	0.000	46.38	1.638	28.60	0.048	0.030	165.0	155.2	97.75	24.07	0.831

GAS CHROMATOGRAPH DATA

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

8/14/1984															
6: 9	14.903	5.502	0.132	0.147	0.000	47.59	1.551	27.90	0.045	0.030	160.0	150.5	97.80	24.23	0.836
6:27	14.880	5.442	0.140	0.147	0.000	47.48	1.573	28.31	0.044	0.030	161.6	152.1	98.04	24.29	0.839
6:46	15.695	5.275	0.134	0.154	0.000	46.32	1.634	28.93	0.046	0.033	167.0	157.0	98.23	24.10	0.832
7: 5	15.394	5.498	0.128	0.148	0.000	46.66	1.560	28.52	0.044	0.034	163.7	154.0	97.99	24.16	0.834
7:24	15.022	5.986	0.124	0.143	0.000	47.30	1.499	27.98	0.042	0.031	159.9	150.4	98.12	24.37	0.841
7:42	15.043	5.987	0.118	0.151	0.000	47.37	1.581	27.57	0.044	0.032	159.6	150.0	97.89	24.30	0.839
8: 1	15.384	5.941	0.113	0.153	0.000	46.49	1.584	28.13	0.045	0.032	162.5	152.7	97.87	24.19	0.835
8:20	15.182	5.541	0.119	0.149	0.000	46.85	1.558	28.14	0.044	0.038	161.8	152.2	97.63	24.12	0.833
8:39	15.575	5.280	0.123	0.153	0.000	45.83	1.579	29.03	0.046	0.040	166.3	156.5	97.66	23.98	0.828
8:57	15.800	4.953	0.119	0.148	0.000	45.78	1.544	29.59	0.045	0.036	168.2	158.3	98.01	23.97	0.828
9:16	15.412	5.074	0.116	0.147	0.000	46.09	1.511	29.45	0.046	0.034	166.1	156.4	97.88	24.06	0.831
9:35	15.716	4.928	0.123	0.154	0.000	45.56	1.572	29.69	0.047	0.034	168.7	158.8	97.83	23.93	0.826
9:54	15.609	4.873	0.126	0.148	0.000	45.59	1.537	29.70	0.047	0.033	168.0	158.2	97.66	23.91	0.825
10:13	15.281	5.179	0.127	0.158	0.000	46.11	1.588	29.08	0.049	0.030	165.6	155.9	97.60	24.02	0.829
10:31	15.993	4.919	0.119	0.167	0.000	45.24	1.696	29.44	0.050	0.030	170.2	160.0	97.65	23.80	0.821
10:50	16.018	4.767	0.111	0.161	0.000	45.17	1.629	29.96	0.048	0.037	171.2	161.1	97.90	23.84	0.823
11: 9	15.938	4.730	0.113	0.163	0.000	45.44	1.743	30.07	0.049	0.031	172.3	162.2	98.27	23.95	0.827
11:28	16.233	4.756	0.114	0.168	0.000	45.29	1.698	30.09	0.050	0.031	173.0	162.7	98.43	23.93	0.826
12:41	14.942	5.532	0.107	0.151	0.000	45.49	1.796	29.57	0.048	0.030	167.7	158.0	97.67	24.16	0.834
12:58	16.175	4.963	0.100	0.143	0.000	47.40	1.597	30.02	0.039	0.028	170.6	160.5	100.47	24.56	0.848
13:29	15.682	5.240	0.102	0.157	0.000	46.66	1.683	29.73	0.048	0.032	169.5	159.6	99.33	24.40	0.842
13:55	17.540	4.427	0.098	0.189	0.000	45.59	2.040	30.34	0.050	0.035	181.7	170.4	100.31	24.02	0.829
14:33	17.722	4.500	0.087	0.174	0.000	44.85	1.896	30.32	0.046	0.034	180.3	169.1	99.63	23.81	0.822
14:52	17.229	4.221	0.088	0.175	0.000	41.43	1.883	28.84	0.045	0.035	173.8	162.9	93.95	22.31	0.770
15:12	17.321	4.300	0.097	0.173	0.000	42.18	1.886	29.34	0.045	0.034	175.8	164.8	95.37	22.69	0.783
15:30	17.688	4.059	0.094	0.177	0.000	42.74	1.936	29.65	0.045	0.034	178.6	167.3	96.42	22.85	0.789
15:49	17.044	4.480	0.094	0.171	0.000	43.92	1.855	29.42	0.048	0.034	174.9	164.0	97.06	23.27	0.803
17: 4	17.216	4.154	0.096	0.168	0.000	44.47	1.837	30.07	0.042	0.030	177.1	166.2	98.08	23.46	0.810
17:22	17.168	4.190	0.108	0.170	0.000	43.89	1.882	30.10	0.043	0.029	177.7	166.8	97.58	23.33	0.805
17:41	16.883	4.256	0.096	0.152	0.000	44.14	1.688	30.12	0.041	0.029	174.3	163.8	97.41	23.39	0.807
17:59	16.906	4.249	0.097	0.152	0.000	43.94	1.685	30.22	0.040	0.031	174.7	164.2	97.31	23.36	0.806
18:18	16.629	4.515	0.114	0.152	0.000	44.09	1.708	29.72	0.040	0.033	172.8	162.3	97.00	23.38	0.807
18:36	16.856	4.343	0.107	0.152	0.000	44.10	1.699	29.83	0.040	0.033	173.7	163.1	97.16	23.34	0.806
18:55	16.965	4.261	0.100	0.153	0.000	44.53	1.687	30.01	0.043	0.033	174.5	163.8	97.78	23.47	0.810
19:14	16.832	4.021	0.101	0.159	0.000	43.17	1.742	30.28	0.040	0.038	175.6	165.0	96.38	23.07	0.796
19:32	17.026	4.135	0.103	0.161	0.000	43.81	1.758	30.21	0.042	0.037	176.3	165.5	97.28	23.29	0.804
19:51	17.117	4.145	0.098	0.162	0.000	43.49	1.776	30.08	0.041	0.029	176.1	165.3	96.94	23.17	0.800
20: 9	16.395	4.402	0.109	0.155	0.000	45.02	1.714	29.20	0.040	0.028	170.2	159.9	97.06	23.44	0.809
20:28	16.685	4.453	0.114	0.157	0.000	44.28	1.748	29.62	0.043	0.029	173.1	162.6	97.13	23.39	0.807
20:47	16.736	4.274	0.113	0.159	0.000	44.57	1.762	29.69	0.043	0.031	173.7	163.1	97.38	23.42	0.808
21: 5	16.596	4.329	0.120	0.153	0.000	44.72	1.712	29.60	0.042	0.031	172.4	162.0	97.31	23.45	0.809
21:25	16.840	4.284	0.119	0.152	0.000	43.86	1.719	29.84	0.043	0.032	174.1	163.5	96.89	23.26	0.803
21:44	16.661	4.242	0.114	0.147	0.000	44.32	1.660	29.76	0.044	0.033	172.5	162.1	96.98	23.33	0.805
22: 2	16.586	4.299	0.127	0.149	0.000	44.87	1.684	29.68	0.049	0.029	172.5	162.1	97.46	23.49	0.811
22:21	16.252	4.853	0.122	0.155	0.000	45.22	1.725	28.63	0.049	0.028	168.5	158.2	97.03	23.54	0.813
22:40	16.297	4.708	0.117	0.142	0.000	44.41	1.620	28.92	0.037	0.028	167.9	157.7	96.28	23.31	0.805
22:58	16.359	4.442	0.128	0.144	0.000	44.22	1.655	29.22	0.037	0.028	169.6	159.4	96.22	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

8/14/1984															
23:17	16.596	4.385	0.137	0.156	0.000	44.19	1.764	29.31	0.037	0.029	172.2	161.7	96.60	23.25	0.803
23:36	16.762	4.347	0.135	0.151	0.000	44.24	1.728	29.39	0.035	0.031	172.5	162.0	96.82	23.27	0.803
8/15/1984															
8:13	15.354	5.140	0.102	0.162	0.000	47.41	1.576	28.93	0.046	0.031	164.9	155.1	98.75	24.32	0.839
8:31	15.725	4.558	0.098	0.160	0.000	46.06	1.727	28.30	0.048	0.034	165.6	155.6	96.71	23.54	0.813
8:50	16.906	4.089	0.081	0.186	0.000	45.26	2.072	28.58	0.046	0.031	173.9	162.9	97.26	23.27	0.803
9: 9	16.470	4.414	0.092	0.179	0.000	46.33	2.028	27.87	0.045	0.033	169.8	159.1	97.47	23.50	0.811
9:46	14.197	4.082	0.114	0.137	0.000	52.08	1.562	25.47	0.041	0.031	149.5	140.4	97.71	24.16	0.834
10: 5	16.281	4.448	0.122	0.152	0.000	45.14	1.739	29.00	0.045	0.031	169.9	159.5	96.96	23.45	0.809
10:23	16.325	4.611	0.116	0.152	0.000	45.29	1.713	29.32	0.045	0.032	170.7	160.4	97.60	23.65	0.816
10:42	17.833	4.245	0.087	0.182	0.000	42.63	2.072	29.78	0.046	0.035	180.8	169.4	96.91	22.96	0.793
11: 1	17.506	4.521	0.093	0.187	0.000	43.07	2.087	29.49	0.046	0.036	179.2	167.9	97.03	23.12	0.798
11:20	17.240	4.714	0.099	0.187	0.000	43.51	2.106	29.24	0.047	0.035	177.8	166.6	97.18	23.26	0.803
11:38	16.101	5.029	0.122	0.144	0.000	44.95	1.628	28.71	0.042	0.031	167.0	156.9	96.75	23.54	0.813
11:57	16.276	4.372	0.122	0.157	0.000	44.61	1.769	29.65	0.046	0.031	172.3	162.0	97.03	23.45	0.810
12:16	16.398	4.549	0.107	0.150	0.000	44.85	1.659	29.64	0.040	0.031	171.1	160.8	97.43	23.57	0.814
12:34	16.553	4.342	0.098	0.153	0.000	44.33	1.674	29.72	0.043	0.031	172.0	161.6	96.95	23.36	0.806
12:53	16.784	4.245	0.101	0.153	0.000	44.10	1.692	30.02	0.045	0.032	174.0	163.4	97.17	23.35	0.806
13:12	16.947	4.213	0.107	0.160	0.000	43.39	1.754	30.22	0.046	0.031	176.0	165.3	96.87	23.21	0.801
13:31	16.985	4.311	0.107	0.157	0.000	43.85	1.750	30.02	0.047	0.031	175.4	164.7	97.26	23.32	0.805
13:50	16.694	4.401	0.101	0.155	0.000	43.99	1.705	30.10	0.047	0.032	174.2	163.7	97.22	23.41	0.808
14: 9	16.238	4.579	0.120	0.158	0.000	45.06	1.753	29.20	0.049	0.031	170.7	160.3	97.19	23.54	0.813
14:28	16.660	4.606	0.116	0.156	0.000	44.11	1.774	29.56	0.046	0.032	173.3	162.7	97.05	23.40	0.808
14:47	16.619	4.422	0.104	0.152	0.000	44.06	1.682	29.97	0.044	0.033	173.2	162.8	97.09	23.40	0.808
15: 6	16.782	4.317	0.111	0.157	0.000	43.63	1.755	30.11	0.048	0.034	175.3	164.6	96.94	23.29	0.804
15:24	16.807	4.339	0.114	0.158	0.000	44.12	1.770	29.98	0.048	0.034	175.1	164.5	97.37	23.40	0.808
15:43	16.623	4.362	0.106	0.152	0.000	44.19	1.675	30.02	0.047	0.033	173.4	163.0	97.21	23.42	0.809
16:36	16.653	4.541	0.121	0.163	0.000	44.67	1.806	29.82	0.051	0.029	174.6	164.0	97.86	23.61	0.815
16:55	16.340	4.476	0.116	0.151	0.000	44.72	1.688	29.83	0.047	0.033	172.2	161.9	97.41	23.57	0.814
17:14	16.494	4.452	0.124	0.163	0.000	44.47	1.795	29.82	0.050	0.031	174.1	163.6	97.39	23.51	0.811
17:32	16.759	4.317	0.105	0.156	0.000	44.48	1.733	30.23	0.048	0.034	175.2	164.6	97.86	23.56	0.813
17:51	16.866	4.251	0.090	0.157	0.000	44.59	1.738	30.25	0.046	0.034	175.4	164.8	98.02	23.56	0.813
18:10	16.305	4.426	0.096	0.159	0.000	44.99	1.734	29.42	0.046	0.030	170.9	160.6	97.21	23.51	0.811
18:29	16.537	4.419	0.105	0.154	0.000	44.50	1.728	29.76	0.047	0.032	172.8	162.4	97.29	23.47	0.810
18:48	17.006	4.220	0.094	0.171	0.000	43.81	1.834	30.22	0.049	0.032	177.1	166.3	97.43	23.34	0.806
19: 6	16.869	4.362	0.086	0.157	0.000	43.98	1.732	29.86	0.046	0.029	173.9	163.3	97.12	23.33	0.805
19:25	16.323	4.545	0.103	0.148	0.000	45.13	1.666	29.60	0.047	0.029	170.8	160.5	97.59	23.64	0.816
19:44	15.570	4.900	0.112	0.130	0.000	45.53	1.505	28.90	0.041	0.038	164.4	154.7	96.73	23.67	0.817

MIFGA PROGRAM
TEST BOM/FGT-015

SULFUR GAS CHROMATOGRAPH DATA

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

8/12/1984						
17:21	46.2	0.0	38.0	15.8	383	382
17:58	86.0	7.9	6.1	0.0	2646	383
19:17	85.0	8.9	6.2	0.0	2515	384
19:59	87.5	8.5	4.0	0.0	2569	385
22:19	84.9	8.9	6.1	0.0	2446	387
22:41	83.2	8.4	5.5	2.9	2615	388
23:26	86.1	8.0	5.9	0.0	2644	389
23:55	85.8	8.8	5.3	0.0	2490	390
8/13/1984						
0:41	84.4	8.7	6.9	0.0	2501	391
1: 1	85.1	9.2	5.7	0.0	2390	392
3: 1	84.4	8.6	7.0	0.0	2405	394
3:35	82.3	9.4	6.4	1.9	2443	395
4: 0	82.7	8.9	5.8	2.6	2346	396
5: 1	83.9	9.2	6.9	0.0	2151	397
5:19	88.5	9.0	0.0	2.5	2531	398
5:55	87.3	8.8	3.9	0.0	2481	399
8:22	74.2	19.4	6.4	0.0	2292	400
8:50	84.9	9.4	5.7	0.0	2503	401
9:26	82.0	10.0	5.6	2.5	2612	402
10: 1	81.8	10.1	5.5	2.6	2545	403
12:42	85.4	9.3	5.3	0.0	2264	405
13:11	53.8	0.0	29.5	16.7	369	407
13:51	82.7	9.1	5.3	2.9	2410	408
14:47	84.0	9.9	4.2	1.9	2904	409
15:55	84.2	9.3	3.2	3.2	2574	410
16:59	82.2	9.2	4.4	4.2	2172	412
17:22	82.9	8.4	4.9	3.9	2415	413
17:52	82.0	8.1	6.1	3.9	2605	414
18:12	84.0	9.6	5.3	5.1	2524	415
18:40	82.5	8.3	5.3	3.9	2528	416
18:59	83.1	8.1	5.2	3.6	2552	417
20:10	80.4	9.5	4.9	5.2	2843	418
20:56	82.8	8.0	5.4	3.8	3326	419
21:54	82.0	8.0	5.8	4.1	2883	420
23: 3	82.2	8.2	5.3	4.3	2736	421
23:19	82.8	7.8	5.0	4.3	3124	422
23:49	81.3	8.0	5.3	5.3	2570	423
8/14/1984						
0:53	81.0	8.6	5.8	4.6	2559	424
1:54	81.7	8.4	5.4	4.5	3110	425
2:53	82.8	8.5	3.7	5.0	2497	426
3:53	80.7	8.6	5.0	5.7	2410	427
4:52	81.1	8.4	5.2	5.2	2871	428
6:15	80.2	8.6	5.6	5.7	2567	429

MIFGA PROGRAM
TEST BOM/FGT-015

SULFUR GAS CHROMATOGRAPH DATA

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

8/14/1984						
6:54	82.1	8.1	5.1	4.7	2640	430
7:43	78.0	11.5	5.5	5.0	2667	431
8: 6	77.8	11.6	5.2	5.4	2391	432
8:33	81.4	8.5	5.1	4.9	2566	433
9: 1	82.3	8.2	4.9	4.6	2570	434
9:46	85.3	8.2	2.1	4.3	2471	436
10: 5	82.3	10.1	3.0	4.5	2562	437
10:23	84.9	7.4	3.7	3.9	2791	438
10:44	84.3	7.4	4.3	3.9	2747	439
11:26	82.7	7.9	5.5	4.0	2686	440
11:46	83.1	8.2	4.9	3.8	2747	441
12:40	81.6	9.1	5.6	3.8	2426	442
12:57	83.1	8.5	4.8	3.5	2533	443
13:34	83.5	8.8	5.0	2.7	2628	444
13:51	84.1	8.1	5.2	2.6	2988	445
14:14	81.0	10.7	5.1	3.2	2655	446
14:42	83.6	8.2	5.6	2.7	2866	447
15: 0	84.6	7.7	5.3	2.3	2871	448
15:30	84.7	7.9	5.3	2.2	2860	449
15:52	83.7	7.7	5.4	3.2	2813	450
16:12	81.9	9.4	5.3	3.4	2713	451
17: 7	83.3	7.6	6.0	3.1	2772	452
18: 2	82.1	7.9	6.0	3.9	2446	453
18:20	86.8	8.5	0.0	4.7	2485	454
19: 4	84.1	8.0	4.0	3.9	2481	455
8/15/1984						
11:52	82.7	7.2	4.3	5.8	2341	484
12:12	80.0	10.8	4.2	5.0	2044	485
12:41	82.4	7.9	4.4	5.2	2184	486
13:34	83.5	8.2	3.8	4.5	2354	487
14:54	81.0	7.9	5.9	5.2	2181	488
19:10	82.8	8.9	5.4	2.9	4025	493

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.

Reference: Thimsen, Maurer et al, 1984

AVERAGE FROM PERIOD: 8/12/84 0:00 TO 8/13/84 8:00

SIGNAL	AVERAGE	UNITS	STD.DEV.
CO	28.492	%	1.510
CO2	5.578	%	0.563
O2	-0.362	%	0.239
SIGMA	163.584	BTU/SCF	7.986
AG VEL	0.055	SPH	0.691
GR VEL	0.378	RPD/T	0.307
T - 3	--OFF--	DEG C	
T - 8	--OFF--	DEG C	
T - 9	--OFF--	DEG C	
T-701	21.345	DEG C	3.212
T-702	33.382	DEG C	3.235
T-703	57.059	DEG C	2.706
T-703A	49.428	DEG C	2.848
TT1-703	59.396	DEG C	1.114
TT2-703	59.074	DEG C	1.101
T-705	231.648	DEG C	36.633
T-706	153.467	DEG C	12.719
T-707	179.143	DEG C	19.893
T-710	19.769	DEG C	1.137
T-711	83.201	DEG C	4.120
T-712	19.960	DEG C	1.150
T-713	24.502	DEG C	2.801
T-715	137.932	DEG C	6.562
T-806	165.295	DEG C	16.723
T-811	--OFF--	DEG C	
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	390.775	DEG C	29.287
T-820	128.149	DEG C	59.097
T-821	64.273	DEG C	6.246
T-822	66.116	DEG C	3.214
T-823	69.116	DEG C	3.296
F-701	793.266	SCFM	27.194
F-715	187.730	LBS/HR	116.160
F-802	3135.350	SCFM	306.798
F-803	0.000	SCFM	0.000
P-703	5.300	IN WC	1.054
P-705	0.874	IN WC	0.409
P-704	4.427	IN WC	0.856
P-706	0.713	IN WC	0.400
P-707	-7.502	IN WC	0.000
P-810	0.454	IN WC	2.567

AVERAGE BASE TEMPERATURE 21.541

AVERAGE FROM PERIOD: 8/13/84 9:00 TO 8/14/84 8:00

SIGNAL	AVERAGE	UNITS	STD.DEV.
CO	29.178	%	0.713
CO2	5.232	%	0.258
O2	-0.404	%	0.230
SIGMA	161.362	BTU/SCF	1.567
AG VEL	-0.008	SPH	0.002
GR VEL	0.563	RPD/T	0.212
T - 3	--OFF--	DEG C	
T - 8	--OFF--	DEG C	
T - 9	--OFF--	DEG C	
T-701	23.263	DEG C	3.060
T-702	34.250	DEG C	2.931
T-703	56.982	DEG C	0.558
T-703A	47.251	DEG C	3.642
TT1-703	59.666	DEG C	0.088
TT2-703	59.344	DEG C	0.096
T-705	388.520	DEG C	57.209
T-706	239.557	DEG C	38.830
T-707	286.781	DEG C	39.571
T-710	19.530	DEG C	0.514
T-711	81.198	DEG C	6.324
T-712	19.663	DEG C	0.475
T-713	26.152	DEG C	1.423
T-715	138.374	DEG C	1.031
T-806	265.494	DEG C	36.836
T-811	--OFF--	DEG C	
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	441.715	DEG C	31.980
T-820	111.840	DEG C	22.285
T-821	61.434	DEG C	2.050
T-822	68.054	DEG C	0.931
T-823	71.939	DEG C	0.915
F-701	1192.001	SCFM	0.000
F-715	469.745	LBS/HR	199.480
F-802	3629.742	SCFM	326.490
F-803	0.000	SCFM	0.000
P-703	10.814	IN WC	0.854
P-705	1.751	IN WC	0.453
P-704	9.064	IN WC	1.077
P-706	1.085	IN WC	0.389
P-707	-7.503	IN WC	0.000
P-810	-1.569	IN WC	3.110

AVERAGE BASE TEMPERATURE 21.876

AVERAGE FROM PERIOD: 8/14/84 9:00 TO 8/15/84 20:00

SIGNAL	AVERAGE	UNITS	STD.DEV.
CO	29.009	%	1.266
CO2	4.836	%	0.279
O2	-0.369	%	0.238
SIGMA	157.705	BTU/SCF	26.075
AG VEL	0.258	SPH	2.720
GR VEL	1.025	RPD/T	0.322
T - 3	--OFF--	DEG C	
T - 8	--OFF--	DEG C	
T - 9	--OFF--	DEG C	
T-701	26.397	DEG C	2.882
T-702	37.003	DEG C	2.573
T-703	57.513	DEG C	0.520
T-703A	44.494	DEG C	1.895
TT1-703	59.745	DEG C	0.122
TT2-703	59.428	DEG C	0.137
T-705	399.887	DEG C	38.425
T-706	222.476	DEG C	12.188
T-707	306.662	DEG C	26.438
T-710	19.917	DEG C	0.563
T-711	74.800	DEG C	3.463
T-712	20.090	DEG C	0.479
T-713	28.397	DEG C	1.713
T-715	141.573	DEG C	2.504
T-806	336.171	DEG C	23.087
T-811	--OFF--	DEG C	
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	626.567	DEG C	59.226
T-820	227.412	DEG C	26.091
T-821	59.837	DEG C	3.784
T-822	74.202	DEG C	2.780
T-823	77.672	DEG C	5.739
F-701	1406.943	SCFM	309.829
F-715	710.076	LBS/HR	170.586
F-802	2723.011	SCFM	519.200
F-803	0.000	SCFM	0.000
P-703	19.006	IN WC	5.780
P-705	7.811	IN WC	2.879
P-704	11.194	IN WC	2.966
P-706	6.754	IN WC	2.561
P-707	-7.502	IN WC	0.000
P-810	-6.597	IN WC	3.848

AVERAGE BASE TEMPERATURE 21.855

APPENDIX K

Retort Pressure and Temperature Probe Data

Reference: Thimsen, Maurer et al (1984)

RETORT TEMPERATURE AND PRESSURE PROBE DATA

TEST: BOM/FGT-015

COAL: KEMMERER

DATE: 08/12/84

RETORT ACCESS PORT NUMBER:

5

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

0	0.0	---
6	0.05	943
12	0.2	910
18	0.4	888
24	0.8	849
30	1.4	---
36	1.9	849
42	2.5	832
54	3.1	---
60	3.3	---
48	2.8	---
66	3.6	804
72	3.7	804
78	3.8	204

TIME (hrs)	1413	1440
Blast Air (scfm)	804	774
Saturation Temperature (deg C)	60.0	60.0
Ashpit Pressure (inwc)	5.9	4.8
Offtake Temperature (deg C)	212	218

RETORT TEMPERATURE AND PRESSURE PROBE DATA

TEST: BOM/FGT-015

COAL: KEMMERER

DATE: 08/13/84

RETORT ACCESS PORT NUMBER:

5

DATA: INCHES ABOVE GRATE	PRESSURE (inwc)	TEMPERATURE (deg C)	TIME (hrs)	710	745
0	0.0	---	Blast Air	776	801
6	0.1	---	(scfm)		
12	0.4	---			
18	0.7	1154	Saturation	60.0	60.0
24	0.9	932	Temperature		
30	1.3	932	(deg C)		
36	1.8	904			
42	2.4	860	Ashpit	7.2	7.2
48	3.4	827	Pressure		
54	4.0	793	(inwc)		
60	4.5	793			
66	4.9	782	Offtake	259	256
72	5.5	---	Temperature		
78	5.5	510	(deg C)		
84	5.6	227			

RETORT TEMPERATURE AND PRESSURE PROBE DATA

TEST: BOM/FGT-015 COAL: KEMMERER
 DATE: 08/14/84
 RETORT ACCESS PORT NUMBER: 5

DATA: INCHES ABOVE GRATE	PRESSURE (inwc)	TEMPERATURE (deg C)	TIME (hrs)	718	748
0	0.7	---	Blast Air	1195	1196
6	1.5	---	(scfm)		
12	1.8	---	Saturation	60.0	60.0
18	1.9	916	Temperature		
24	2.1	860	(deg C)		
30	2.6	832			
36	3.0	838			
42	3.6	821	Ashpit	10.5	10.0
48	4.2	799	Pressure		
54	5.0	788	(inwc)		
60	5.6	777			
66	6.5	771	Offtake	483	453
72	7.1	---	Temperature		
78	7.4	643	(deg C)		
84	7.6	382			

RETORT TEMPERATURE AND PRESSURE PROBE DATA

TEST: BOM/FGT-015

COAL: KEMMERER

DATE: 08/15/84

RETORT ACCESS PORT NUMBER:

5

DATA: INCHES ABOVE GRATE	PRESSURE (inwc)	TEMPERATURE (deg C)	TIME (hrs)	713	757
6	1.9	738	Blast Air (scfm)	1490	1496
12	2.0	982			
18	2.3	960			
24	2.7	843	Saturation Temperature (deg C)	60.0	60.0
30	3.4	860			
36	4.0	849			
42	4.9	843			
48	5.7	832	Ashpit Pressure (inwc)	21.5	21.1
54	6.9	804			
60	8.1	793			
66	9.2	782			
72	10.5	---	Offtake Temperature (deg C)	423	418
78	11.0	649			
84	11.0	349			

APPENDIX L

Gas Cooler/Tar Separator Operator's Log

These are the comments recorded by the operators of the enlarged gas cooler/tar scrubber during its operation.

GLO - Gasifier Lead Operator

CETCO - Condensor ESP Tar Collection Operator

August 11, 1984

- 1320 Alarm sounds, system shutdown. Blown out diaphragm gone for unknown reason, but the load changed less than an hour ago.
- 1420 Tar drain
- 1430 Steam cleaned the system.
- 1814 The oxygen level went over 1.0. The system was down for 5 minutes due to the fire test.
- 2145 System down to clean the ESP top.

August 12, 1984

- 0000 System is up now. Removed the ESP top, cleaned the teflon high voltage insulator, removed tar spots about 1/8 inch in diameter. When the high voltage shorts to the ground through the tarred high voltage insulator, the thermocouple readout gives 1888. Now the system works fine.

Note: Due to the long fire tests, the oxygen level exceeds 1.0% thus the oxygen alarm sounds. To avoid this, turn the oxygen analyzer to Calib., wait for the oxygen level to drop to less than 0.5 of full scale (full scale 0 to 10).

- 0930 Restricted the flow to about 4 cfm since we were getting negative pressure in the system. I will bring it up again if the cyclone outlet pressure is raised high again.
- 1000 Talked to BS&B and they agreed to raise the cyclone pressure during the fire tests. They also adjusted the setting on the RAPs to reduce the air intrusion to a minimum. I, therefore, raised P-4 back to normal.
- 1430 Drained 78 pounds of juice into new drum.

August 13, 1984

- 0930 Tar drain into drum number 5.
- 1745 System down for cleaning the high voltage insulator.
- 1950 CETCO system up. The teflon high voltage insulator had no tar on it or any electrical continuity. I played with the electrode spacing, with

air in the ESP the current was 0.1 millamp with 6.5 Kvolt.

August 14, 1984

- 1200 System is down because P-1 reads -1.0 inch water and the cyclone outlet is 6.2 inches water. The clog is somewhere above the V-1 and V-2 valves. I will drain the system and steam clean it.
- 1500 System up, now using the second tank of nitrogen. Majid needs gas for his engine.

August 15, 1984

- 0000 System is down because of negative P-1, P-2, P-3 readings.
- 1200 System is still down. I will steam clean the system and then do some efficiency testing. Last tar drain into drum number 5 for the period ending 0000 on 8/15.
- 1400 I ruptured the last rupture disc when I was steaming. Steam was input via the V-4 valve, V-1 and V-2 were open while V-11 and V-12 were closed. I watched P-2 high range and it never went over 1 psig when the disc ruptured. Maybe the high temperature lowered the rating of the disc. Now we are using 1/8 inch red rubber for a diaphragm.
- 1500 System is up for testing.
- 1800 End of test. Start purging with nitrogen.

APPENDIX M

Gas Cooler/Tar Separator Operator Logged Data

Signals are identified in Figure 4-3.

TIME	11-AUG-84 11:20:00	11-AUG-84 17:11:00	11-AUG-84 18:08:00	11-AUG-84 19:02:00	11-AUG-84 20:00:00	11-AUG-84 21:20:00
O2 (%)		0.2	0.60	0.00	0.7	
HV kv	11.00	11.5	10.00	10.00	10.0	
I millA	0.50	0.4	0.60	0.60	0.5	
P1 "H2O	2.10	-0.5	0.00	0.00	0.0	
P2 "H2O	2.10	-0.5	0.00	0.00	0.0	
P3 "H2O	2.10	-0.4	0.00	0.00	0.0	
P1-P2 "H2O	0.00	0.0	0.00	0.00	0.0	
P2-P3 "H2O	0.15	0.0	0.00	0.10	0.1	
DP4 "H2O	7.20	8.0	6.00	6.00	6.0	
T1 DEG F	394.00	231.0	270.00	217.00	210.0	209.0
T2 DEG F	118.00	121.0	120.00	114.00	125.0	114.0
T3 DEG F	123.00	130.0	111.00	110.00	112.0	108.0
T4 DEG F	134.00	137.0	85.00	97.00	90.0	93.0
T5 DEG F	116.00	127.0	81.00	82.00	83.0	83.0
T6 DEG F	92.00	98.0	78.00	82.00	83.0	83.0
T7 DEG F	91.00	91.0	78.00	92.00	79.0	82.0
T8 DEG F	86.00	87.0	77.00	74.00	75.0	76.0
T9 DEG F	118.00	116.0	98.00	98.00	99.0	98.0
T10 DEG F	112.00	105.0	95.00	100.00	96.0	96.0
ROTOMETER (GPM)	MAX	41.0	MAX	MAX	MAX	MAX
P5 PSI	40.00	52.0	52.00	54.00	54.0	54.0
P6 PSI	91.00	85.0	80.00	80.00	84.0	84.0
V11	4.00	3.0	3.00	3.00	3.0	3.0
P704 "H2O		0.7	1.00	1.00	1.0	0.7

M-2

TIME	12-AUG-84 00:20:00	12-AUG-84 01:00:00	12-AUG-84 02:00:00	12-AUG-84 03:00:00	12-AUG-84 04:00:00	12-AUG-84 05:00:00
O2 (%)	0.50	0.00	0.00	0.00	0.00	0.00
HV kv	9.00	11.00	10.50	10.00	10.00	10.00
I millA	1.00	0.50	0.50	0.80	0.80	0.80
P1 "H2O	0.50	0.00	0.00	-0.50	-0.70	-0.30
P2 "H2O	-0.50	0.00	0.00	-0.50	-0.70	-0.30
P3 "H2O	-0.50	0.00	0.00	-0.50	-0.70	-0.30
P1-P2 "H2O	0.00	0.00	0.00	0.00	0.00	0.00
P2-P3 "H2O	0.05	0.07	0.07	0.07	0.07	0.06
DP4 "H2O	6.00	6.50	6.50	6.00	6.50	7.00
T1 DEG F	211.00	229.00	240.00	245.00	251.00	251.00
T2 DEG F		114.00	116.00	121.00	121.00	123.00
T3 DEG F	105.00	110.00	107.00	106.00	105.00	110.00
T4 DEG F	84.00	87.00	87.00	85.00	86.00	93.00
T5 DEG F	78.00	79.00	78.00	78.00	78.00	80.00
T6 DEG F	75.00	75.00	75.00	76.00	75.00	76.00
T7 DEG F	77.00	78.00	77.00	79.00	78.00	80.00
T8 DEG F	73.00	73.00	73.00	73.00	73.00	74.00
T9 DEG F	92.00	94.00	95.00	96.00	95.00	98.00
T10 DEG F	90.00	90.00	93.00	95.00	93.00	96.00
ROTOMETER (GPM)	MAX	MAX	MAX	MAX	MAX	MAX
P5 PSI	54.00	54.00	54.00	53.00	53.00	52.00
P6 PSI	98.00	88.00	82.00	88.00	84.00	84.00
V11	3.00	3.00	3.00	3.00	3.00	3.00
P704 "H2O	0.80	0.80	0.80	0.70	1.00	0.80

TIME	12-AUG-84 06:00:00	12-AUG-84 07:20:00	12-AUG-84 08:00:00	12-AUG-84 09:15:00	12-AUG-84 10:00:00	12-AUG-84 11:55:00
O2 (%)	0.00	0.00	0.00	0.02	0.00	0.01
HV kv	10.00	10.00	10.00	10.00	10.00	11.00
I millA	0.90	0.90	0.90	0.90	0.90	0.50
P1 "H2O	-0.40	-0.40	-0.50	-0.80	-0.20	-0.40
P2 "H2O	-0.40	-0.40	-0.50	-0.80	-0.20	-0.30
P3 "H2O	-0.40	-0.40	-0.50	-0.80	-0.20	-0.20
P1-P2 "H2O	0.00	0.00	0.00	0.00	0.00	0.00
P2-P3 "H2O	0.07	0.07	0.06	0.07	0.05	0.05
DP4 "H2O	6.50	7.00	6.00	5.60	4.50	4.50
T1 DEG F	247.00	251.00	260.00	267.00	260.00	260.00
T2 DEG F	119.00	119.00	114.00	111.00	111.00	116.00
T3 DEG F	107.00	106.00	107.00	103.00	121.00	128.00
T4 DEG F	91.00	92.00	89.00	93.00	130.00	136.00
T5 DEG F	80.00	78.00	79.00	75.00	110.00	119.00
T6 DEG F	75.00	75.00	76.00	75.00	85.00	90.00
T7 DEG F	79.00	78.00	79.00	80.00	88.00	91.00
T8 DEG F	73.00	73.00	75.00	75.00	83.00	86.00
T9 DEG F	97.00	97.00	93.00	94.00	110.00	111.00
T10 DEG F	96.00	94.00	93.00	92.00	103.00	107.00
ROTOMETER (GPM)	MAX	MAX	MAX	50.00	45.00	50.00
P5 PSI	54.00	54.00	52.00	55.00	50.00	48.00
P6 PSI	84.00	84.00	90.00	78.00	80.00	75.00
V11	3.00	3.00	3.00	3.00	3.00	3.00
P704 "H2O	0.80	0.90	0.70	0.50	1.30	0.80

TIME	12-AUG-84 13:20:00	12-AUG-84 14:30:00	12-AUG-84 15:55:00	12-AUG-84 17:00:00	12-AUG-84 18:00:00	12-AUG-84 19:00:00
O2 (%)	0.02	0.02	0.03	0.04	0.00	0.00
HV kv	11.00	11.00	10.60	10.00	10.80	10.80
I millA	0.50	0.60	0.70	0.60	0.55	0.60
P1 "H2O	-0.30	-0.40	-0.50	-0.50	0.00	-0.40
P2 "H2O	-0.30	-0.40	-0.50	-0.70	-0.10	-0.60
P3 "H2O	-0.30	-0.30	-0.40	-0.60	-0.10	-0.60
P1-P2 "H2O	0.00	0.00	0.00	0.00	0.00	0.00
P2-P3 "H2O	0.05	0.04	0.05	0.05	0.05	0.05
DP4 "H2O	4.50	4.50	4.50	4.50	4.50	4.50
T1 DEG F	248.00	242.00	248.00	252.00	254.00	257.00
T2 DEG F	116.00	112.00	112.00	114.00	117.00	121.00
T3 DEG F	128.00	119.00	117.00	119.00	121.00	123.00
T4 DEG F	128.00	112.00	109.00	112.00	118.00	112.00
T5 DEG F	115.00	103.00	97.00	101.00	104.00	99.00
T6 DEG F	88.00	84.00	82.00	82.00	82.00	85.00
T7 DEG F	93.00	90.00	89.00	92.00	89.00	90.00
T8 DEG F	87.00	81.00	80.00	82.00	82.00	85.00
T9 DEG F	118.00	113.00	111.00	112.00	114.00	115.00
T10 DEG F	111.00	110.00	108.00	102.00	110.00	109.00
ROTOMETER (GPM)	50.00	50.00	MAX	MAX	MAX	MAX
P5 PSI	48.00	48.00	48.00	47.00	45.00	48.00
P6 PSI	75.00	85.00	78.00	93.00	92.00	92.00
V11	3.00	3.00	3.00	3.00	3.00	3.00
P704 "H2O	0.70	0.70	0.60	0.55	0.55	0.50

TIME	12-AUG-84 20:00:00	12-AUG-84 22:00:00	12-AUG-84 23:40:00	12-AUG-84 00:15:00	13-AUG-84 01:05:00	13-AUG-84 02:10:00
O2 (%)	0.00	0.00	0.00	0.01	0.01	0.05
HV kv	10.00	9.80	10.00	10.00	10.30	10.50
I millA	0.85	0.90	0.09	0.90	0.83	0.75
P1 "H2O	0.00	-0.10	-0.10	-0.10	-0.20	0.10
P2 "H2O	-0.10	-0.20	-0.20	-0.30	-0.50	-0.10
P3 "H2O	-0.20	-0.30	-0.20	-0.20	-0.50	0.00
P1-P2 "H2O	0.00	0.00	0.00	0.00	0.00	0.00
P2-P3 "H2O	0.05	0.06	0.05	0.04	0.04	0.04
DP4 "H2O	4.50	5.00	4.00	4.00	3.50	3.50
T1 DEG F	257.00	255.00	253.00	257.00	261.00	226.00
T2 DEG F	115.00	112.00	113.00	114.00	111.00	115.00
T3 DEG F	104.00	103.00	102.00	101.00	104.00	111.00
T4 DEG F	84.00	84.00	85.00	82.00	96.00	101.00
T5 DEG F	80.00	79.00	80.00	78.00	81.00	84.00
T6 DEG F	76.00	77.00	76.00	76.00	78.00	77.00
T7 DEG F	76.00	78.00	77.00	77.00	80.00	82.00
T8 DEG F	74.00	75.00	75.00	74.00	76.00	75.00
T9 DEG F	90.00	90.00	87.00	91.00	97.00	105.00
T10 DEG F	88.00	89.00	90.00	90.00	95.00	102.00
ROTOMETER (GPM)	MAX	MAX	MAX	MAX	MAX	MAX
P5 PSI	45.00	45.00	46.00	45.00	45.00	45.00
P6 PSI	92.00	92.00	78.00	82.00	82.00	80.00
Vll	3.00	3.00	3.00	3.00	3.00	3.00
P704 "H2O	0.60	0.60	0.90	1.00	0.70	1.30

M-4

TIME	13-AUG-84 03:05:00	13-AUG-84 04:05:00	13-AUG-84 05:15:00	13-AUG-84 06:05:00	13-AUG-84 07:12:00	13-AUG-84 08:14:00
O2 (%)	0.00	0.00	0.00	0.00	0.01	0.03
HV kv	10.00	10.10	10.00	10.10	10.00	10.00
I millA	0.95	0.85	0.90	0.90	1.00	0.90
P1 "H2O	0.00	0.20	0.00	0.30	0.10	0.10
P2 "H2O	0.10	0.10	-0.05	0.10	0.00	-0.10
P3 "H2O	-0.10	0.10	-0.10	0.10	0.00	0.00
P1-P2 "H2O	0.00	0.00	0.00	0.00	0.00	0.01
P2-P3 "H2O	0.04	0.05	0.06	0.06	0.04	0.05
DP4 "H2O	4.00	3.80	4.30	4.00	4.00	4.00
T1 DEG F	253.00	268.00	269.00	269.00	266.00	264.00
T2 DEG F	111.00	113.00	111.00	111.00	109.00	117.00
T3 DEG F	104.00	105.00	101.00	101.00	104.00	107.00
T4 DEG F	90.00	104.00	94.00	98.00	96.00	94.00
T5 DEG F	84.00	84.00	78.00	80.00	80.00	80.00
T6 DEG F	77.00	77.00	75.00	75.00	75.00	76.00
T7 DEG F	79.00	80.00	78.00	78.00	79.00	80.00
T8 DEG F	75.00	76.00	75.00	74.00	74.00	74.00
T9 DEG F	98.00	100.00	94.00	96.00	96.00	98.00
T10 DEG F	96.00	96.00	92.00	91.00	92.00	95.00
ROTOMETER (GPM)	MAX	MAX	MAX	MAX	MAX	MAX
P5 PSI	45.00	45.00	45.00	45.00	45.00	45.00
P6 PSI	78.00	79.00	90.00	92.00	83.00	75.00
Vll	3.00	3.00	3.00	3.00	3.00	3.00
P704 "H2O	0.90	1.20	0.90	1.10	1.20	1.00

TIME	13-AUG-84 09:20:00	13-AUG-84 10:20:00	13-AUG-84 11:14:00	13-AUG-84 11:55:00	13-AUG-84 13:00:00	13-AUG-84 14:00:00
O2 (%)	0.00	1.50	0.10	0.00	0.10	0.20
HV kv	11.00	1.50	11.30	10.90	10.10	9.50
I millA	0.80	0.80	0.75	0.87	0.80	0.95
P1 "H2O	-1.00	-0.75	-0.75	-1.00	-1.20	-1.00
P2 "H2O	-1.00	-0.75	-0.75	-1.00	-1.20	-1.00
P3 "H2O	-1.10	-0.75	-0.75	-1.00	-1.30	-1.20
P1-P2 "H2O	0.00	0.00	0.00	0.00	0.00	0.00
P2-P3 "H2O	0.05	0.05	0.05	0.06	0.04	0.04
DP4 "H2O	4.50	4.50	4.10	4.50	6.00	4.50
T1 DEG F	288.00	296.00	298.00	301.00	312.00	319.00
T2 DEG F	117.00	108.00	109.00	107.00	108.00	107.00
T3 DEG F	104.00	104.00	105.00	106.00	109.00	106.00
T4 DEG F	94.00	97.00	95.00	99.00	104.00	99.00
T5 DEG F	79.00	81.00	83.00	86.00	86.00	85.00
T6 DEG F	75.00	76.00	77.00	78.00	79.00	80.00
T7 DEG F	79.00	80.00	80.00	82.00	83.00	83.00
T8 DEG F	74.00	74.00	75.00	75.00	77.00	78.00
T9 DEG F	96.00	97.00	95.00	95.00	99.00	97.00
T10 DEG F	93.00	94.00	95.00	95.00	99.00	97.00
ROTOMETER (GPM)	MAX	MAX	MAX	MAX	MAX	MAX
P5 PSI	45.00	45.00	45.00	45.00	45.00	45.00
P6 PSI	95.00	75.00	88.00	75.00	95.00	90.00
V11	2.00	3.00	3.00	3.00	3.00	3.00
P704 "H2O	0.70	1.00	0.90	0.90	0.70	0.70

TIME	13-AUG-84 14:55:00	13-AUG-84 16:00:00	13-AUG-84 17:00:00	13-AUG-84 18:00:00	13-AUG-84 20:00:00	13-AUG-84 21:00:00
O2 (%)	0.20	0.20	0.10	SYSTEM DOWN	0.20	0.30
HV kv	9.50	9.00	9.00		8.50	8.50
I millA	0.95	0.95	0.90		0.80	0.30
P1 "H2O	-1.10	-0.50	-1.10		-0.20	-1.75
P2 "H2O	-1.10	-0.50	-1.10		-0.20	-1.75
P3 "H2O	-1.20	-0.50	-1.20		-0.22	-1.75
P1-P2 "H2O	0.00	0.00	0.00		0.00	0.00
P2-P3 "H2O	0.05	0.04	0.04		0.20	0.06
DP4 "H2O	4.00	4.00	4.00		7.00	6.00
T1 DEG F	324.00	335.00	332.00		251.00	327.00
T2 DEG F	105.00	407.00	109.00		103.00	116.00
T3 DEG F	105.00	105.00	108.00		99.00	115.00
T4 DEG F	102.00	104.00	100.00		86.00	85.00
T5 DEG F	86.00	88.00	86.00		79.00	79.00
T6 DEG F	80.00	81.00	80.00		76.00	76.00
T7 DEG F	84.00	85.00	83.00		76.00	77.00
T8 DEG F	78.00	78.00	77.00		76.00	74.00
T9 DEG F	99.00	99.00	100.00		86.00	90.00
T10 DEG F	99.00	99.00	99.00		86.00	88.00
ROTOMETER (GPM)	MAX	MAX	MAX		1.10	1.10
P5 PSI	45.00	45.00	44.00		50.00	50.00
P6 PSI	75.00	95.00	85.00		80.00	80.00
V11	3.00	3.00	3.00		3.00	3.00
P704 "H2O	0.80	0.80	0.90		0.90	1.10

TIME	13-AUG-84 22:00:00	13-AUG-84 23:10:00	14-AUG-84 00:00:00	14-AUG-84 01:00:00	14-AUG-84 02:05:00	14-AUG-84 03:00:00
O2 (%)	0.20	0.20	0.10	0.20	0.20	0.10
HV kv	8.50	8.00	8.00	8.10	8.10	8.00
I millA	0.30	0.40	0.50	0.45	0.40	0.40
P1 "H2O	-1.75	-1.75	-1.75	-2.00	-1.50	-2.00
P2 "H2O	-1.75	-1.75	-1.75	-2.00	-1.50	-2.00
P3 "H2O	-1.90	-1.90	-1.90	-2.00	-1.50	-2.00
P1-P2 "H2O	0.00	0.00	0.00	0.00	0.00	0.00
P2-P3 "H2O	0.08	0.06	0.06	0.05	0.04	0.05
DP4 "H2O	7.50	6.50	6.00	5.50	5.50	6.00
T1 DEG F	245.00	352.00	361.00	362.00	371.00	370.00
T2 DEG F	120.00	114.00	118.00	116.00	108.00	103.00
T3 DEG F	117.00	112.00	114.00	114.00	107.00	104.00
T4 DEG F	90.00	89.00	90.00	86.00	89.00	89.00
T5 DEG F	80.00	80.00	80.00	78.00	78.00	78.00
T6 DEG F	77.00	76.00	76.00	76.00	75.00	75.00
T7 DEG F	78.00	75.00	75.00	74.00	74.00	77.00
T8 DEG F	75.00	75.00	75.00	74.00	74.00	74.00
T9 DEG F	95.00	91.00	94.00	91.00	94.00	90.00
T10 DEG F	93.00	90.00	90.00	89.00	91.00	88.00
ROTOMETER (GPM)	1.10	1.00	1.05	1.05	1.05	1.05
P5 PSI	50.00	50.00	50.00	50.00	50.00	50.00
P6 PSI	80.00	90.00	100.00	100.00	90.00	90.00
V11	3.00	3.00	3.00	3.00	3.00	3.00
P704 "H2O	1.20	1.40	1.40	1.40	1.60	1.70

TIME	14-AUG-84 04:00:00	14-AUG-84 05:00:00	14-AUG-84 06:00:00	14-AUG-84 07:00:00	14-AUG-84 08:00:00	14-AUG-84 09:15:00
O2 (%)	0.20	0.10	0.10	0.10	0.50	0.20
HV kv	8.00	8.00	8.10	8.10	8.10	8.10
I millA	0.40	0.50	0.40	0.40	0.40	0.40
P1 "H2O	-3.00	-2.75	-2.75	-2.50	-2.75	0.10
P2 "H2O	-3.00	-2.75	-2.75	-2.50	-2.75	0.00
P3 "H2O	-3.00	-2.90	-2.25	-2.50	-2.75	0.00
P1-P2 "H2O	0.00	0.00	0.00	0.00	0.00	0.00
P2-P3 "H2O	0.05	0.05	0.05	0.05	0.04	0.08
DP4 "H2O	6.00	6.00	6.00	6.00	5.50	6.50
T1 DEG F	381.00	389.00	395.00	390.00	379.00	380.00
T2 DEG F	107.00	105.00	114.00	114.00	107.00	104.00
T3 DEG F	107.00	109.00	112.00	112.00	109.00	105.00
T4 DEG F	86.00	87.00	87.00	87.00	85.00	87.00
T5 DEG F	78.00	78.00	77.00	78.00	77.00	78.00
T6 DEG F	75.00	75.00	75.00	75.00	76.00	76.00
T7 DEG F	77.00	77.00	77.00	77.00	76.00	76.00
T8 DEG F	74.00	74.00	73.00	73.00	74.00	74.00
T9 DEG F	91.00	90.00	91.00	93.00	89.00	90.00
T10 DEG F	89.00	88.00	90.00	91.00	86.00	88.00
ROTOMETER (GPM)	1.05	1.05	1.05	0.90	0.90	0.90
P5 PSI	50.00	50.00	50.00	50.00	50.00	50.00
P6 PSI	80.00	80.00	80.00	95.00	95.00	95.00
V11	3.00	3.00	3.00	3.00	3.00	3.00
P704 "H2O	1.20	1.40	1.80	1.80	1.40	5.50

TIME	14-AUG-84 10:07:00	14-AUG-84 11:08:00	14-AUG-84 12:00:00	14-AUG-84 15:02:00	14-AUG-84 17:00:00	14-AUG-84 18:00:00
O2 (%)	0.40	0.20	SYSTEM DOWN	0.10	0.10	0.40
HV kv	8.30	7.90		9.00	8.00	8.00
I millA	0.32	0.30		0.40	0.40	0.40
P1 "H2O	0.60	0.00		0.50	0.50	-0.30
P2 "H2O	0.50	-0.10		0.50	0.50	-0.30
P3 "H2O	0.60	0.00		0.50	0.50	-0.30
P1-P2 "H2O	0.00	0.00		0.00	0.00	0.00
P2-P3 "H2O	0.09	1.00		0.09	0.08	0.08
DP4 "H2O	6.25	6.50		4.50	4.00	4.00
T1 DEG F	382.00	373.00		218.00	326.00	337.00
T2 DEG F	106.00	107.00		97.00	108.00	107.00
T3 DEG F	111.00	111.00		100.00	102.00	104.00
T4 DEG F	91.00	89.00		83.00	86.00	87.00
T5 DEG F	80.00	80.00		80.00	81.00	81.00
T6 DEG F	78.00	78.00		77.00	77.00	79.00
T7 DEG F	78.00	78.00		78.00	78.00	78.00
T8 DEG F	76.00	75.00		77.00	76.00	76.00
T9 DEG F	94.00	93.00		84.00	87.00	90.00
T10 DEG F	93.00	91.00		83.00	90.00	91.00
ROTOMETER (GPM)	0.90	0.90		1.00	1.10	1.10
P5 PSI	50.00	50.00		45.00	44.00	44.00
P6 PSI	95.00	95.00		75.00	97.00	96.00
V11	3.00	3.00		3.00	3.00	3.00
P704 "H2O	5.30	5.50			5.90	7.00

TIME	14-AUG-84 19:00:00	14-AUG-84 20:00:00	14-AUG-84 21:00:00	14-AUG-84 22:00:00	14-AUG-84 23:00:00	15-AUG-84 00:00:00
O2 (%)	0.10	0.30	0.10	0.60	0.20	0.10
HV kv	7.50	8.00	8.00	8.00	8.00	8.00
I millA	0.52	0.50	0.40	0.50	0.60	0.60
P1 "H2O	-0.30	-1.40	-2.00	-1.00	-3.00	-4.00
P2 "H2O	-0.30	-1.40	-2.00	-1.00	-3.00	-4.00
P3 "H2O	-0.30	-1.40	-2.00	-1.00	-3.00	-4.00
P1-P2 "H2O	0.00	0.00	0.00	0.00	0.00	0.00
P2-P3 "H2O	0.06	0.20	0.02	0.20	0.00	0.00
DP4 "H2O	4.00	4.50	5.00	4.00	3.00	2.00
T1 DEG F	337.00	344.00	356.00	363.00	355.00	342.00
T2 DEG F	110.00	113.00	119.00	120.00	111.00	102.00
T3 DEG F	103.00	113.00	107.00	109.00	104.00	99.00
T4 DEG F	84.00	92.00	86.00	86.00	84.00	85.00
T5 DEG F	79.00	80.00	80.00	81.00	79.00	81.00
T6 DEG F	77.00	77.00	77.00	77.00	76.00	76.00
T7 DEG F	78.00	78.00	78.00	78.00	75.00	75.00
T8 DEG F	76.00	76.00	75.00	76.00	78.00	75.00
T9 DEG F	89.00	92.00	92.00	94.00	90.00	88.00
T10 DEG F	89.00	91.00	91.00	92.00	91.00	87.00
ROTOMETER (GPM)	1.10	1.10	1.00	0.00	1.00	1.00
P5 PSI	44.00	44.00	42.00	44.00	43.00	43.00
P6 PSI	90.00	88.00	80.00	76.00	97.00	85.00
V11	3.00	3.00	3.00	3.00	3.00	3.00
P704 "H2O	5.40	6.10	6.30	7.50	7.10	7.10