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**METC/3M Cooperative Agreement CRADA 94-024  
High Temperature High Pressure Filter Materials  
Exposure Test Program**

**Final Report, Volume I**

June 1995

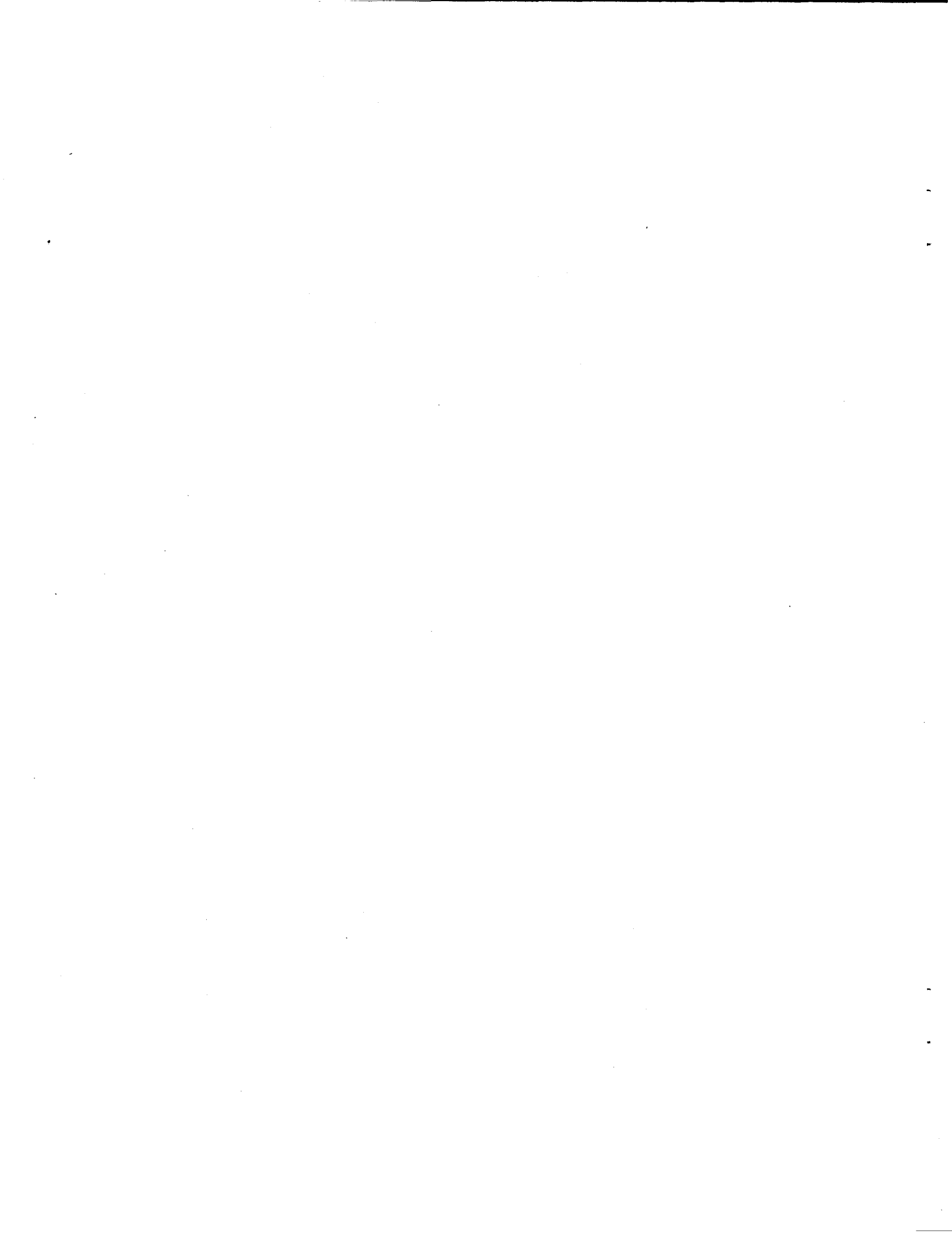
U.S. Department of Energy  
Office of Fossil Energy  
Morgantown Energy Technology Center  
3610 Collins Ferry Road  
Morgantown, WV 26505

and

Minnesota Mining and Manufacturing Company  
3M Ceramic Materials Department  
3M Center Building 207-1S-23  
St. Paul, MN 55144-1000

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Table of Contents

Volume I

	<u>PAGE</u>
1. Executive Summary . . . . .	03
2. Objective . . . . .	04
3. Gasifier and Cleanup Facility Description . . . . .	04
4. Gasifier and Cleanup Facility Operation . . . . .	13
A. Test Run 93FBG/MGC07 . . . . .	13
a. Test Objectives . . . . .	13
b. Run Highlights . . . . .	13
c. Summary of Gasifier Operating Conditions . . . . .	14
d. Product Analysis . . . . .	15-17
e. Summary of Cleanup Rig Conditions . . . . .	18
B. Test Run 93FBG/MGC08 . . . . .	19
a. Test Objectives . . . . .	19
b. Run Highlights . . . . .	19
c. Summary of Gasifier Operating Conditions . . . . .	20
d. Product Analysis . . . . .	21-23
e. Summary of Cleanup Rig Conditions . . . . .	24
C. Test Run 93FBG/MGC09 . . . . .	25
a. Test Objectives . . . . .	25
b. Run Highlights . . . . .	25
c. Summary of Gasifier Operating Conditions . . . . .	26
d. Product Analysis . . . . .	27-28
e. Summary of Cleanup Rig Conditions . . . . .	29
D. Test Run 94FBG/MGC010 . . . . .	30
a. Test Objectives . . . . .	30
b. Run Highlights . . . . .	30
c. Summary of Gasifier Operating Conditions . . . . .	31
d. Product Analysis . . . . .	32-33
e. Summary of Cleanup Rig Conditions . . . . .	34

Volume II

Appendix 1: Summary of Particulate Monitoring Results . . . . .	A1
Appendix 2: Detailed Chronology of Significant Run Events . . . . .	A2
Appendix 3: Daily Process Variable Plots . . . . .	A3
Appendix 4: Process and Instrumentation Drawings . . . . .	A4

## 1. Executive Summary

In conjunction with shakedown, operation, and desulfurization testing at the Morgantown Energy Technology Center (METC) 10" Fluid Bed Gasification and Cleanup facility, a series of tests was completed in cooperation with the Minnesota Mining and Manufacturing Company (3M). This cooperative research and development agreement (CRADA) between METC and 3M was to evaluate exposure of 3M SICONEX™ fiber-reinforced ceramic and NEXTEL™ 312 and 550 ceramic fabric materials to a gasifying environment at high temperatures (1000 - 1100°F) and high pressure (300 psia).

Minnesota Mining and Manufacturing Company (3M) provided two 60mm I.D. x 0.5m SICONEX™ spools and one each of the NEXTEL™ 312 and 550 ceramic fabrics for exposure to coal gas from the METC gasifier. METC installed the materials in a vessel existing in the METC Cleanup Facility and provided process data in exchange for ceramic filter and ash/char characterization. Details of the CRADA are found in CRADA #94-024. This report contains METC's contribution to CRADA #94-024.

Four gasifier runs were conducted over a five month period to accumulate 483 hours of operation. During this time, 2 LayCer™ 70/3 filters were used for filtering the coal gas while the SICONEX™ and NEXTEL™ were exposed along side of the filters. During one 89 hour test, one Laycer™ 70/3 candle was installed with a 3M ceramic composite filter. The face velocity through the candles was maintained nominally at 2.5 ft/min throughout the testing.

Average operating conditions are as follows:

The approximate gas composition in mole percent was 15% H<sub>2</sub>, 10% CO, 49% N<sub>2</sub>, 12% H<sub>2</sub>O, 2.4% CH<sub>4</sub>, 11% CO<sub>2</sub>, 0.3% H<sub>2</sub>S, and 0.3% Ar.

Based on analysis of the condensables in the gas stream (stream cooled to 34°F) the ammonia concentration was on the order of 2000 ppmw.

The average gas flow to the filter vessel was 123 lb/hr.

The average of the filter inlet and outlet temperatures was 1063°F.

The average filter operating pressure was 294 psig.

The average candle purge pressure was 454 psig.

The average operating differential pressure was 5 psid.

The blow-back cycle for the filters was approximately once per hour for a 100 - 200 msec duration.

Based on char recovery from the filter vessel, the average loading of particulate in the coal gas was 0.028 lb/hr (0.23) gm/Nm<sup>3</sup>.

Online monitoring of particulate loading and sizes in the coal gas fed to the filter vessel was conducted per availability of the equipment.

Online particulate monitoring was conducted during specific periods for each of the runs. Detailed loading and particle size analysis is included in Appendix 1 of this report.

## 2. Objective

The purpose of this effort was to evaluate exposure of 3M SICONEX<sup>TM</sup> fiber-reinforced ceramic and NEXTEL<sup>TM</sup> 312 and 550 ceramic fabric materials to a gasifying (reducing) environment at temperatures of 1,000 - 1,100 °F, pressures between 300 and 350 psia (pounds per square inch absolute) and solids loadings typical of the METC 10-inch diameter fluid bed gasifier.

## 3. Gasifier and Cleanup Facility Description

A simplified process flow diagram of the METC Integrated Gasification and Cleanup Facility is shown in Figure 1 and a summary of operating conditions is shown in Table 1. .

Coal ground to 14 X 60 mesh (1.41 mm to 0.250 mm) is pneumatically conveyed into the bottom of a 3 stage, refractory-lined gasifier along with steam, preheated air and a small amount of nitrogen. Solids from the gasification process are continuously withdrawn from the top and intermittently withdrawn from the bottom of a 10 foot high, 10-inch diameter fluid bed. Representative feed and residue solid particle sizes are shown in Table 2. The product gases are processed through two cyclone separators and heat traced to the inlet of a candle filter vessel in an adjacent structure.

The gasifier operates at 425 psig (30 atm). The pressure is let down to approximately 290 psig (20 atm) prior to the inlet of the candle filter vessel. Downstream of the candle filter vessel, the pressure is controlled to 285 psig (20 atm) in the desulfurizer. The portion of the system upstream of the pressure letdown valve is considered the gasification system and that downstream is the cleanup system.

Located just upstream of the pressure letdown, a gas slip stream is used for monitoring particulate specie. The particulate system was used per availability throughout the experimental testing of this CRADA (June 1994 - October 1994). Table 3 shows

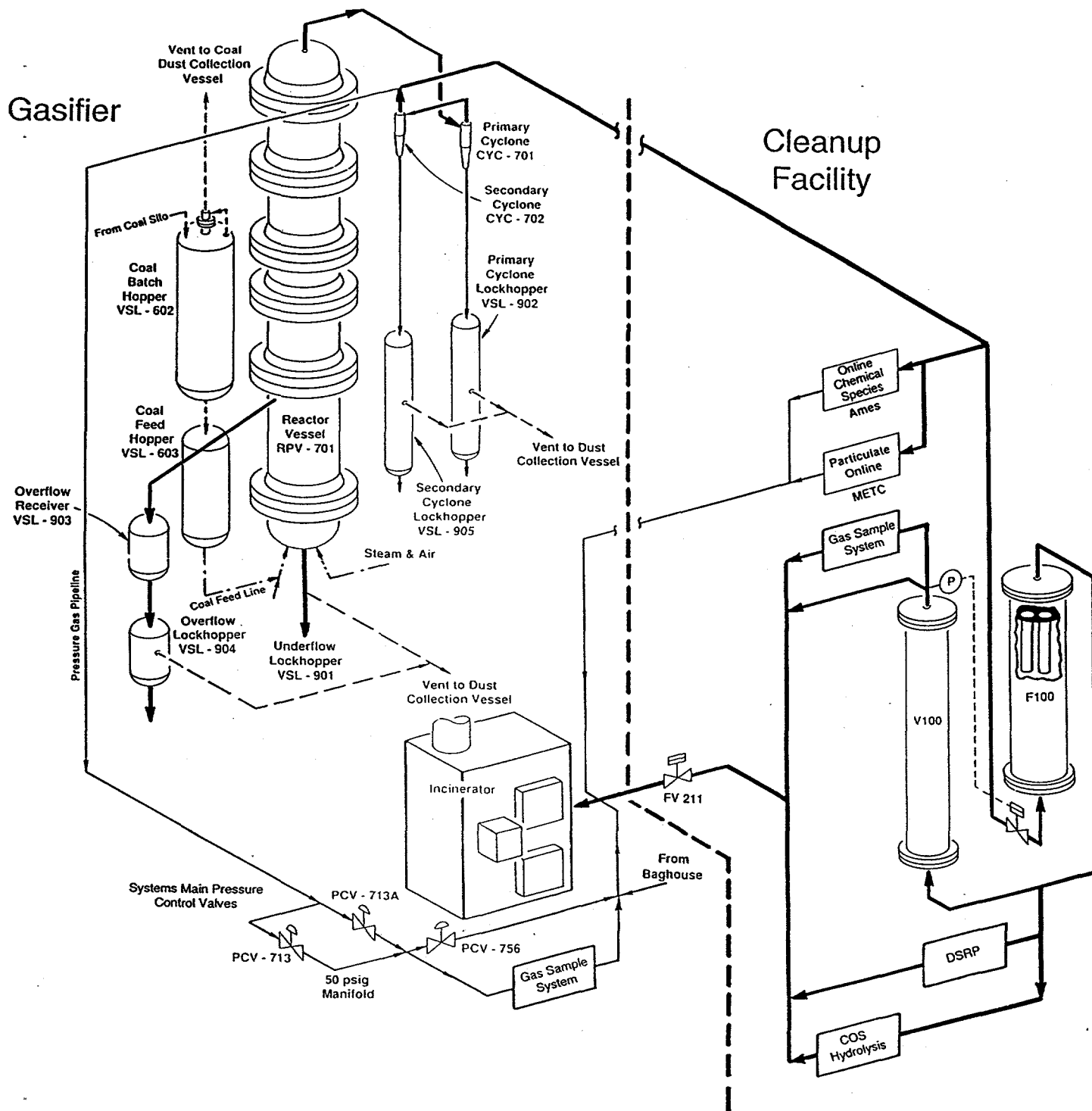


Figure 1. METC Integrated Gasification & Cleanup Facility

M95002401\*

Table 1.

SUMMARY OF OPERATING CONDITIONS

	FBG	Filter	Desulfurizer
Coal Feed Rate (lb/hr)	70	—	—
Particle Size Range (microns)	<1400	<7	150 - 500
Air Flow Rate (lb/hr)	150	—	—
Steam Flow Rate (lb/hr)	50	—	—
Gas Throughput (lb/hr)	290	123	123
Bed Velocity (ft/s)	0.3	2.5	0.5
Temperature (°F)	1550	1100	1100
Pressure (psig)	425	295	285



**Table 2. Feed and Residue Solid Particle Size Distribution**

**Screen Analysis of Raw Coal Before Passing Through Feeder**

Description: Montana Rosebud #7  
 Collection Time: 09/16/94 Sample No.: 94FBG09-RC1  
 Report Received: 09/23/94 CH No.: 9410

Screen Passing	Size, mesh Retained	micron	Avg. di	Cumulative %wt	Direct xi, %wt	xi/(di* 100)
	14	1410	1545.0	0.0	0.00	0.00E+00
14	16	1190	1300.0	3.92	3.92	3.02E-05
16	30	595	892.5	75.52	71.60	8.02E-04
30	50	297	446.0	97.42	21.90	4.91E-04
50	80	177	237.0	99.25	1.83	7.71E-05
80	100	149	163.0	99.40	0.16	9.63E-06
100	Pan	30	89.5	100.00	0.60	6.67E-05

Avg. Particle Size, microns 677.10

**Screen Analysis of Raw Coal After Passing Through Feeder**

Description: Montana #7 (Bituminous Coal) after feeder "A"  
 Collection Time: 11/04/94 Sample No.: 94FBG09-CFA3  
 Report Received: 11/18/94 CH No.: 9484

Screen Passing	Size, mesh Retained	micron	Avg. di	Cumulative %wt	Direct xi, %wt	xi/(di* 100)
	25	707	774.0	15.89	15.89	2.05E-04
25	35	500	603.5	35.09	19.20	3.18E-04
35	45	354	427.0	45.55	10.46	2.45E-04
45	60	250	302.0	70.64	25.09	8.31E-04
60	80	177	213.5	79.36	8.72	4.09E-04
80	200	74	125.5	92.13	12.77	1.02E-03
200	Pan	30	52.0	100.00	7.87	1.51E-03

Avg. Particle Size, microns 220.30

**(Cont'd) Table 2. Feed and Residue Solid Particle Size Distribution**

**Screen Analysis of Representative Char Sample of Overflow Solid (94FBG09)**

Description: Overflow  
Collection Time: 11/07/93 Sample No.: 94FBG09-OF29  
Report Received: 12/06/93 CH No.: 9419

Screen	Size, mesh	Avg.	Cumulative	Direct		
Passing	Retained	di	%wt	xi, %wt	xi/(di*100)	
	35	500	547.5	16.61	16.61	3.03E-04
35	45	354	427.0	36.56	19.96	4.67E-04
45	60	250	302.0	58.55	21.99	7.28E-04
60	80	177	213.5	70.23	11.68	5.47E-04
80	170	88	132.5	85.42	15.19	1.15E-03
170	325	44	66.0	91.69	6.28	9.51E-04
325	Pan	30	37.0	100.00	8.31	2.25E-03

Avg. Particle Size, microns 156.54

**Screen Analysis of Representative Char Sample of Underflow Solid (94FBG09)**

Description: Underflow  
Collection Time: 09/16/94 Sample No.: 94FBG09-UF29  
Report Received: 11/21/94 CH No.: 9441

Screen	Size, mesh	Avg.	Cumulative	Direct		
Passing	Retained	di	%wt	xi, %wt	xi/(di*100)	
	14	1410	1545.0	5.1	5.12	3.31E-05
14	18	1000	1205.0	17.9	12.75	1.06E-04
18	25	707	853.5	33.2	15.29	1.79E-04
25	35	595	651.0	58.2	24.99	3.84E-04
35	45	354	474.5	83.3	25.19	5.31E-04
45	60	250	302.0	94.8	11.49	3.80E-04
60	Pan	30	140.0	100.0	5.17	3.69E-04

Avg. Particle Size, microns 504.40

**(Cont'd) Table 2. Feed and Residue Solid Particle Size Distribution**

**Screen Analysis of Representative Char Sample of Cyclone Solid (94FBG09)**

Description: Mixed Cyclone  
Collection Time: 09/16/94 Sample No.: 94FBG09-PSC6  
Report Received: 11/21/94 CH No.: 9464

Screen Passing	Size, mesh Retained	micron	Avg. di	Cumulative %wt	Direct xi, %wt	$xi/(di*100)$
	170	88	96.5	11.98	11.98	1.24E-03
170	200	74	81.0	28.81	16.83	2.08E-03
200	230	63	68.5	56.87	28.06	4.10E-03
230	270	53	58.0	75.27	18.40	3.17E-03
270	325	44	48.5	86.85	11.57	2.39E-03
325	400	37	40.5	97.61	10.77	2.66E-03
400	Pan	30	33.5	100.00	2.39	7.13E-04

Avg. Particle Size, microns 61.18

Table 3.

ONLINE PARTICULATE AND ALKALI MONITORING PERIODS

RUN	DATE	TIME PERIOD (hh:mm:ss)	SYSTEM
7	06/14/94	00:17:44 - 09:11:13	P
8	07/20/94 07/21/94 07/22/94	00:47:29 - 07:23:49 18:09:09 - 00:12:19 00:13:49 - 23:07:35	P
9	09/13/94 09/15/94 09/15-16/94	09:51:47 - 17:46:48 04:58:42 - 11:38:03 20:20:09 - 05:19:38	P
10	10/26/94	09:30:00 - 19:30:00	P

P - Particulate

the time and dates when the particulate monitoring system was operational throughout the CRADA test campaign.

Instantaneous gas grab samples and accumulated liquid and solid samples upstream of the candle filter vessel and down stream of the desulfurizer were also obtained periodically throughout the test campaign. The sampling intervals varied from hourly to every four hours and results were normally averaged over 12 hour steady state periods.

Table 4 gives the analyses of the feed coal used during the test campaign. Montana #6 and #7 is subbituminous coal from the Rosebud seam. The numbers (6,7) denote shipments that have been received at different times. Montana #6 was used for 340 hours of the testing. Montana #6 was used in runs 7, 8, and during two 16 hour test period in runs 9 and 10. Montana #7 was used for 129 hours in runs 9 and 10. Coke breeze and Illinois #6 were each used for 7 hours in run 9.

Table 4. Analysis of Feed Solids Used in FBG Tests

METC Lab #:	042885	044128	043023	045335	044921	045336	044920
Solids:	Coke Breeze	Montana #6	Montana #6	CI-M#6	Montana #7	Montana #7	Illinois #6
Used in Test Run:	-09	-07 to -08	-09	-10	-09	-10	-09
Ultimate Analysis, %wt:			(For DCR test only)				
Moisture	0.46	6.38	3.48	5.55	7.35	6.06	3.38
Carbon	85.84	64.54	61.92	63.77	63.38	63.74	73.39
Hydrogen	1.22	4.4	4.61	4.85	4.52	4.47	3.6
Nitrogen	1.01	0.97	0.98	0.69	0.88	0.76	1.26
Sulfur	0.78	0.86	2.92	1.77	1.03	1.12	1.98
Oxygen (by diff.)	2.14	16.56	15.77	14.31	16.23	16.42	11.1
Ash*	8.55	6.29	10.32	9.07	6.62	7.43	5.29
Proximate Analysis %wt:							
Volatile Matter	3.28	41.94	40.54	40.68	40.54	39.73	26.34
Fixed Carbon (by diff.)	87.71	44.1	45.66	44.705	45.495	46.78	64.99
GCV, MJ/kg	28.59	25.38	24.95	24.85	25.25	25.41	28.53
Btu/lb	12316	10935	10750	10705	10879	10948	12294
Mineral Carbon, %wt	0.06	0.14	0.14	0.09	0.11	0.14	0.04
Chloride, ppmw	NA	8	<10	4500	<10	38	77
Ash Analysis, %wt of Ash							
Al <sub>2</sub> O <sub>3</sub>	NA	24.35	NA	NA	15.63	NA	17.79
CaO	NA	21.3	NA	NA	17.32	NA	3.14
Fe <sub>2</sub> O <sub>3</sub>	NA	6.58	NA	NA	8.28	NA	11.74
K <sub>2</sub> O	NA	0.36	NA	NA	0.13	NA	1.5
MgO	NA	4.74	NA	NA	4.75	NA	0.92
MnO	NA	0.08	NA	NA	0.14	NA	0
P <sub>2</sub> O <sub>5</sub>	NA	1.31	NA	NA	0.41	NA	0.12
SiO <sub>2</sub>	NA	32.28	NA	NA	27.24	NA	39.1
TiO <sub>2</sub>	NA	1.31	NA	NA	0.59	NA	0.24
Others	NA	7.69	NA	NA	25.51	NA	25.45
Density, kg/l							
Helium	1.86	1.55	1.58	1.5	1.43	1.44	1.55
Skeletal by Hg	1.87	1.5	1.47	1.543	1.49	1.4967	1.52
Bulk (packed in air)	0.443	NA	0.6411	NA	0.4973	NA	0.681
Pore Volume, l/kg							
by N <sub>2</sub> Adsorption	0.0017	0.0294	NA	0.01213	0.013	0.01145	0.006
by N <sub>2</sub> Desorption	0.0021	NA	NA	0.01318	0.0138	0.0124	0.00645
by Hg Intrusion (Cum.)	0.23	0.16	0.1639	0.2278	0.31	0.1558	0.48
BET Surface Area, m <sup>2</sup> /kg	2000	2855	NA	3167	2843	2558	1728
Ash Fusion Temp., °F:							
ID/HT	2420/2520	2100/2200	2080/2140	2080/2120	2180/2240	2060/2100	2140/2220
ST/FT	2440/2580	2160/2220	2100/2200	2100/2140	2220/2260	2080/2120	2180/2380
Coke F.S.I.	0	0	0	NA	0	NA	1
Particle Size (Mean), um	NA	NA	NA	NA	220.3	NA	426

Note: All %wt are on As-Received basis except specified otherwise. \*corrected for SO<sub>3</sub> formed in ash during analysis.

#### **4. Gasifier and Cleanup Facility Operation**

##### **A. Test Run 94FBG/MGC07**

Test run 94FBG/MGC07 was conducted from June 6, 1994, through June 15, 1994, (6/6/94 (00:00) to 6/15/94 (24:00)).

##### **a. Test Objective**

The objective of this run was to attain 170 hours of steady state operation of the integrated gasifier and hot gas cleanup facility to accumulate additional hours on the C34 and C36 candles, initiate exposure testing of 3 materials supplied by 3M (SICONEX™, NEXTEL™ 312 and NEXTEL™ 550), and to test a fixed bed of desulfurization sorbent prepared by researchers at METC (METC #2).

##### **b. Run Highlights**

Below is a bulletized listing of the run highlights. Appendix 2 contains a detailed chronology of significant run events.

- 119 hours of integrated steady-state operation was attained during 3 steady state periods.
- The longest continuous, steady-state gasification period was 89 hours.
- The sulfur breakthrough curve (hydrogen sulfide level at the outlet of the desulfurizer versus time) for METC #2 was obtained.
- Approximately 9 hours of online particulate monitoring of the coal gas entering F-100 was attained.
- The fluctuations in flow to vessel F-100 were greatly reduced from previous runs when the pneumatics of the control valve upstream of that vessel were replaced.

C. SUMMARY OF GASIFIER OPERATING CONDITIONS

Operating Conditions of Steady-State Periods  
 Test No. 94FBG07 (06/06 - 06/15/94)

10" Fluid Bed Gasifier

Period #	Test Date (Time)		Duration hrs	Reactor		Coal Feed lb/h (3)	Convey Air (4) scfh	Reactor Air (6) scfh	Steam+		Underflow N <sub>2</sub>		Air/H <sub>2</sub> O (12) lb/lb	H <sub>2</sub> O/Coal (13) lb/lb		
	Start	End		Press. psig (1)	Temp. of (2)				(8) lb/h	(9) of	(10) scfh	(11) of				
1*	06/06 (18:30)	06/07 (05:38)	11.13	425	1480	69.3	946.2	55	1333	570	39.1	570	314.3	68	4.5	0.56
2	06/08 (18:30)	06/12 (11:30)	89.00	425	1500	69.3	857.4	55	1192.4	670	37.3	670	430.8	70	4.2	0.54
3	06/13 (19:00)	06/15 (12:40)	41.67	425	1530	69.3	1652.4	67	812.0	670	39.1	670	402.0	80	4.8	0.56
		Total:	141.80	Avg:	1507.2	69.3	1098.0	58.5	1091.6	662.2	37.9	662.2	413.2	72.8	4.4	0.5

Followings are time-averaged values:

(1): PT-713 reading.

(2): TE-703 reading.

(3): (ST-603 reading in rpm) x CFC lb/h/rpm

where: CFC = 2.12

(4): Average of FT-107, -109 readings.

(5): TE-108 reading.

(6): Average of FT-113, -115 readings.

\*A newly designed feed nozzle (with steam cone jet) was test in Test Period #7-1. In other test periods the originally designed nozzle was used.

(7): TE-504 reading.

(8): Average of FT-219, -221 readings.

(9): TE-504 reading.

(10): Average of FT-311, -313 readings.

(11): TE-312 reading.

(12): [(4) + (6)] \* 0.0765/(8)

(13): (8)/(3)

+ Adjusted by reducing 32%wt from measured flow



d. PRODUCT GAS ANALYSIS

Test No. 94FBG07 (6/6-6/15/94)

B. Mole Percent (Wet Basis)

10" Fluid Bed Gasifier

Date/ Sample I.D. (Time Taken)	Test Period #	Ar %	H2 %	O2 %	N2 %	CH4 %	CO %	CO2 %	C2H6 %	H2S PPM	COS PPM	SO2 PPM	CS2 PPM	C4H6S PPM	H2O* %	Total %
June 6, 1994																
1 (1850)	1	0.47	14.54	0.84	48.82	4.01	7.46	13.99	0.14	1633.50	259.98	3.62	1.81	27.86	9.73	100.00
2 (2030)	1	0.42	0.51	0.36	84.48	0.38	0.32	3.67	0.04	744.22	133.34	1.07	0.00	5.64	9.73	100.00
3 (2130)	1	0.43	12.69	0.35	50.14	5.81	5.77	14.42	0.06	5695.68	285.40	4.19	3.19	4.37	9.73	100.00
4 (2230)	1	0.00	12.08	0.75	52.59	3.37	9.11	12.08	0.02	2649.83	169.43	6.20	0.64	2.10	9.73	100.00
June 7, 1994																
5 (0230)	1	0.45	13.62	0.16	51.89	2.77	8.61	12.28	0.00	4753.38	229.76	4.75	0.55	0.00	9.73	100.00
June 8, 1994																
6 (1830)	2	0.17	6.80	0.20	72.48	2.18	2.57	6.64	0.07	1501.91	71.55	5.76	0.18	5.39	8.72	100.00
7 (1930)	2	0.47	17.33	0.12	42.75	5.18	8.80	16.25	0.11	2562.67	180.47	5.21	0.28	6.70	8.72	100.00
8 (2230)	2	0.46	16.69	0.11	44.36	4.52	8.71	15.69	0.03	4961.85	224.03	2.40	0.37	9.40	8.72	100.00
June 9, 1994																
9 (0230)	2	0.46	15.88	0.15	46.16	4.65	8.08	15.47	0.02	3938.40	183.49	7.40	0.00	4.25	8.72	100.00
10 (0630)	2	0.39	15.29	0.08	48.72	4.76	6.68	14.82	0.03	5034.04	103.01	6.94	0.00	10.50	8.72	100.00
11 (1030)	2	0.41	15.76	0.21	48.02	4.62	7.25	14.73	0.02	2554.44	70.53	9.46	1.00	0.18	8.72	100.00
12 (1430)	2	0.42	15.87	0.09	47.39	4.46	7.80	14.43	0.04	3589.53	86.42	5.79	5.61	6.25	9.13	100.00
13 (1830)	2	0.39	15.55	0.09	48.66	4.36	7.55	13.95	0.02	2742.57	116.25	3.54	4.36	3.27	9.13	100.00
14 (2230)	2	0.42	15.59	0.09	48.50	4.39	7.45	14.17	0.02	2358.80	107.65	9.41	0.45	5.79	9.13	100.00
June 10, 1994																
15 (0230)	2	0.41	15.95	0.11	48.03	4.17	7.58	14.25	0.03	3323.65	156.93	6.67	0.72	7.86	9.13	100.00
16 (0630)	2	0.41	15.63	0.07	48.18	4.16	7.40	14.64	0.03	3342.75	155.48	5.55	2.06	4.20	9.13	100.00
17 (1030)	2	0.40	15.59	0.07	48.18	4.36	7.63	14.29	0.03	3157.72	169.56	11.80	0.63	8.85	9.13	100.00
18 (1430)	2	0.39	15.59	0.07	48.43	4.29	7.35	14.40	0.04	3133.28	151.02	6.26	0.72	9.75	9.13	100.00
19 (1830)	2	0.42	15.39	0.14	48.39	4.48	7.36	14.31	0.05	3273.21	215.79	4.42	0.83	7.47	9.13	100.00
20 (2230)	2	0.39	15.26	0.09	49.09	3.98	6.86	14.39	0.06	7335.94	124.85	5.61	0.64	5.43	9.13	100.00
June 11, 1994																
21 (0230)	2	0.40	15.29	0.16	48.75	4.29	7.36	14.16	0.06	3763.27	165.91	6.33	0.55	10.64	9.13	100.00
22 (0630)	2	0.40	15.45	0.10	49.01	3.95	7.30	14.08	0.04	5238.41	132.34	6.51	0.64	6.05	9.13	100.00
23 (1030)	2	0.43	15.86	0.11	48.23	4.04	7.53	14.11	0.05	4889.07	211.83	18.38	0.00	8.05	9.13	100.00
24 (1430)	2	0.44	14.90	0.06	50.55	3.70	6.89	13.83	0.04	4525.31	111.25	5.57	0.65	8.26	9.13	100.00
25 (1830)	2	0.42	15.60	0.04	48.66	3.85	7.68	14.02	0.03	3491.28	194.96	5.15	1.22	7.76	9.13	100.00
26 (2230)	2	0.00	6.59	10.04	63.69	1.66	3.10	5.67	0.02	860.69	76.21	26.32	0.18	1.38	9.13	100.00

d. (Cont.) PRODUCT GAS ANALYSIS

Test No. 94FB607 (6/6-8/15/94)

10" Fluid Bed Gasifier

B. (Cont'd) Mole Percent (Wet Basis)

Date/ Sample I.D. (Time Taken)	Test Period #	Ar %	H2 %	O2 %	N2 %	CH4 %	CO %	CO2 %	C2H6 %	H2S PPM	COS PPM	SO2 PPM	CS2 PPM	C4H4S PPM	H2O* %	Total %
June 12, 1994																
27 (0230)	2	0.00	2.51	12.82	71.11	0.66	1.22	2.56	0.00	0.00	21.16	6.59	0.00	0.09	9.13	100.00
28 (0630)	2	0.00	3.10	13.79	68.64	0.76	1.69	2.89	0.00	0.00	28.43	5.28	0.00	0.19	9.13	100.00
29 (1030)	2	0.00	3.11	14.35	68.12	0.80	1.70	2.79	0.00	0.00	27.78	3.62	0.00	0.28	9.13	100.00
June 13, 1994																
30 (1900)	3	0.44	14.53	0.08	50.88	3.34	6.42	14.35	0.08	4354.93	211.94	10.74	0.37	12.22	9.40	100.00
31 (2000)	3	0.50	2.93	14.22	67.30	0.76	1.47	3.33	0.06	144.91	43.58	12.78	0.00	1.38	9.40	100.00
32 (2100)	3	0.45	14.74	0.17	49.61	3.79	6.89	14.45	0.07	3021.71	136.60	12.54	0.46	4.89	9.40	100.00
33 (2300)	3	0.45	14.73	0.06	50.24	3.80	6.25	14.61	0.05	4026.28	167.70	8.03	0.46	4.47	9.40	100.00
34 (2400)	3	0.44	14.54	0.05	50.08	4.11	6.76	14.28	0.04	2905.17	130.43	6.22	0.00	1.10	9.40	100.00
June 14, 1994																
35 (0100)	3	0.43	13.98	0.12	49.39	4.24	6.73	14.21	0.04	124.78	91.59	1.35	0.00	0.81	10.84	100.00
36 (0200)	3	0.43	13.42	0.45	50.15	3.95	6.36	14.08	0.04	2777.88	80.93	15.93	0.00	3.67	10.84	100.00
37 (0300)	3	0.40	14.29	0.09	49.24	3.97	6.81	14.08	0.03	2391.31	143.01	9.22	0.53	1.68	10.84	100.00
38 (0400)	3	0.40	14.57	0.07	48.46	4.13	6.94	14.32	0.04	2306.86	92.71	7.37	0.00	1.32	10.84	100.00
39 (0500)	3	0.39	14.40	0.09	49.17	4.12	6.76	13.97	0.04	1986.55	89.59	7.91	0.00	4.48	10.84	100.00
40 (0600)	3	0.41	14.30	0.08	49.44	3.94	6.56	14.12	0.03	2729.90	108.27	5.72	0.00	4.84	10.84	100.00
41 (0700)	3	0.41	14.19	0.08	49.44	4.15	6.69	13.99	0.04	1622.66	84.90	3.43	0.00	3.43	10.84	100.00
42 (0800)	3	0.40	14.15	0.10	49.26	4.07	7.01	13.96	0.04	1686.75	85.60	4.32	0.00	0.97	10.84	100.00
43																
44 (1100)	3	0.42	14.64	0.09	48.22	3.95	7.83	13.75	0.03	2043.33	84.60	10.69	0.00	5.43	10.84	99.99
45 (1500)	3	0.41	15.07	0.08	48.05	3.90	7.93	13.44	0.03	2397.46	103.08	8.26	0.00	0.97	10.84	100.00
46 (1710)	3	0.42	14.08	0.16	48.88	3.50	6.95	13.61	0.02	4011.27	129.88	7.46	0.00	9.26	12.00	100.00
47 (1800)	3	0.39	13.82	0.25	48.98	3.45	7.07	13.62	0.02	3929.95	95.61	12.11	0.00	9.78	12.00	100.00
48 (1900)	3	0.37	14.18	0.09	48.36	3.49	7.37	13.45	0.02	3375.75	167.92	8.73	0.00	4.45	12.30	100.00
49 (2000)	3	0.39	14.67	0.07	47.23	3.73	8.16	13.10	0.02	3146.63	127.51	10.37	0.00	5.59	12.30	100.00
50 (2100)	3	0.40	14.67	0.08	47.64	3.60	8.00	13.06	0.02	2176.65	122.30	7.17	0.00	0.89	12.30	100.00
51 (2200)	3	0.43	14.13	0.08	48.53	3.52	7.57	13.12	0.03	2793.00	149.10	10.81	0.00	7.35	12.30	100.00
52 (2300)	3	0.41	14.12	0.14	48.09	3.66	7.92	13.11	0.03	2055.37	112.33	9.57	0.00	5.88	12.30	100.00
53 (2400)	3	0.43	14.51	0.09	47.52	3.70	8.14	13.07	0.02	2084.86	88.40	7.35	0.00	1.24	12.30	100.00
June 15, 1994																
54 (0100)	3	0.38	14.42	0.07	48.41	3.68	7.78	13.27	0.02	1954.77	105.27	7.78	0.00	5.77	11.75	100.00
55 (0200)	3	0.42	14.77	0.09	48.15	3.56	7.89	13.13	0.02	2119.40	93.57	7.39	0.00	5.13	11.75	100.00

d. (Cont.) PRODUCT GAS ANALYSIS

Test No. 94FBG07 (6/6-6/15/94)

10" Fluid Bed Gasifier

B. (Cont'd) Mole Percent (Wet Basis)

Date/ Sample I.D. (Time Taken)	Test Period #	Ar %	H2 %	O2 %	N2 %	CH4 %	CO %	CO2 %	C2H6 %	H2S PPM	COS PPM	SO2 PPM	CS2 PPM	C4H4S PPM	H2O* %	Total %
June 15, 1994																
56 (0300)	3	0.42	14.71	0.06	47.73	3.78	8.08	13.25	0.02	1971.14	93.67	6.55	0.00	5.60	11.75	100.00
57 (0400)	3	0.44	14.31	0.11	48.96	3.50	7.64	13.01	0.02	2676.20	121.36	11.42	0.00	7.41	11.75	100.00
58 (0500)	3	0.43	14.39	0.19	48.66	3.72	7.86	12.76	0.02	2042.01	101.27	18.90	0.00	5.72	11.75	100.00
59 (0600)	3	0.43	14.85	0.11	48.25	3.58	7.84	12.92	0.03	2216.93	112.20	4.15	0.00	1.99	11.75	100.00
60 (0700)	3	0.41	15.11	0.07	47.47	3.81	7.86	13.34	0.03	1432.94	84.09	9.81	0.00	5.08	11.75	100.00
61 (0800)	3	0.42	14.55	0.10	48.41	3.36	7.90	13.18	0.02	2820.25	123.06	10.15	0.00	6.20	11.75	100.00
62 (0900)	3	0.43	14.79	0.08	47.86	3.63	8.24	12.96	0.02	2310.47	112.39	9.55	0.00	3.47	11.75	100.00
63 (1000)	3	0.43	14.35	0.12	48.10	3.41	8.62	12.98	0.02	2164.87	140.81	8.23	0.00	5.11	11.75	100.00
64 (1100)	3	0.39	14.21	0.09	48.39	3.55	8.35	12.94	0.03	2872.41	129.69	10.29	0.17	5.36	11.75	100.00
65 (1200)	3	0.42	14.67	0.08	47.77	3.63	8.70	12.82	0.02	1376.47	96.97	7.92	0.00	0.09	11.75	100.00

\* Averaged gas flow across the collection period is used to calculate H2O content in gas.

e. Summary of Clean Up Rig Steady-State Conditions  
Test No. 93MGC07

Period #	Steady - State		Duration, hrs.	Test Mode*	Coal Type	Gas Flow Rates (SCFH)	Filter Temperatures		Filter Operating Pressure (psig)	Single Filter Differential Pressure (psig)	Filter Assembly Differential Pressure (psig)	Filter Blowback Pressure (psig)
	Date (Time)						Inlet TIR-248 (deg F)	Outlet TIR-224 (deg F)				
	Start	End										
2A	06/08	06/09	25.08	F	M6	1837.2	1105.3	1055.9	290.21	2.086	3.85	442.3
	21:15	22:20										
2B	06/10	06/11	27.17	F	M6	1723.1	1102.7	1042.1	289.2	2.094	3.775	475.5
	00:40	03:50										
2C	06/11	06/12	30.42	F	M6	1601.6	1080.2	1029.0	291.93	2.024	3.60	444.57
	04:48	11:30										
3A	06/13	06/13	0.48	F, P, S	M6	1809.8	796.17	926.59	274.92	1.74	2.64	494.26
	19:22	19:51										
3B	06/13	06/14	16.0	F, P, S	M6	1799.1	1075.7	1075.4	291.80	2.201	3.35	492.6
	22:05	13:05										
3C	06/14	06/15	19.7	F	M6	1717.8	1082.9	1048.9	290.28	1.974	2.778	491.16
	17:05	12:47										
Average			118.85*			1683.6	1089.0	1046.8	290.58	2.063	3.52	465.55

\*\* Steady-state Periods are based on FBG Steady-state Periods

\* Total Steady-State Run Time

+Key to Test Mode Symbols

- Filtering (F)
- Sorbent Test Period (S)
- Nahcolite Bed (Na)
- COS Hydrolysis Bed (C)
- Particle Monitoring (P)
- Alkali Monitoring (A)
- Ammonia Monitor (N)

-Key to Coal Type Symbols

- Montana #5 (M5)
- Montana #6 (M6)
- Montana #7 (M7)
- Floride Salt with Montana #6 (CL/M6)
- Illinois #6 (I6)

## **B. Test Run 94FBG/MGC08**

Test run 94FBG/MGC08 was conducted from July 18, 1994, through July 27, 1994, (7/18/94 (00:00) to 7/27/94 (24:00)).

### **a. Test Objective**

The objective of this run was to attain 200 hours of steady state operation of the integrated gasifier and hot gas cleanup facility to accumulate additional hours on the C34, C36 candles and 3M materials (SICONEX™, NEXTEL™ 312 and NEXTEL™ 550), test a fixed bed of desulfurization sorbent prepared by researchers at METC (METC #2), and to initiate a slip stream test to determine the ability of nahcolite to remove chloride from the coal gas stream.

### **b. Run Highlights**

Below is a bulletized listing of the run highlights. Appendix 2 contains a detailed chronology of significant run events.

- 191 hours of integrated steady-state operation was attained during 3 steady state periods.
- The longest continuous, steady-state gasification period was 132.6 hours.
- The sulfur breakthrough curve (hydrogen sulfide level at the outlet of the desulfurizer versus time) for METC #2 was obtained.
- Approximately 40 hours of online particulate monitoring of the coal gas entering F-100 was attained.
- A slip stream test of a nahcolite sorbent bed for removal of chloride from the coal gas was completed. (CaCl was used added to the feed coal to give a level of 1000 ppm of Cl in the feed coal.)

C. SUMMARY of GASIFIER OPERATING CONDITIONS

Test No. 94F8G08 (07/18-07/27/94)

10" Fluid Bed Gasifier

Period #	Steady-State Date (Time)		Duration hrs	Reactor		Coal Feed lb/h (3)	Convey Air		Reactor Air		Steam		Underflow N <sub>2</sub>		Air/H <sub>2</sub> O	H <sub>2</sub> O/Coal
	Start	End		Press. psig (1)	Temp. of (2)		(4) scfh	(5) of	(6) scfh	(7) of	(8) lb/h	(9) of	(10) scfh	(11) of	(12) lb/lb	(13) lb/lb
1	07/18 (16:30)	07/20 (12:45)	44.25	425	1464.5	70.0	1604.1	67	500.2	704	54.8	704	404.0	495	2.9	0.78
2	07/20 (12:45)	07/21 (04:45)	16.00	425	1479	67.9	1698.0	68	588.3	818	53.9	818	401.0	495	3.2	0.79
3	07/21 (04:45)	07/27 (00:35)	139.83	425	1432	70.0	1602.4	67	532.2	740	54.6	740	399.3	495	3.0	0.78
		Total:	200.08	Avg:	1442.9	69.8	1610.4	67	529.6	738	54.6	738	400.5	495	3.0	0.78

Followings are time-averaged values:

- (1): PT-713 reading.
- (2): TE-703 reading.
- (3): (ST-603 reading in rpm) x CFC lb/h/rpm  
where: CFC = 2.32
- (4): Average of FT-107, -109 readings.
- (5): TE-108 reading.
- (6): Average of FT-113, -115 readings.
- (7): TE-504 reading.
- (8): Average of FT-219, -221 readings.
- (9): TE-504 reading.
- (10): Average of FT-311, -313 readings.
- (11): TE-312 reading.
- (12): [(4) + (6)] \* 0.0765 / (8)
- (13): (8) / (3)

d. PRODUCT GAS ANALYSIS

Test No. 94F8G08 (7/18-7/27/94)

10" Fluid Bed Gasifier

Date/ Sample I.D. (Time Taken)	Test Period #	8. Mole Percent (Wet Basis)												Total %			
		Ar %	H <sub>2</sub> %	O <sub>2</sub> %	N <sub>2</sub> %	CH <sub>4</sub> %	CO %	CO <sub>2</sub> %	C <sub>2</sub> H <sub>6</sub> %	H <sub>2</sub> S PPM	COS PPM	SO <sub>2</sub> PPM	CS <sub>2</sub> PPM		C <sub>4</sub> H <sub>10</sub> PPM	H <sub>2</sub> O* %	
July 18, 1994																	
1 (1630)	1	0.44	12.34	0.45	46.57	2.91	5.49	12.67	0.10	2205.83	212.23	5.03	0.00	4.31	18.80	100.00	
2 (1720)	1	0.38	11.98	0.39	48.50	2.77	5.65	11.27	0.09	1437.40	235.92	4.55	0.00	2.82	18.80	100.00	
3 (1830)	1	0.38	11.85	0.38	51.39	2.80	5.61	11.06	0.02	75.04	8.70	0.97	0.00	0.56	16.50	100.00	
4 (1930)	1	0.45	14.08	0.44	47.92	3.19	6.61	13.24	0.05	2940.03	257.07	9.30	0.00	2.54	13.70	100.00	
5 (2155)	1	0.44	14.48	0.45	46.50	4.03	7.04	13.14	0.05	1619.70	124.41	4.40	0.00	1.01	13.70	100.00	
6 (2230)	1	0.44	13.79	0.50	47.89	3.62	6.54	13.20	0.04	2534.56	171.31	18.72	0.26	1.57	13.70	100.00	
7 (2330)	1	0.48	13.89	0.48	47.57	3.99	6.58	13.06	0.03	2028.80	156.94	15.31	0.00	0.61	13.70	100.00	
July 19, 1994																	
8 (0030)	1	0.43	13.26	0.50	48.84	3.85	5.95	13.20	0.04	3082.12	182.69	16.15	0.00	1.48	13.60	100.00	
9 (0130)	1	0.44	13.61	0.52	49.48	3.98	6.17	13.80	0.05	2946.53	177.57	19.54	0.98	1.33	11.64	100.00	
10 (0230)	1	0.42	13.27	0.48	47.25	3.94	6.20	12.83	0.03	2256.25	165.04	12.91	0.00	1.02	15.33	100.00	
11 (0330)	1	0.43	13.40	0.50	49.41	3.83	5.67	13.13	0.04	2756.87	169.95	18.91	0.17	1.39	13.10	100.00	
12 (0430)	1	0.44	13.56	0.48	48.43	3.96	6.25	13.22	0.04	2100.86	125.60	9.63	0.00	0.95	13.40	100.00	
13 (0630)	1	0.45	14.51	0.52	50.01	4.06	6.51	14.28	0.04	3358.11	158.91	5.89	0.36	1.63	9.27	100.00	
14 (1230)	1	0.43	13.77	0.49	48.54	3.90	6.29	13.24	0.03	3459.98	178.63	22.44	0.00	1.48	12.93	100.00	
15 (1630)	1	0.44	14.11	0.51	48.06	4.19	6.58	13.57	0.04	2453.02	129.63	5.52	0.36	0.80	12.24	100.00	
16 (2030)	1	0.44	13.72	0.50	46.77	3.72	6.66	13.04	0.03	2497.50	170.90	7.15	0.17	1.03	14.84	100.00	
July 20, 1994																	
17 (0030)	1	0.44	13.75	0.50	47.29	3.93	6.76	13.02	0.05	2665.18	141.00	7.75	0.00	0.87	13.97	100.00	
18 (0430)	1	0.44	13.52	0.68	48.14	4.05	7.07	12.99	0.05	1260.36	100.33	15.54	0.00	0.70	12.93	100.00	
19 (0830)	1	0.44	13.96	0.48	47.25	4.12	6.93	13.72	0.04	1172.75	80.18	4.18	0.00	0.61	12.93	100.00	
20 (1030)	1	0.44	13.93	0.50	47.63	4.02	6.79	13.56	0.03	1590.81	80.41	4.70	0.00	0.78	12.93	100.00	
21 (1130)	1	0.39	12.37	0.44	45.08	3.73	6.00	12.12	0.05	1595.10	83.61	2.63	0.00	0.70	19.67	100.00	
22 (1230)	1	0.43	12.99	0.47	44.77	3.63	6.44	13.26	0.05	2456.28	114.98	4.26	0.08	1.15	17.70	100.00	
23 (1330)	2	0.41	12.44	0.47	46.57	3.65	5.81	13.36	0.03	2302.94	134.84	20.24	0.00	0.98	17.02	100.00	
24 (1430)	2	0.43	12.55	0.46	47.25	3.59	5.80	12.66	0.02	2167.44	123.36	5.70	0.08	1.98	17.02	100.00	
25 (1530)	2	0.43	12.64	0.50	49.83	3.71	5.60	13.35	0.02	2692.52	143.30	14.02	0.00	1.19	13.63	100.00	
26 (1630)	2	0.44	12.60	0.52	50.61	3.44	5.65	14.27	0.00	3633.83	193.96	8.00	1.12	2.24	12.08	100.00	
27 (1730)	2	0.45	13.04	0.50	49.01	3.68	6.10	13.93	0.00	2904.54	169.64	5.12	0.43	1.71	12.97	100.00	
28 (1830)	2	0.44	13.33	0.51	47.39	3.79	6.51	13.02	0.00	1945.85	109.84	9.44	0.09	0.95	14.80	100.00	
29 (1830)	2	0.42	13.60	0.73	51.06	3.93	6.46	13.23	0.00	1108.53	119.08	8.05	0.09	1.36	10.45	100.00	
30 (2030)	2	0.43	13.66	0.52	52.59	3.85	6.41	13.83	0.00	1806.76	131.83	3.67	0.00	1.47	8.50	100.00	
31 (2130)	2	0.44	13.38	0.50	49.28	3.84	6.41	13.17	0.00	2052.28	120.21	15.73	0.18	0.88	12.76	100.00	
32 (2230)	2	0.44	13.46	0.51	49.18	3.78	6.40	13.19	0.03	2251.46	120.67	15.91	0.00	0.70	12.71	100.00	

d. (Cont.) PRODUCT GAS ANALYSIS

10" Fluid Bed Gasifier

Test No. 94FB608

(7/18-7/27/94)

B. (Cont'd) Mole Percent (Wet Basis)

Date/ Sample I.D. (Time Taken)	Test Period #	Ar %	H2 %	O2 %	N2 %	CH4 %	CO %	CO2 %	C2H6 %	H2S PPM	COS PPM	SO2 PPM	CS2 PPM	C4H4S PPM	H2O* %	Total %
July 21, 1994																
33 (0030)	2	0.42	12.93	0.51	46.65	3.74	6.41	12.45	0.02	1250.20	83.76	10.16	0.25	1.00	16.74	100.00
34 (0130)	2	0.44	12.37	0.60	47.10	3.68	6.08	12.66	0.03	1602.72	109.23	13.45	0.00	1.09	16.87	100.00
35 (0230)	2	0.41	12.88	0.50	46.77	3.61	6.22	12.65	0.02	1520.09	96.73	12.75	0.00	1.08	16.78	100.00
36 (0330)	2	0.45	12.41	0.50	47.10	3.29	5.94	12.99	0.01	3711.79	197.03	10.65	0.08	2.15	16.93	100.00
37 (0430)	2	0.42	13.07	0.47	46.69	3.69	6.62	12.14	0.00	1980.54	127.37	15.22	0.00	0.91	16.69	100.00
38 (0530)	3	0.44	12.56	0.50	47.45	3.03	5.89	12.71	0.00	4892.87	253.26	32.81	0.00	1.16	16.90	100.00
39 (0630)	3	0.42	13.71	0.48	46.73	3.69	7.15	13.17	0.04	2791.05	140.31	11.48	0.00	0.88	14.31	100.00
40 (0830)	3	0.42	14.04	0.48	47.04	3.57	7.58	12.43	0.02	1904.41	114.83	10.50	0.00	0.52	14.20	100.00
41 (1230)	3	0.43	13.91	0.48	47.25	3.62	7.18	12.65	0.03	1981.71	121.22	5.57	0.00	0.96	14.24	100.00
42 (11630)	3	0.46	14.19	0.53	48.85	3.57	6.84	13.65	0.03	4688.12	185.12	9.65	1.17	1.44	10.38	100.00
43 (2030)	3	0.39	13.52	0.47	45.61	3.92	6.86	12.33	0.03	1949.76	94.14	8.41	0.68	0.59	16.57	100.00
July 22, 1994																
44 (0030)	3	0.43	13.42	0.50	45.95	3.57	6.57	12.80	0.03	2225.55	149.25	24.49	0.34	1.02	16.50	100.00
45 (0430)	3	0.39	12.22	0.50	42.56	3.40	6.14	11.49	0.02	1662.88	93.99	10.80	0.00	1.00	23.10	100.00
46 (0830)	3	0.41	13.69	0.48	45.20	3.96	7.11	13.10	0.05	1674.30	109.50	17.95	0.17	0.76	15.82	100.00
47 (1230)	3	0.43	13.53	0.48	45.11	3.56	6.98	12.65	0.03	2095.50	111.63	7.88	0.00	1.43	17.02	100.00
48 (1630)	3	0.41	13.32	0.49	46.03	3.53	6.81	13.11	0.03	2575.54	139.70	8.51	0.34	0.93	15.99	100.00
49 (2030)	3	0.41	13.16	0.48	45.81	3.64	6.64	12.80	0.03	2395.55	140.01	9.66	0.42	1.34	16.78	100.00
July 23, 1994																
50 (0030)	3	0.38	13.53	0.49	44.50	3.53	6.32	12.38	0.03	2234.42	119.56	23.38	0.16	0.97	18.61	100.00
51 (0430)	3	0.40	12.49	0.48	43.64	3.63	6.41	12.18	0.03	1971.33	88.42	21.49	0.32	1.84	20.52	100.00
52 (0830)	3	0.42	13.11	0.48	45.59	3.81	6.75	12.89	0.03	1949.23	101.84	9.38	0.08	0.50	16.72	100.00
53 (1230)	3	0.42	13.08	0.48	45.08	3.70	6.63	12.77	0.03	2776.00	113.51	11.27	0.25	0.91	17.63	100.00
54 (1630)	3	0.42	13.59	0.48	45.57	3.90	7.01	13.04	0.03	2355.17	125.02	12.29	0.42	0.76	15.72	100.00
55 (2030)	3	0.45	13.08	0.50	47.02	3.43	6.52	13.01	0.03	3719.09	160.93	21.11	0.69	1.80	15.57	100.00
July 24, 1994																
56 (0030)	3	Bottle broken at sample station														
57 (0430)	3	Bottle broken at sample station														
58 (0830)	3	0.42	12.81	0.46	45.21	3.68	6.73	12.11	0.03	2399.37	119.61	7.63	0.33	1.57	18.28	100.00
59 (1230)	3	0.40	13.71	0.47	45.28	3.99	7.18	12.41	0.03	2162.78	124.56	7.01	0.08	0.93	16.31	100.00
60 (2030)	3	0.44	13.83	0.49	49.33	3.67	6.84	13.16	0.03	3065.75	196.19	8.45	0.89	5.96	11.90	100.00



d. (Cont.) PRODUCT GAS ANALYSIS

10" Fluid Bed Gasifier Test No. 94FB608 (7/18-7/27/94)

Date/ Sample I.D. (Time Taken)	Test Period #	B. (Cont'd) Mole Percent (Wet Basis)														Total %
		Ar %	H <sub>2</sub> %	O <sub>2</sub> %	N <sub>2</sub> %	CH <sub>4</sub> %	CO %	CO <sub>2</sub> %	C <sub>2</sub> H <sub>6</sub> %	H <sub>2</sub> S PPM	COS PPM	SO <sub>2</sub> PPM	CS <sub>2</sub> PPM	C <sub>4</sub> H <sub>8</sub> PPM	H <sub>2</sub> O* %	
July 25, 1994	3	0.00	14.34	0.47	48.60	4.05	7.47	13.24	0.04	1531.50	0.00	0.00	0.00	0.00	11.65	100.00
61 (0030)	3	0.38	12.57	0.46	45.18	3.52	6.16	12.15	0.04	1813.54	121.99	8.30	0.33	4.64	18.34	100.00
62 (0430)	3	0.43	13.81	0.54	47.63	4.05	6.97	12.75	0.04	2595.30	101.84	8.57	0.35	0.87	13.50	100.00
63 (0830)	3	0.40	13.52	0.46	45.88	3.95	7.04	12.28	0.03	1053.71	79.81	19.15	0.25	0.67	16.34	100.00
64 (1230)	3	0.42	13.62	0.47	45.49	3.87	6.99	12.58	0.03	1601.43	92.17	8.68	0.33	1.67	16.36	100.00
65 (1630)	3	0.43	13.16	0.52	45.79	3.62	6.73	12.64	0.03	2555.70	125.85	10.43	0.33	2.17	16.80	100.00
66 (2030)	3	0.42	13.34	0.48	45.88	3.73	6.61	12.26	0.04	1351.11	118.99	5.90	0.00	0.91	17.07	100.00
July 26, 1994	3	0.44	14.16	0.53	49.87	4.12	7.14	13.11	0.05	1932.22	75.66	15.85	0.18	0.90	10.37	100.00
67 (0030)	3	0.39	12.91	0.47	45.14	3.74	6.63	11.97	0.03	1156.19	81.57	8.09	0.00	0.82	18.60	100.00
68 (0430)	3	0.43	13.64	0.47	46.00	3.94	7.06	12.31	0.03	1191.00	89.45	5.20	0.00	0.67	16.00	100.00
69 (0830)	3	0.39	12.44	0.48	41.59	3.59	6.55	11.49	0.05	1075.87	69.56	9.51	0.08	0.62	23.31	100.00
70 (1230)	3	0.58	2.92	10.72	61.80	1.16	2.14	4.02	0.01	237.61	25.42	22.14	0.00	0.00	16.62	100.00
71 (1630)	3	0.46	13.11	1.32	46.71	3.60	7.32	11.92	0.03	1047.43	60.08	8.03	0.00	0.00	15.41	100.00
72 (2030)	3	0.02	0.00	0.11	82.60	0.00	0.00	0.72	0.00	20.14	0.00	1.69	0.00	0.00	16.55	100.00
July 27, 1994	3															
73 (0030)	3															
74 (0430)	Shut Off															

\* Averaged gas flow across the collection period is used to calculate H<sub>2</sub>O content in gas.

e. Summary of Clean Up Rig Steady-State Conditions  
Test No. 94MGC08

Period #	Steady - State		Duration, hrs.	Test Mode*	Coal Type*	Gas Flow Rates	Filter Temperatures		Filter Operating Pressure	Single Filter Differential Pressure	Filter Assembly Differential Pressure	Filter Blowback Pressure
	Date (Time)						Inlet TIR-248 (deg F)	Outlet TIR-224 (deg F)				
	Start	End										
1A	7/18 (17:10)	7/18 (19:48)	2.63	F	M6	800	960	910	PIR-247 (psig)	PDIR-459 (psig)	PDIR-155 (psig)	PIR-458 (psig)
1B	7/18 (21:48)	7/19 (07:45)	9.95	F, S	M6	1254	1091	1039	285	0.90	1.33	457
1C, 2A	7/19 (09:15)	7/20 (12:50)	27.58	F, P	M6	2112	1110	1049	287	2.09	3.04	451
2B	7/20 (12:50)	7/21 (4:50)	16.00	F, P, Na	CL/M6	1986	1030	1040	292	2.27	3.31	454
3A	7/21 (04:50)	7/26 (17:25)	132.58	F, P	M6	1950	871	1050	291	2.53	3.48	454
3B	7/26 (22:30)	7/27 (00:40)	2.17	F	M6	1837	396	799	286	1.17	1.52	456
Average	Values		190.91*			1921	926	1043	290	2.31	3.22	453

\* Total Steady-State Run Time

\*\* Steady-state Periods are based on FBG Steady-state Periods

+Key to Test Mode Symbols

- Filtering (F)
- Sorbent Test Period (S)
- Naphcolite Bed (Na)
- COS Hydrolysis Bed (C)
- Particle Monitoring (P)
- Alkali Monitoring (A)
- Ammonia Monitor (N)

-Key to Coal Type Symbols

- Montana #5 (M5)
- Montana #6 (M6)
- Montana #7 (M7)
- Cloride Salt with Montana #6 (CL/M6)
- Illinois #6 (I6)

### **C. Test Run 94FBG/MGC09**

Test run 94FBG/MGC09 was conducted from September 12, 1994, through September 16, 1994, (9/12/94 (00:00) to 9/16/94 (24:00)).

#### **a. Test Objective**

The objective of this run was to attain 90 hours of steady state operation of the integrated gasifier and hot gas cleanup facility to accumulate additional hours on the C34, C36 candles and 3M materials (SICONEX™, NEXTEL™ 312 and NEXTEL™ 550), test a fluid bed of desulfurization sorbent prepared by Contract Materials Processing (CMP) for RTI (Zt-4L), to perform a slip stream test to determine the ability of nahcolite to remove chloride from the coal gas stream, to initiate testing of the Direct Sulfur Recovery Process (patented by RTI and METC) using a slip stream of filtered hot coal gas, and to begin parametric testing of the gasifier by making slight adjustments to gasifier inputs.

#### **b. Run Highlights**

Below is a bulletized listing of the run highlights. Appendix 2 contains a detailed chronology of significant run events.

- 85 hours of integrated steady-state operation was attained during 10 steady state periods.
- The sulfur breakthrough curve (hydrogen sulfide level at the outlet of the desulfurizer versus time) for ZT-4L was obtained.
- Approximately 23 hours of online particulate monitoring of the coal gas entering F-100 was attained.
- A slip stream test of a nahcolite sorbent bed for removal of chloride from the coal gas was completed. (CaCl was used added to the feed coal to give a level of 1000 ppm of Cl in the feed coal.)
- 2 integrated DSRP tests and 2 cycles of sorbent testing were completed.

C. Operating Conditions of Steady-State Periods  
Test No. 94FBG09 (09/12 - 09/16/94)

10" Fluid Bed Gasifier

Period #	Steady-State Date (Time)		Reactor		Coal Feed lb/h (3)	Convey Air		Reactor Air		Steam+		Underflow N2		Air/H2O (12) lb/lb	H2O/Coal (13) lb/lb	
	Start	End	Duration hrs	Press. psig (1)		Temp. of (2)	(4) scfh	(5) of	(6) scfh	(7) of	(8) lb/h	(9) of	(10) scfh			(11) of
1	09/12 (18:22)	09/13 (08:15)	13.88	425	1070.5	68.9	1627.3	52	507.0	635	53.8	635	405.0	493	3.0	0.78
2	09/13 (06:15)	09/13 (18:00)	11.75	425	1050	69.1	1601.6	65	796.2	641	53.4	641	402.3	493	3.4	0.77
3*	09/13 (18:00)	09/14 (08:10)	12.17	425	1048	68.1	1624.3	59	1012.3	649	51.8	649	400.7	321	3.9	0.76
4*	09/14 (06:10)	09/14 (10:22)	4.20	425	995.5	68.1	1585.0	62	1019.0	658	51.1	658	484.0	447	3.9	0.75
5	09/14 (10:22)	09/14 (19:27)	9.08	425	1002	69.1	1613.9	76	1009.9	658	52.2	658	463.0	NA	3.8	0.76
6	09/14 (19:27)	09/15 (06:10)	10.72	425	1067.6	76.7	1615.0	65	1011.8	661	51.7	661	402.3	NA	3.9	0.67
7	09/15 (06:10)	09/15 (18:06)	9.93	425	1107.4	76.7	1602.8	71	1337.7	674	49.5	674	400.2	NA	4.5	0.64
8	09/15 (18:06)	09/15 (21:12)	5.10	425	1200	76.5	1599.0	NA	1008.0	NA	51.9	NA	400.0	NA	3.8	0.68
9**	09/15 (21:12)	09/16 (07:00)	9.80	425	1147.7	70.2	1620.3	63	1032.7	639	50.3	639	471.3	437	4.0	0.72
10***	09/16 (07:00)	09/16 (14:00)	7.00	425	1200.2	72.1	1606.3	70	1145.9	584	50.8	584	403.8	NA	4.1	0.70
		Total:	93.63	Avg:	1083.4	71.3	1612.6	60	956.7	610	51.8	610	419.0	242	3.8	0.73

Followings are time-averaged values:  
 (1): PT-713 reading.  
 (2): TE-703 reading.  
 (3): (ST-603 reading in rpm) x CFC lb/hr/rpm where: CFC = 2.61 (Montana #7); 2.58 (Cl-doped N#6)  
 (4): Average of FT-107, -109 readings.  
 (5): TE-108 reading.  
 (6): Average of FT-113, -115 readings.  
 (7): TE-504 reading.  
 (8): Average of FT-219, -221 readings.  
 (9): TE-504 reading.  
 (10): Average of FT-311, -313 readings.  
 (11): TE-312 reading.  
 (12): [(4) + (6)] \* 0.0765 / (8)  
 (13): (9) / (3)

\* Cl-doped Montana #6 Coal  
 \*\* Coke Brezza  
 \*\*\* Illinois #6 Coal  
 + Adjusted by reducing 9% wt from measured flow

d. PRODUCT GAS ANALYSIS

Test No. 93FBG09 (9/12-9/16/94)

10" Fluid Bed Gasifier

B. Mole Percent (Wet Basis)

Date/ Sample I.D. (Time Taken)	Steady- State #	Ar %	H2 %	O2 %	N2 %	CH4 %	CO %	CO2 %	C2H6 %	H2S PPM	COS PPM	SO2 PPM	CS2 PPM	C4H8S PPM	H2O* %	Total %
September 12, 1994																
1 (1800)	1	0.45	13.48	0.03	47.10	3.13	6.23	13.47	0.13	1693.47	205.56	2.02	0.00	4.46	15.79	100.00
2 (1900)	1	0.44	14.36	0.03	45.58	3.48	6.49	13.72	0.12	1287.02	150.23	2.19	0.00	3.21	15.65	100.00
3 (2000)	1	0.43	14.26	0.04	45.47	3.53	6.14	13.98	0.10	1904.28	136.71	1235.30	0.00	1.43	15.71	100.00
4 (2100)	1	0.44	13.96	0.04	45.93	3.68	6.41	13.63	0.08	1375.05	79.93	5.40	0.00	0.93	15.68	100.00
5 (2200)	1	0.40	14.08	0.06	45.70	3.74	6.96	13.27	0.04	1055.59	120.40	1.60	0.00	0.42	15.63	100.00
6 (2300)	1	0.43	14.29	0.06	45.38	3.54	7.40	13.05	0.04	2023.08	127.37	3.12	0.00	1.86	15.59	100.00
7 (2400)	1	0.43	14.43	0.05	45.12	3.69	7.77	12.78	0.03	1555.06	103.56	2.53	0.00	1.01	15.53	100.00
September 13																
8 (0100)	1	0.41	14.13	0.06	45.64	3.70	7.68	12.66	0.03	1228.62	62.99	2.03	0.00	1.01	15.56	100.00
9 (0200)	1	0.41	14.29	0.06	45.32	3.52	8.06	12.58	0.03	1742.35	118.91	6.08	0.00	1.01	15.55	100.00
10 (0300)	1	0.42	14.14	0.06	45.56	3.59	8.02	12.50	0.03	1238.13	73.38	4.05	0.00	2.28	15.56	100.00
11 (0400)	1	0.41	14.32	0.08	45.35	3.54	8.30	12.33	0.02	1294.72	88.46	2.11	0.00	0.93	15.52	100.00
12 (0500)	1	0.41	14.43	0.07	45.26	3.51	8.47	12.22	0.03	1201.16	68.88	2.45	0.00	0.76	15.49	100.00
13 (0600)	1	0.41	14.32	0.05	45.36	3.56	8.48	12.15	0.03	1359.34	85.43	2.11	0.00	0.51	15.50	100.00
14 (0700)	2	0.42	14.54	0.05	45.15	3.24	9.29	11.70	0.01	1407.79	94.20	3.04	0.00	0.51	15.44	100.00
15 (0800)	2	0.44	14.54	0.06	44.92	3.21	9.99	11.30	0.02	1109.62	72.24	4.65	0.00	0.42	15.41	100.00
16 (0900)	2	0.42	14.81	0.05	44.74	3.16	9.97	11.36	0.02	934.48	59.33	2.45	0.00	1.27	15.37	100.00
17 (1000)	2	0.42	14.52	0.05	45.01	3.26	9.73	11.44	0.02	1243.54	88.30	2.54	0.00	0.93	15.42	100.00
18 (1100)	2	0.42	14.71	0.05	44.37	3.42	9.64	11.83	0.02	1153.43	74.35	2.54	0.00	1.95	15.41	100.00
19 (1500)	2	0.40	14.39	0.08	45.00	3.36	9.17	11.94	0.03	1461.54	83.42	3.04	0.00	0.34	15.48	100.00
20 (1600)	2	0.41	14.50	0.05	44.90	3.49	8.99	12.07	0.02	1072.27	78.11	1.86	0.00	1.27	15.46	100.00
21 (2000)	3	0.43	13.43	0.08	46.69	2.66	8.67	12.06	0.00	2567.59	188.25	5.14	0.00	0.51	15.70	100.00
22 (2400)	3	0.43	13.33	0.08	47.47	2.44	9.23	11.17	0.00	2022.90	169.98	4.47	0.00	0.00	15.64	100.00
September, 14																
23 (0400)	3	0.44	13.16	0.17	46.69	2.39	9.65	10.94	0.00	1715.18	93.59	8.78	0.00	0.59	16.37	100.00
24 (0600)	3	0.43	13.25	0.11	47.03	2.35	9.50	10.81	0.00	1788.48	138.71	10.37	0.00	0.33	16.34	100.00
25 (1000)	4	0.36	8.35	0.06	58.61	1.64	4.21	9.37	0.02	3104.63	191.79	5.81	0.00	2.16	17.05	100.00
26 (1400)	5	0.34	9.84	0.06	60.54	2.27	5.11	9.81	0.03	1184.22	80.55	3.44	0.00	1.67	11.87	100.00
27 (1800)	5	0.47	14.91	0.02	47.85	2.94	9.96	12.11	0.00	3077.42	219.66	5.23	0.00	0.53	11.43	100.00

d. (Cont.) PRODUCT GAS ANALYSIS

Test No. 93F6609

10" Fluid Bed Gasifier

B. (Cont'd) Mole Percent (Wet Basis)

Date/ Sample I.D. (Time Taken)	Steady- State #	Ar %	H2 %	O2 %	N2 %	CH4 %	CO %	CO2 %	C2H6 %	H2S PPM	COS PPM	SO2 PPM	CS2 PPM	C4H8S PPM	H2O* %	Total %
28 (2200)	6	0.46	15.07	0.04	47.50	3.10	9.80	12.25	0.00	3468.40	237.07	6.91	0.00	0.87	11.41	100.00
September 15																
29 (0200)	6	0.43	15.21	0.09	45.43	3.33	10.89	11.45	0.01	1628.35	144.95	7.57	0.00	0.78	12.99	100.00
30 (0600)	6	0.43	13.96	0.31	47.05	2.99	9.74	11.99	0.00	2710.98	182.22	10.85	0.00	2.95	13.23	100.00
31 (1000)	7	0.43	14.66	0.06	46.82	2.58	11.14	10.87	0.00	2691.07	225.13	8.16	0.00	0.86	13.14	100.00
32 (1400)	7	0.46	13.57	0.59	47.75	2.67	11.26	10.31	0.00	1393.20	115.56	2.78	0.00	1.85	13.24	100.00
33 (1800)	8	0.42	14.85	0.08	46.26	3.07	10.42	11.55	0.01	1746.52	123.00	4.26	0.00	0.86	13.14	100.00
34 (2200)	9	0.48	12.69	0.03	51.15	1.23	9.30	11.48	0.00	1083.00	39.77	2.59	0.00	0.00	13.53	100.00
35 (2400)	9	0.52	9.23	0.06	56.54	0.67	5.69	12.95	0.00	1789.30	138.64	4.38	0.00	0.00	14.15	100.00
September, 16																
36 (0400)	9	0.43	3.17	0.06	71.21	0.16	1.47	9.98	0.00	1230.65	59.60	2.86	0.00	0.00	13.38	100.00
37 (0745)	10	0.49	12.84	0.09	51.27	1.98	7.80	11.44	0.00	2867.26	207.19	8.19	0.00	2.33	13.78	100.00
38 (0900)	10	0.47	13.38	0.04	51.53	1.74	8.03	10.83	0.00	2959.11	221.45	5.53	0.00	0.00	13.67	100.00
39 (1000)	10	0.47	13.89	0.05	50.41	1.81	8.39	11.03	0.00	3241.59	243.19	4.06	0.00	0.00	13.61	100.00
40 (1100)	10	0.47	14.27	0.05	49.89	2.07	8.20	11.11	0.00	3601.63	221.66	5.10	0.00	0.00	13.55	100.00
41 (1200)	10	0.47	13.30	0.07	50.92	1.60	8.37	11.23	0.00	2892.17	228.16	7.16	0.00	0.00	13.72	100.00
42 (1300)	10	0.47	11.05	0.08	53.87	1.11	7.28	11.83	0.00	2028.02	156.68	5.15	0.00	0.00	14.10	100.00
43 (1400)	10	0.48	10.78	0.06	54.77	1.18	6.89	11.50	0.00	2128.33	155.81	4.12	0.00	0.00	14.11	100.00

\* Averaged gas flow across the collection period is used to calculate H2O content in gas.

e. Summary of Clean Up Rig Steady-State Conditions  
Test No. 94MGCO9

Period #	Steady - State		Duration, hrs.	Test Mode*	Coal Type*	Gas Flow Rates (SCFH)	Filter Temperatures		Filter Operating Pressure (psig)	Single Filter Differential Pressure (psig)	Filter Assembly Differential Pressure (psig)	Filter Blowback Pressure (psig)
	Date (Time)						Inlet TIR-248 (deg F)	Outlet TIR-224 (deg F)				
	Start	End										
1, 2	9/12 (20:00)	9/13 (18:45)	22.75	F, P, S	M7	1947	1085	1050	PIR-247 (psig)	PDIR-459 (psig)	PDIR-155 (psig)	PIR-458 (psig)
3, 4A	9/13 (19:02)	9/14 (10:33)	15.52	F, Na	M7, CL/M6	1877	1151	1090	294	5.56	4.36	459
4B, 5, 6A	9/14 (10:33)	9/15 (01:50)	15.28	F, P, S	M7	1898	1144	1081	288	5.58	4.52	453
6B, 7A	9/15 (04:50)	9/15 (11:25)	6.58	F, S	M7	2015	1115	1063	293	5.16	4.16	458
7B, 8	9/15 (12:55)	9/15 (21:12)	8.28	F, P	M7	1828	1124	1076	295	5.59	4.45	457
9	9/15 (21:12)	9/16 (07:00)	9.80	F, P	Coke breeze	2263	1164	1091	293	4.29	3.10	458
10	9/16 (07:00)	9/16 (14:00)	7.00	F, P	I6	2226	1149	1090	294	4.60	3.32	457
Average	Values		85.22			1979	1128	1074	292	5.29	4.14	457

\*\* Steady-state Periods are based on FBG Steady-state Periods

\* Total Steady-State Run Time

-Key to Coal Type Symbols

- Montana #5 (M5)
- Montana #6 (M6)
- Montana #7 (M7)
- Cloride Salt with Montana #6 (CL/M6)
- Illinois #6 (I6)

+Key to Test Mode Symbols

- Filtering (F)
- Sorbent Test Period (S)
- Nahcolite Bed (Na)
- COS Hydrolysis Bed (C)
- Particle Monitoring (P)
- Alkali Monitoring (A)
- Ammonia Monitor (N)

#### **D. Test Run 94FBG/MGC010**

Test run 94FBG/MGC010 was conducted from October 24, 1994, through October 28, 1994, (10/24/94 (00:00) to 10/28/94 (24:00)).

##### **a. Test Objective**

The objective of this run was to attain 200 hours of steady state operation of the integrated gasifier and hot gas cleanup facility to accumulate additional hours on the C34 candle, 3M materials (SICONEX™, NEXTEL™ 312 and NEXTEL™ 550), to initiate filter testing of a ceramic composite candle, test a fluid bed of desulfurization sorbent prepared by Contract Materials Processing (CMP) for RTI (Zt-4L), to perform a slip stream test to expose a COS hydrolysis catalyst to a coal gas stream, to perform a test of the Direct Sulfur Recovery Process (patented by RTI and METC) using a slip stream of filtered hot coal gas, and to continue parametric testing of the gasifier by making slight adjustments to gasifier inputs.

##### **b. Run Highlights**

Below is a bulletized listing of the run highlights. Appendix 2 contains a detailed chronology of significant run events.

- 89 hours of integrated steady-state operation was attained during 11 steady state periods.
- The sulfur breakthrough curve (hydrogen sulfide level at the outlet of the desulfurizer versus time) for ZT-4L was obtained.
- Approximately 10 hours of online particulate monitoring of the coal gas entering F-100 was attained.
- A slip stream test of a COS hydrolysis bed was completed. (CaCl was used added to the feed coal to give a level of 1000 ppm of Cl in the feed coal.)
- 2 integrated DSRP tests and 18 hours of simulated SO<sub>2</sub> DSRP testing were completed.
- The run was shortened by 5 days when an overheated pipe buckled and could not be repaired in time to continue the run on the planned schedule.



C . . Operating Conditions of Steady-State Periods  
 Test No. 94FBG10 (10/24 - 10/28/94)

10" Fluid Bed Gasifier

Period #	Steady-State Date (Time)		Duration hrs	Reactor		Coal Feed lb/h (3)	Convey Air		Reactor Air		Steam+		Underflow N2		Cons N2		Air/H2O		H2O/Coal lb/lb (15)
	Start	End		Press. psig (1)	Temp. of (2)		(4) scfh	(5) of	(6) scfh	(7) of	(8) lb/h	(9) of	(10) scfh	(11) of	(12) scfh	(13) of	(14) lb/lb		
1	10/24 (15:00)	10/24 (23:00)	8.00	425	1243	71.8	1600.6	57	665.0	726	46.1	726	500	50.7	57	3.8	0.64		
2	10/24 (23:00)	10/25 (05:00)	6.00	425	968	71.1	1607.8	48	982.0	744	42.2	744	495	123.2	48	4.7	0.59		
3	10/25 (05:00)	10/25 (17:00)	12.00	425	929	71.6	1607.8	49	986.0	725	42.0	725	496	138.0	49	4.7	0.59		
4	10/25 (17:00)	10/26 (05:00)	12.00	425	939	71.6	1607.8	43	984.0	729	38.0	729	497	47.9	43	5.2	0.53		
5	10/26 (05:00)	10/26 (11:00)	6.00	425	940	71.8	1608.1	42	989.0	744	38.7	744	497	99.3	42	5.1	0.54		
6*	10/26 (11:00)	10/26 (23:00)	12.00	425	944	70.1	1607.8	47	1044.0	744	42.1	744	500	100.0	47	4.8	0.60		
7*	10/26 (23:00)	10/27 (03:00)	4.00	425	945	70.1	1607.6	43	923.0	747	40.9	747	495	99.8	43	4.7	0.58		
8	10/27 (03:00)	10/27 (15:00)	12.00	425	904	74.9	1607.7	42	923.0	750	43.9	750	495	100.0	42	4.4	0.59		
9	10/27 (15:00)	10/27 (21:00)	6.00	425	904	74.2	1607.4	52	983.0	751	42.9	751	500	100.8	52	4.6	0.58		
10	10/27 (21:00)	10/28 (09:00)	12.00	440-425	960	75.6	1608.0	34	983.0	739	50.5	739	496	210.3	34	3.9	0.67		
11	10/28 (09:00)	10/28 (13:30)	4.50	415	928	75.3	1607.0	44	860.0	714	48.1	714	NA	97.0	44	3.9	0.64		
		Total:	94.50	Avg:	961.7	72.6	1607.2	40	948.6	642	43.3	642	431	109.4	44.9	4.6	0.60		

Followings are time-averaged values:  
 (1): PT-713 reading.  
 (2): TE-703 reading.  
 (3): (ST-603 reading in rpm) x CFC lb/h/rpm where: CFC = 2.61 (Montana #7); 2.58 (Cl-doped M#6)  
 (4): Average of FT-107, -109 readings.  
 (5): TE-108 reading.  
 (6): Average of FT-113, -115 readings.  
 (7): TE-504 reading.  
 (8): Average of FT-219, -221 readings.  
 (9): TE-504 reading.  
 (10): FT-313 reading.  
 (11): TE-319 reading.  
 (12): FT-311 reading.  
 (13): TE-108 reading (assumed).  
 (14): [(4) + (6)] \* 0.0765/(8)  
 (15): (8)/(3)

\* Cl-doped Montana #6 Coal  
 + Adjusted by reducing 20%wt from measured flow

d. PRODUCT GAS ANALYSIS

Test No. 93FBG10 (10/24-10/29/94)

10" Fluid Bed Gasifier

Date/ Sample I.D. (Time Taken)	Test- Period #	B. Mole Percent (Wet Basis)														Total	
		Ar %	H2 %	O2 %	N2 %	CH4 %	CO %	CO2 %	C2H6 %	H2S PPM	COS PPM	SO2 PPM	CS2 PPM	CAH4S PPM	H2O* %	Total %	
October 24, 1994																	
1 (1600)	1	0.47	16.05	0.00	44.43	3.40	7.30	15.15	0.10	2594.74	269.50	5.83	0.00	5.83	12.82	100.00	
2 (1700)	1	0.42	14.74	0.00	48.71	3.25	5.86	13.79	0.10	2278.74	257.72	4.88	0.00	1.42	12.88	100.00	
3 (1800)	1	0.42	13.26	0.00	50.63	3.41	4.62	13.99	0.07	4838.33	267.11	7.90	0.80	4.26	13.09	100.00	
4 (1900)	1	0.42	14.42	0.02	47.99	3.35	6.78	13.66	0.04	3638.14	330.77	6.48	0.35	3.46	12.92	100.00	
5 (2000)	1	0.43	14.68	0.00	47.45	3.25	7.96	13.01	0.04	3298.06	189.54	4.79	0.44	0.71	12.83	100.00	
6 (2100)	1	0.44	14.18	0.00	49.01	2.70	8.18	12.24	0.02	3368.72	297.84	6.02	0.44	0.00	12.87	100.00	
7 (2200)	1	0.43	14.41	0.01	48.07	2.67	8.99	12.26	0.01	2832.09	262.94	7.85	0.27	0.09	12.84	100.00	
8 (2300)	1	0.42	14.32	0.00	48.34	2.61	9.77	11.51	0.00	2086.38	210.70	6.15	0.18	0.09	12.80	100.00	
9 (2400)	2	0.44	14.90	0.02	48.04	2.50	9.83	11.83	0.00	3206.10	280.42	7.12	1.05	0.00	12.10	100.00	
October 25, 1994																	
10 (0100)	2	0.45	14.45	0.01	48.94	2.29	9.43	11.85	0.00	3971.25	177.48	11.39	0.61	3.33	12.17	100.00	
11 (0200)	2	0.42	14.86	0.02	48.51	2.50	9.88	11.47	0.00	2462.80	223.58	6.88	0.35	0.70	12.07	100.00	
12 (0500)	2	0.44	14.18	0.00	49.24	2.35	10.52	10.80	0.00	3379.93	123.47	6.85	0.35	0.61	12.11	100.00	
13 (0900)	3	0.45	14.93	0.00	50.03	2.52	10.97	10.81	0.00	1960.05	131.35	3.85	0.63	5.38	10.09	100.00	
14 (1300)	3	0.48	14.97	0.00	49.60	2.84	10.62	11.20	0.01	1711.82	123.33	4.89	1.16	1.60	10.10	100.00	
15 (1700)	3	0.48	15.32	0.00	48.89	3.02	10.40	11.57	0.01	2053.10	112.50	6.77	0.63	0.00	10.08	100.00	
16 (2100)	4	0.48	15.47	0.00	48.79	2.58	11.52	11.28	0.00	2687.74	134.84	5.72	0.64	0.00	9.59	100.00	
October 26, 1994																	
17 (0100)	4	0.46	15.55	0.01	48.83	2.32	12.55	10.51	0.00	1947.10	167.33	10.80	0.73	0.00	9.55	100.00	
18 (0500)	4	0.46	14.83	0.03	50.10	2.19	11.45	11.06	0.00	2140.83	79.30	13.88	0.63	0.00	9.66	100.00	
19 (0900)	5	0.46	15.43	0.00	48.78	2.31	12.46	10.54	0.00	2043.62	87.36	4.79	0.36	0.00	9.80	100.00	
20 (1100)	5	0.48	15.03	0.00	50.24	2.15	10.97	10.89	0.00	3382.17	271.62	6.05	1.26	2.89	9.87	100.00	

d. (Cont.) PRODUCT GAS ANALYSIS

Test No. 9378610 (10/24-10/29/94)

10" Fluid Bed Gasifier

Date/ Sample I.D. (Time Taken)	Test- Period #	B. (Cont'd) Mole Percent (Wet Basis)											Total				
		Ar	H2	O2	N2	CH4	CO	CO2	C2H6	H2S	COS	SO2	CS2	C4H4S	H2O*	%	
October 26, 1994																	
21 (1500)	6	0.48	15.01	0.00	48.77	2.42	10.60	11.26	0.00	1911.36	79.42	6.99	0.44	1.15	11.27	100.00	
22 (1900)	6	0.49	14.73	0.00	48.93	2.52	10.46	11.37	0.00	1804.11	171.86	9.43	0.62	1.87	11.31	100.00	
23 (2300)	6	0.48	14.23	0.00	50.18	2.10	9.72	11.59	0.00	2706.00	202.90	7.72	0.80	5.41	11.40	100.00	
October 27, 1994																	
24 (0300)	7	0.49	14.48	0.02	49.39	2.35	10.56	11.12	0.00	2425.39	224.81	17.16	0.80	3.47	11.33	100.00	
25 (0700)	8	0.51	14.76	0.00	49.01	2.10	10.95	11.27	0.00	3754.99	189.63	13.67	1.07	1.51	11.01	100.00	
26 (0900)	8	0.46	15.28	0.00	48.23	2.50	11.36	11.04	0.00	2071.88	162.99	4.97	0.98	3.11	10.91	100.00	
27 (1300)	8	0.50	15.85	0.00	47.15	2.84	10.98	11.60	0.00	1696.53	159.48	5.58	0.89	4.52	10.87	100.00	
28 (1500)	8	0.47	15.13	0.00	48.73	2.61	9.61	12.09	0.00	3539.00	190.20	7.98	0.80	5.41	11.00	100.00	
29 (1900)	9	0.50	15.05	0.00	47.69	2.26	10.45	11.58	0.00	3358.07	237.77	6.88	1.15	8.64	12.12	100.00	
30 (2100)	9	0.45	14.85	0.00	48.24	2.22	10.75	11.08	0.00	2897.24	224.75	7.01	1.31	5.34	12.10	100.00	
October 28, 1994																	
31 (0100)	10	0.47	14.44	0.00	50.99	2.07	10.90	11.01	0.00	2184.36	110.50	7.95	0.90	3.61	9.89	100.00	
32 (0500)	10	0.45	14.19	0.06	51.49	1.85	10.93	10.89	0.00	2104.44	109.15	10.51	0.36	0.00	9.91	100.00	
33 (0900)	10	0.51	12.93	0.00	53.18	1.36	13.41	8.44	0.00	2274.16	148.22	4.69	1.17	0.00	9.91	100.00	
34 (1300)	11	0.45	15.55	0.00	46.92	3.01	9.69	11.70	0.01	4038.04	223.64	5.80	0.97	0.00	12.25	100.00	

\* Averaged gas flow across the collection period is used to calculate H2O content in gas.

e. Summary of Clean Up Rig Steady-State Conditions  
Test No. 93MGC10

Period #	Steady - State		Duration, hrs.	Test Mode*	Coal Type*	Gas Flow Rates	Filter Temperatures		Filter Operating Pressure	Single Filter Differential Pressure	Filter Assembly Differential Pressure	Filter Blowback Pressure
	Date (Time)						Inlet TIR-248 (deg F)	Outlet TIR-224 (deg F)				
	Start	End										
1, 2, 3, 4, 5	10/24 (16:30)	10/26 (10:10)	41.67	F, P, S, N	M7	2043	1057	1040	PIR-247 (psig)	PDIR-459 (psig)	PDIR-155 (psig)	PIR-458 (psig)
6, 7, 8A	10/26 (11:10)	10/27 (05:04)	17.90	F, S, C	M7, CL/M6	2029	932	938	264	6.98	6.79	450
8B	10/27 (05:04)	10/27 (09:37)	4.55	F, P	M7	1873	1141	1088	300	7.77	6.85	451
8C, 9, 10, 11	10/27 (09:37)	10/28 (10:35)	24.97	F, S	M7	1400	1129	1051	293	4.90	4.46	451
Average	Values		89.08			1871	1053	1024	290	6.34	5.62	450

\* Total Steady-State Run Time \*\* Steady-state Periods are based on FBG Steady-state Periods

- +Key to Test Mode Symbols
- Filtering (F)
  - Sorbent Test Period (S)
  - Nahcolite Bed (Na)
  - COS Hydrolysis Bed (C)
  - Particle Monitoring (P)
  - Alkali Monitoring (A)
  - Ammonia Monitor (N)

- Key to Coal Type Symbols
- Montana #5 (M5)
  - Montana #6 (M6)
  - Montana #7 (M7)
  - Chloride Salt with Montana #6 (CL/M6)
  - Illinois #6 (I6)