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**METC/Shell Cooperative Agreement CRADA 93-011
High Temperature High Pressure Filtration and
Sorbent 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
Shell Synthetic Fuels Incorporated
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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 Shell Synthetic Fuels, Incorporated to obtain data relevant to the design and operation of dry particulate solids filters, and Nahcolite as a chloride removal sorbent.

Shell Synthetic Fuels Incorporated provided 60mm O.D. x 40mm I.D. x 0.5m long silicon carbide, LayCer™ 70/3 candle filters for use in filtering coal gas from the METC gasifier. METC installed the filters 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 cooperative research and development agreement (CRADA) are found in CRADA #93-011. This report contains METC's contribution to CRADA #93-011.

Seven gasifier runs were conducted over an eighteen month period to accumulate 868 hours of operation. During this time, 3 filters were used 2 at a time to give individual candle usage of 254 hours, 525 hours, and 868 hours, respectively. 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% H₂, 10% CO, 49% N₂, 12% H₂O, 2.4% CH₄, 11% CO₂, 0.3% H₂S, 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 100 - 200 msec duration.

Based on char recovery from the filter vessel, the average loading of particulate in the coal gas was 0.28 lb/hr (0.23) gm/Nm³.

Online monitoring of particulate and alkali species in the coal gas fed to the candle filters was conducted per availability of the equipment.

Online particulate monitoring was conducted during runs 5 - 10. Detailed loading and particle size analysis is included in Appendix 1 of this report.

Alkali monitoring was conducted for 6 hours during run 5 and for 30 hours during run 6. A report titled "Summary of Alkali Monitoring Results for November 1993 at the Morgantown Energy Technology Center" is enclosed in Appendix 2.

2. Objective

The purpose of this effort was to collect process data relevant to the design and operation of dry particulate solids filters employing rigid ceramic filter elements in a gasifying environment at temperatures between 1,000 and 1,100 °F, a system pressure of 300 psia, filter differentials between 1 and 10 psid, filter superficial face velocities of about 2.5 feet per minute, and solids loadings from the METC 10-inch diameter fluid bed gasifier.

A second and related purpose was to collect process data relevant to the physical and chemical characteristics of nahcolite after passing filtered coal gas through a packed bed of nahcolite at a temperature of approximately 480 °F, and approximately 300 psia.

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 (20atm) 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 pressure letdown, gas slip streams are used for monitoring particulate and alkali species. These systems were used as they were available throughout the experimental testing of this CRADA (May 1993 - October 1994). Table 3 shows the time and dates when the particulate and alkali systems were 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

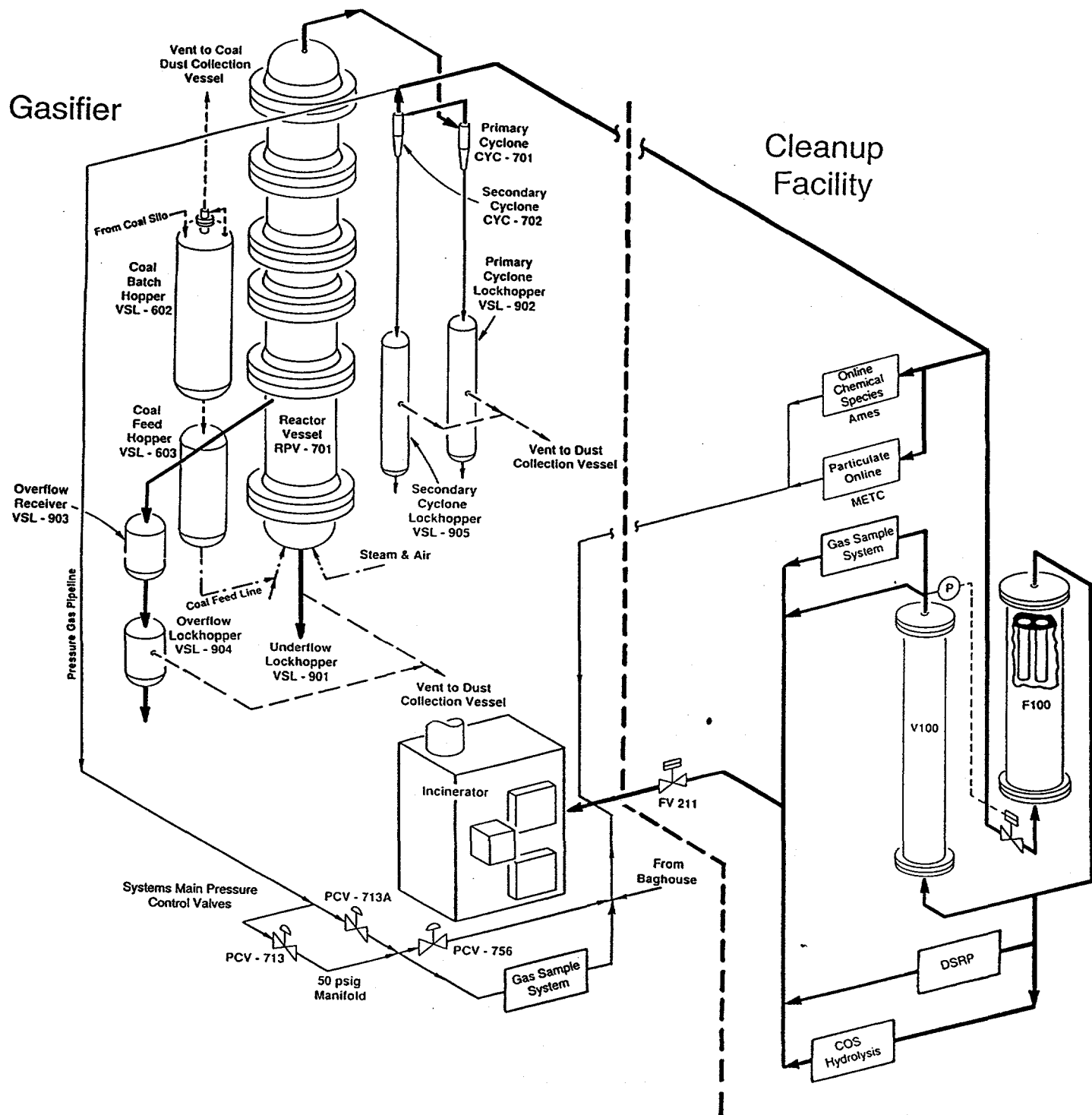


Figure 1. METC Integrated Gasification & Cleanup Facility

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, micron 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, micron 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	micron	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, micron 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	micron	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, micron 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, micron 61.18

Table 3.

ONLINE PARTICULATE AND ALKALI MONITORING PERIODS

RUN	DATE	TIME PERIOD (hh:mm:ss)	SYSTEM
5	08/04/93 08/07/93 08/11/93	10:47:00 - 20:15:00 09:19:46 - 15:27:26 00:00:00 - 06:35:37	P
6	11/02/93 11/04/93 11/05/93 11/06 - 07/93	12:52:00 - 18:07:00 09:46:41 - 20:01:28 13:59:00 - 18:51:22 11:06:33 - 01:32:26	P
6	11/02/93 11/04/93 11/05/93 11/08/93	12:00:00 - 18:00:00 10:00:00 - 20:00:00 14:00:00 - 26:00:00 13:00:00 - 21:45:00	A
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

A - Alkali

every four hours and results were normally averaged over 12 hour steady state periods.

Two parallel gas slip streams located between the candle filter vessel and the desulfurizer were used periodically throughout the test campaign. A slip stream used for testing of industrial grade sodium bicarbonate (nahcolite) as a chloride getter from the coal gas stream was maintained at 400 - 500 °F. A second slip stream for testing of the Direct Sulfur Recovery Process developed by Research Triangle Institute was maintained at 688 °F.

Table 4 gives the analyses of the feed coal used during the test campaign. Montana #5, #6, and #7 is subbituminous coal from the Rosebud seam. The numbers (5,6,7) denote shipments that have been received at different times. Montana #6 was used for 619 hours of the testing. Montana #6 was used in runs 5, 6, 7, 8, and during the nahcolite and COS hydrolysis catalyst testing conducted in runs 9 and 10. Montana #5 was used in run 4 (108 hours). Montana #7 was used for 106 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	043022	044128	043023	045335	044921	045336	044920
Solids:	Coke Breeze	Montana #5	Montana #6	Montana #6	CI-/M#6	Montana #7	Montana #7	Illinois #6
Used in Test Run:	-09	-02 to -04	-05 to -08	-09	-10	-09	-10	-09
Ultimate Analysis, %wt:	(For DCR test only)							
Moisture	0.46	4.17	6.38	3.48	5.55	7.35	6.06	3.38
Carbon	85.84	64.38	64.54	61.92	63.77	63.38	63.74	73.39
Hydrogen	1.22	4.36	4.4	4.61	4.85	4.52	4.47	3.6
Nitrogen	1.01	1.03	0.97	0.98	0.69	0.88	0.76	1.26
Sulfur	0.78	0.61	0.86	2.92	1.77	1.03	1.12	1.98
Oxygen (by diff.)	2.14	17.26	16.56	15.77	14.31	16.23	16.42	11.1
Ash*	8.55	8.20	6.29	10.32	9.07	6.62	7.43	5.29
Proximate Analysis %wt:								
Volatile Matter	3.28	41.43	41.94	40.54	40.68	40.54	39.73	26.34
Fixed Carbon (by diff.)	87.71	46.205	44.1	45.66	44.705	45.495	46.78	64.99
GCV, MJ/kg	28.59	25.38	25.38	24.95	24.85	25.25	25.41	28.53
Btu/lb	12316	10937	10935	10750	10705	10879	10948	12294
Mineral Carbon, %wt	0.06	0.19	0.14	0.14	0.09	0.11	0.14	0.04
Chloride, ppmw	NA	NA	8	<10	4500	<10	38	77
Ash Analysis, %wt of Ash								
Al ₂ O ₃	NA	NA	24.35	NA	NA	15.63	NA	17.79
CaO	NA	NA	21.3	NA	NA	17.32	NA	3.14
Fe ₂ O ₃	NA	NA	6.58	NA	NA	8.28	NA	11.74
K ₂ O	NA	NA	0.36	NA	NA	0.13	NA	1.5
MgO	NA	NA	4.74	NA	NA	4.75	NA	0.92
MnO	NA	NA	0.08	NA	NA	0.14	NA	0
P ₂ O ₅	NA	NA	1.31	NA	NA	0.41	NA	0.12
SiO ₂	NA	NA	32.28	NA	NA	27.24	NA	39.1
TiO ₂	NA	NA	1.31	NA	NA	0.59	NA	0.24
Others	NA	NA	7.69	NA	NA	25.51	NA	25.45
Density, kg/l								
Helium	1.86	1.56	1.55	1.58	1.5	1.43	1.44	1.55
Skeletal by Hg	1.87	1.45	1.5	1.47	1.543	1.49	1.4967	1.52
Bulk (packed in air)	0.443	0.65	NA	0.6411	NA	0.4973	NA	0.681
Pore Volume, l/kg								
by N ₂ Adsorption	0.0017	NA	0.0294	NA	0.01213	0.013	0.01145	0.006
by N ₂ Desorption	0.0021	NA	NA	NA	0.01318	0.0138	0.0124	0.00645
by Hg Intrusion (Cum.)	0.23	0.364	0.16	0.1639	0.2278	0.31	0.1558	0.48
BET Surface Area, m ² /kg	2000	NA	2855	NA	3167	2843	2558	1728
Ash Fusion Temp., °F:								
ID/HT	2420/2520	2220/2280	2100/2200	2080/2140	2080/2120	2180/2240	2060/2100	2140/2220
ST/FT	2440/2580	2240/2380	2160/2220	2100/2200	2100/2140	2220/2260	2080/2120	2180/2380
Coke F.S.I.	0	0	0	0	NA	0	NA	1
Particle Size (Mean), um	NA	218.4	NA	NA	NA	220.3	NA	426
Note: All %wt are on As-Received basis except specified otherwise. *corrected for SO ₃ formed in ash during analysis.								

4. Gasifier and Cleanup Facility Operation

A. Test Run 93FBG/MGC04

Test Run 93FBG04 was conducted from May 16, 1993, through May 26, 1993 (5/16/93 (14:00) to 5/26/93 (23:00)).

a. Test Objective

The overall objective of this run was to initiate multi-day shakedown of the integrated fluid bed gasifier and hot gas cleanup system. No desulfurization sorbent was used in this run. Baseline sulfur levels were determined upstream and downstream of the desulfurization vessel. Coal gas was provided to the filter vessel (F-100) equipped with two 0.5 meter length LayCer™ 70/3 clay bonded silicon carbide candle filters (C34 and C35).

b. Run Highlights

Below is a bulletized listing of the run highlights. Appendix 3 contains a detailed chronology of significant run events.

- Accumulated 108 hours of integrated FBG/MGCR operation. Demonstrated multiple day (45 hr) operation. Longest period - 45 hours; Shortest period - 3 hours.
- The line heaters maintained the process gas temperature throughout the FBG and to the MGCR filter vessel (F-100) above 1000°F as desired.
- Procedures to put the gasifier in a hot depressurized standby condition and then restart it on demand were tested and proven to work.
- Fluctuations in the coal gas flow to the filter vessel were larger than expected and typically varied from 1500 to 2000 SCFH.

c. Summary of Gasifier Operating Conditions

Test No. 93FBG04

Period #	Test Period		Duration hrs	Reactor		Coal Feed lb/h (3)	Convey Air		Reactor Air		Steam	N2 to Reactor (10) scfh	Air/H2O	
	Date (Time)	Start	End	Press. psig (1)	Temp. oF (2)		(4) scfh	(5) oF	(6) scfh	(7) oF	(8) lb/h	(9) oF	(11) oF	(12) lb/lb
1	5/18 (10:32)	5/19 (12:50)		425	1517	83.9	810.0	127	1395.8	647	74.7	647	30	2.3
2	5/21 (04:10)	5/23 (09:08)		425	1482	74.4	800.7	113	1252.4	655	68.7	655	31	2.3
3	5/23 (19:00)	5/24 (16:00)		425	1477	74.1	856.8	125	1153.0	646	70.0	646	0.0	2.2
4	5/26 (03:00)	5/26 (16:30)		425	1400	72.4	899.8	129	1123.6	633	69.8	633	35	2.2
Total:			115.40	Avg:	1479	76.3	826.4	120	1250.4	653	70.5	653	31	2.3

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=2.72

(4) : Average of FT-107, -108, -109 readings.

(5) : Average of TE-107, -108, -109 readings.

(6) : Average of FT-113, -114, -115 readings.

(7) : TE-504 reading.

(8) : Average of FT-219, -220, -221 readings.

(9) : TE-504 reading.

(10) : Average of FT-310, -311, -312, -313 readings.

(11) : Average of TE-310, -311, -312, -313 readings.

(12) : [(4)+(5)]*0.0755/(8)

(13) : (8)/(3)

d. Product Gas Analysis

Test No. 93FBG04

10" Fluid Bed Gasifier

B. Mole Percent (Wet Basis)

Date/ Sample I.D. (Time Taken)	Test Period #	H ₂ %	O ₂ %	N ₂ %	CH ₄ %	CO %	CO ₂ %	C ₂ H ₆ %	H ₂ S PPM	COS PPM	SO ₂ PPM	H ₂ O* %
May 18, 1993												
0.1 (1400)	1	15.38	0.52	45.59	2.89	10.71	12.09	0.02	1000.88	70.71	1.22	12.70
1.1 (1715)	1	16.05	0.52	43.49	2.97	12.56	11.59	0.01	923.65	100.22	1.05	12.70
1.2 (2315)	1	16.34	0.58	46.34	3.22	13.86	11.58	0.00	788.84	53.36	1.20	8.00
May 19, 1993												
2.1 (0515)	1	15.79	0.56	50.49	1.78	10.33	12.76	0.00	634.15	44.14	1.01	8.23
2.2 (1125)	1	15.14	0.52	52.92	4.52	5.53	15.12	0.08	1180.74	53.23	1.22	6.44
May 21, 1993												
3.1 (1020)	2	14.83	0.50	42.33	2.89	11.71	11.16	0.01	825.43	68.99	0.87	16.48
3.2 (1600)	2	14.59	0.52	48.08	2.90	9.36	12.47	0.02	842.78	43.22	2.90	11.97
4.1 (1600)	2	15.63	0.57	46.18	3.07	10.91	12.68	0.01	780.37	56.69	1.34	10.87
May 22, 1993												
4.2 (0400)	2	15.53	0.51	46.42	2.88	10.90	12.24	0.00	995.66	65.12	0.82	11.40
5.1 (1000)	2	15.29	0.49	48.73	2.71	10.33	11.64	0.00	905.88	59.62	1.13	12.71
5.2 (1600)	2	14.64	0.52	47.94	2.54	9.99	11.62	0.01	811.66	55.55	1.31	12.65
6.1 (2200)	2	14.99	0.51	45.98	2.72	10.46	11.52	0.00	985.38	62.72	1.12	13.73
May 23, 1993												
6.2 (0400)	2	15.61	0.50	45.71	2.76	10.99	11.74	0.00	1046.66	65.83	1.14	12.57
7.1 (0910)	2	12.71	0.53	55.11	0.81	8.10	11.88	0.00	1028.66	46.05	0.98	10.76
8.1 (1930)	3	13.92	0.56	48.63	2.49	9.20	11.70	0.01	676.42	48.95	0.96	12.43
May 24, 1993												
8.2 (0700)	3	15.05	0.52	46.97	2.65	10.04	11.90	0.01	882.83	49.29	0.44	12.76
9.1 (1000)	3	14.80	0.53	47.88	2.75	8.65	12.60	0.02	929.29	39.82	0.96	12.67
9.2 (1310)	3	16.13	0.56	52.86	3.37	8.92	13.93	0.02	976.50	36.15	1.15	4.12
May 26, 1993												
10.1 (0310)	4	11.68	0.55	52.78	2.75	7.88	12.59	0.13	20.59	51.44	0.00	11.62
10.2 (0900)	4	14.23	0.49	52.73	2.23	9.84	11.16	0.00	691.18	66.26	0.91	9.23

* Instantaneous gas flow rate at sampling was used to calculate H₂O content in gas. However, it is more accurate to use the averaged gas flow across the collection period.

e. Summary of Clean Up Rig Conditions

Test No. 93MGC04

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
Period #"	Date (Time)						Inlet TIR-248 (deg F)	Outlet TIR-224 (deg F)				
	Start	End										
1A	05/18 (11:47)	05/18 (16:55)	5.13	F	M5	1895.3	972.3	1019.6	PIR-247 (psig)	PDIR-459 (psig)	PDIR-155 (psig)	PIR-458 (psig)
1B	05/18 (18:00)	05/19 (01:02)	7.03	F	M5	1721.3	1084.3	1112.1	289.5	3.71	7.56	425.9
1C	05/19 (02:36)	05/19 (05:15)	2.65	F	M5	1716.7	1031.2	1074.4	295.7	3.18	7.79	425.3
1D	05/19 (05:25)	05/19 (12:00)	6.58	F	M5	1963.6	1061.9	1074.4	296.7	2.65	7.72	424.7
2A	05/21 (06:00)	05/21 (11:35)	5.58	F, P	M5	1793.7	987.5	1134.4	294.2	2.41	6.78	434.0
2B	05/21 (12:22)	05/23 (09:10)	44.80	F, P	M5	1648.8	1015.9	1155.7	294.9	1.96	6.69	431.7
3	05/23 (18:10)	05/24 (17:20)	23.17	F	M5	1688.7	1001.7	1116.3	293.8	0.34	5.35	429.2
4	05/26 (03:03)	05/26 (16:25)	13.37	F	M5	1866.0	1024.5	1131.7	293.5	0.27	5.26	426.1
Average	Values		108.31'			1728.8	1018.0	1127.0	293.7	1.57	6.34	429.3

** 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)
- Chloride Salt with Montana #6 (CL/M6)
- Illinois #6 (I6)

B. Test Run 93FBG/MGC05

Test run 93FBG/MGC05 was conducted from August 1, 1993 through August 13, 1993 (8/1/93 14:00 to 8/13/93 23:00).

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 and C35 candle filters and to test fluidizable zinc ferrite desulfurization sorbent.

b. Run Highlights

Below is a bulletized listing of the run highlights. Appendix 3 contains a detailed chronology of significant run events.

- The second multi-day shakedown run attained 145.5 hours of integrated steady-state operation in 5 periods and the normal shutdown procedure was followed to complete the test.
- The longest continuous, steady-state gasification period was 91 hours, compared to 53 hours in the prior run. The test run was shut down 3 times due to loss of coal feed caused by clinker formation, boiler system valve leakage and coal feeder break-down, respectively. Although the 200-hr goal for this test run was not met, the operation efficiency was improved significantly.
- The sulfur breakthrough curves (hydrogen sulfide level at the outlet of the desulfurizer versus time) for zinc ferrite (35x100 mesh) was obtained during the run.
- Approximately 22 hours of online particulate monitoring of the coal gas entering F-100 was attained.

c. Summary of Gasifier Operating Conditions

Test No. 93FBG05

10" Fluid Bed Gasifier

Period #	Test Period		Duration hrs	Reactor		Coal Feed lb/h (3)	Convey Air		Reactor Air		Steam		N2 to Reactor		Air/H2O		H2O/Coal lb/lb
	Date (Time)	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)	
1	8/02 (22:45)	8/03 (05:20)	6.58	425	1468	82.7	800.0	61	2000.0	685	74.7	685	0.0	-	-	2.9	0.90
2	8/03 (07:00)	8/03 (12:00)	5.00	425	1482	85.0	800.7	67	2000.0	670	73.2	670	0.0	-	-	2.9	0.86
3	8/04 (08:45)	8/04 (20:45)	12.00	425	1468	81.6	795.0	70	1480.0	625	58.2	625	0.0	-	-	3.0	0.71
4	8/05 (21:30)	8/09 (16:15)	90.75	425	1473	71.7	850.0	57	1201.0	586	49.9	586	149.6	64	-	3.1	0.70
5	8/10 (23:35)	8/13 (05:35)	54.00	425	1434	71.2	833.0	66	1075.0	597	48.4	597	258.4	74	-	3.0	0.68
			Total:	168.33	Avn:	1465	815.7	64	1551.2	633	60.9	633	81.6	69	-	3.0	0.77

Followings are time-averaged values:

- (1): FT-713 reading.
(2): TE-703 reading.
(3): (ST-603 reading in rpm) $\times$ CFC lb/h/rpm
where: CFC=2.12 for S.S. 1 & 2; = 2.58 for S.S. 3 & 4
(4): Average of FT-107, -108, -109 readings.
(5): Average of TE-107, -108, -109 readings.
(6): Average of FT-113, -114, -115 readings.
(7): TE-504 reading.
(8): Average of FT-219, -220, -221 readings.
(9): TE-504 reading.
(10): Average of FT-311 reading.
(11): TE-311 reading.
(12): [(4)-(6)] $\times$ 0.0765/(8)
(13): (6)/(3)

d. Product Gas Analysis

Test No. 93FBG05

10" Fluid Bed Gasifier

B. Mole Percent (wet basis)

Date/ Sample I.D. (Time Taken)	Test Period #	H2 %	O2 %	N2 %	CH4 %	CO %	CO2 %	C2H6 %	H2S PPM	COS PPM	SO2 PPM	H2O* %
August 2, 1993 0.1 (2312)	1	15.38	0.94	48.18	3.89	7.95	16.17	0.20	1621.7	156.04	9.01	7.12
August 3, 1993 1.1a (0015)	1	17.02	0.66	46.54	3.85	8.36	16.03	0.08	3283.7	231.14	8.27	7.10
1.1b (0430)	1	17.43	0.68	45.59	3.48	10.95	14.55	0.02	2090.7	165.75	3.53	7.09
1.2 (0800)	2	15.64	0.56	46.00	2.82	8.56	14.09	0.01	4891.1	285.44	8.03	11.79
August 4, 1993 2.1 (0930)	3	14.86	0.59	44.09	3.61	7.27	14.57	0.14	2904.6	142.25	10.85	14.56
2.2 (1530)	3	16.23	0.56	41.24	4.85	8.47	14.65	0.03	2455.1	123.21	2.84	13.90
August 5, 1993 4.1a (2130)	4	10.55	0.57	55.88	3.59	4.92	13.59	0.37	2466.9	117.01	6.10	10.27
August 6, 1993 4.1b (0320)	4	14.46	0.54	49.92	3.81	7.27	13.47	0.03	2990.7	96.54	3.59	10.19
4.2 (0925)	4	14.84	0.53	48.54	3.81	8.54	12.83	0.02	1960.2	105.58	5.72	10.68
5.1 (1530)	4	12.88	0.45	40.09	3.28	6.73	11.43	0.02	2655.7	113.95	2.41	24.83
5.2 (2125)	4	14.39	0.55	45.75	3.75	8.05	12.39	0.02	1592.1	240.69	7.59	14.92
August 7, 1993 6.1 (0325)	4	13.71	0.51	45.71	3.42	7.34	12.40	0.02	4288.2	95.26	17.30	16.44
6.2 (0925)	4	14.37	0.50	47.66	3.82	8.22	12.22	0.03	1923.2	127.49	8.16	12.98
7.1 (1530)	4	13.72	0.54	45.69	3.88	7.75	12.18	0.02	2937.8	144.98	9.23	16.11
7.2 (2115)	4	15.06	0.55	48.27	3.95	8.54	13.45	0.02	3674.9	180.63	5.95	9.78
August 8, 1993 8.1 (0315)	4	15.19	0.54	49.13	3.86	8.87	13.05	0.02	2671.6	136.31	4.00	9.07
8.2 (0915)	4	14.72	0.51	49.47	3.89	8.67	12.55	0.03	1867.3	105.09	3.96	9.95
9.1 (1515)	4	13.13	0.51	44.97	3.76	7.03	11.85	0.02	1966.5	92.88	11.32	18.53
9.2 (2115)	4	0.96	17.80	66.42	0.22	0.41	0.67	0.00	29.75	6.05	0.86	13.52
August 9, 1993 10.1 (0315)	4	15.00	0.54	49.97	3.84	8.71	12.78	0.02	2731.4	125.86	10.48	8.86
10.2 (0915)	4	14.49	0.51	47.32	3.99	8.28	12.67	0.03	2644.6	120.85	9.37	12.42
11.1 (1515)	4	13.77	0.49	41.43	3.87	8.12	12.10	0.02	1789.9	0.00	5.28	20.01

(Cont'd) Product Gas Analysis

Test No. 93FBG05

10" Fluid Bed Gasifier

B. Mole Percent (wet basis)

Date/ Sample I.D. (Time Taken)	Test Period #	H2 %	O2 %	N2 %	CH4 %	CO %	CO2 %	C2H6 %	H2S PPM	COS PPM	SO2 PPM	H2O* %
August 10, 1993 12.0 (2336)	5	12.64	0.55	49.93	3.47	6.25	12.99	0.17	2440.9	210.08	7.33	13.72
August 11, 1993 12.1 (0515)	5	13.30	0.54	48.55	3.47	7.73	12.35	0.02	3575.1	199.33	15.80	13.67
12.2 (1115)	5	13.41	0.56	48.66	3.59	7.50	12.23	0.04	3248.7	79.61	4.58	13.66
13.1 (1715)	5	13.67	0.51	50.58	3.75	6.89	12.49	0.03	3338.3	218.05	17.74	11.72
13.2 (2315)	5	13.56	0.49	47.57	3.75	7.18	12.48	0.03	2716.1	169.39	1.02	14.66
August 12, 1993 14.1 (0515)	5	12.69	0.44	50.78	3.38	6.08	11.90	0.03	2305.5	118.06	3.76	14.45
14.2 (1115)	5	11.58	0.51	51.48	3.03	6.67	10.81	0.03	1935.5	108.41	4.05	15.70
15.1 (1715)	5	12.92	0.53	51.34	3.34	7.16	11.79	0.04	2239.3	116.20	7.86	12.63
15.2 (2315)	5	10.86	0.47	56.97	2.82	5.46	10.22	0.05	1472.9	82.92	3.92	12.99
August 13, 1993 16.1 (0515)	5	11.34	0.47	59.74	3.11	5.45	10.95	0.05	2033.6	97.53	5.57	8.68

* Instantaneous gas flow rate was used to calculate H2O content in gas. However, it is more accurate to use the averaged gas flow across the collection period.

e. Summary of Clean Up Rig Conditions

Test No. 93MGC05

Steady - State				Test Mode*	Coal Type*	Gas Flow Rates	Filter Temperatures		Filter Operating Pressure	Single Filter Differential Pressure	Filter Assembly Differential Pressure	Filter Blowback Pressure
Period #"	Date (Time)		Duration, hrs.				Inlet TIR-248 (deg F)	Outlet TIR-224 (deg F)				
	Start	End										
1	08/02 (23:45)	08/03 (05:17)	5.50	F	M6	1928.6	1024.8	1133.6	297.32	PIR-247 (psig)	PDIR-459 (psig)	PIR-458 (psig)
2	08/03 (07:12)	08/03 (11:00)	3.77	F, P, S	M6	2085.6	1016.8	1137.5	296.6			434.00
3	08/04 (08:45)	08/04 (20:37)	11.87	F, P, S	M6	2019.0	1069.9	1129.2	296.92		5.17	420.82
4A	08/05 (21:30)	08/06 (09:25)	11.92	F, P, S	M6	1660.5	1047.2	1134.0	294.32		5.19	436.43
4B	08/06 (16:25)	08/06 (18:00)	1.42	F, S	M6	1741.2	974.43	1103.4	294.11		5.98	436.00
4C	08/07 (07:15)	08/09 (16:15)	57.00	F, P, S	M6	1694.2	1056.1	1102.4	287.40		4.59	434.26
5	08/10 (23:30)	08/13 (5:35)	54.08	F, P, S	M6	1622.3	1089.1	1147.8	299.26		5.86	431.88
Average	Values	145.56*				1710.7	1065.8	1126.1	293.83		5.18	432.47

* 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)

C. Test Run 93FBG/MGC06

Test run 93FBG/MGC06 was conducted from November 1, 1993 through November 9, 1993 (11/1/93 00:00 to 11/9/93 18:00).

a. Test Objective

The objective of this run was to attain 190 hours of steady state operation of the integrated gasifier and hot gas cleanup facility to accumulate additional hours on the C34 candle, initiate operation with candle C36 and to test fluidizable zinc titanate desulfurization sorbent. Candle C35 was removed from service for analysis after 254 hours of operation.

b. Run Highlights

Below is a bulletized listing of the run highlights. Appendix 3 contains a detailed chronology of significant run events.

- 130 hours of integrated steady-state operation was attained during 6 steady state periods.
- The longest continuous, steady-state gasification period was 60 hours.
- The sulfur breakthrough curves (hydrogen sulfide level at the outlet of the desulfurizer versus time) for two fluidizable zinc titanate materials (Zt-2 and Zt-5) manufactured by Research Triangle Institute (RTI) were obtained.
- Approximately 35 hours of online particulate and 30 hours of online alkali monitoring of the coal gas entering F-100 was attained.

c. Summary of Gasifier Operating Conditions

Test No. 93FBG06

10" Fluid Bed Gasifier

Test Period		Duration hrs	Reactor		Coal Feed lb/h (3)	Convey Air		Reactor Air		Steam		N2 to Reactor		Air/H2O		H2O/Coal (13) lb/lb
Period #	Date (Time) Start		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		
1*	11/01 (14:00)	11/02 (18:42)	28.70	425	1514.31	78.3	812.7	35	1079.5	639	78.1	639	289.2	35	1.9	1.00
2	11/04 (01:00)	11/04 (21:11)	20.18	425	1441.65	80.4	823.4	46	814.1	624	67.6	624	228.1	44	1.9	0.84
3	11/05 (01:00)	11/07 (13:00)	60.00	425	1429.96	77.4	816.8	46	742.3	651	73.5	651	240.6	44	1.6	0.95
4	11/07 (20:00)	11/07 (23:20)	3.34	425	1386.94	79.4	806.8	41	887.1	609	62.6	609	235.7	30	2.0	0.79
5	11/08 (06:00)	11/08 (07:30)	1.50	425	1388.65	80.5	825.4	31	807.8	583	82.9	583	314.0	26	1.5	1.03
6	11/08 (11:00)	11/09 (09:00)	22.00	425	1392.45	79.3	792.2	39	773.4	664	81.4	664	732.6	33	1.5	1.03
Total:			135.72	Avg:	1441.9396	78.4	812.8	42	833.1	645	74.7	645	329.2	40	1.7	0.95

Followings are time-averaged values:

- (1) : PT-713 reading.
- (2) : TE-703 reading.
- (3) : (ST-603 reading in rpm) x CFC lb/hrpm where: CFC=2.12
- (4) : Average of FT-107, -108, -109 readings.
- (5) : Average of TE-107, -108, -109 readings.
- (6) : Average of FT-113, -114, -115 readings.
- (7) : TE-504 reading.
- (8) : Average of FT-219, -220, -221 readings.
- (9) : TE-504 reading.
- (10) : Average of FT-311, -312 readings.
- (11) : TE-311 reading.
- (12) : [(4)+(6)]*0.0765/(8)
- (13) : (8)/(3)

* A newly designed feed nozzle was tested in S.S. #1. Other S.S periods used the originally designed nozzle.

d. Product Gas Analysis

Test No. 92FBC06

10" Fluid Bed Gasifier

B. Mole Percent (Wet Basis)

Date/ Sample ID (Time Taken)	Test Period #	Ar %	H2 %	O2 %	N2 %	CH4 %	CO %	CO2 %	C2H6 %	H2S PPM	COS PPM	SO2 PPM	CS2 PPM	C4H8S PPM	H2O* %
November 1, 1993 2 (1400)	1	0.37	14.81	0.17	46.34	2.72	9.31	10.80	12.56	0.01	271.98	6.62	0.78	0.00	12.85
November 1, 1993 3 (1800)	1	0.38	14.95	0.19	46.46	2.62	9.31	10.80	12.56	0.01	271.98	6.62	0.78	0.00	12.85
November 2, 1993 5 (0200)	1	0.39	14.87	0.21	45.08	3.21	9.10	12.47	0.01	2397.40	144.07	11.56	8.30	0.00	14.40
November 2, 1993 6 (0800)	1	0.41	14.77	0.18	43.38	3.00	9.63	11.51	0.01	2083.70	114.07	4.82	8.81	0.00	16.87
November 2, 1993 7 (1000)	1	0.38	15.10	0.16	45.70	2.38	9.63	11.51	0.01	3772.47	210.39	8.87	2.13	0.00	14.72
November 2, 1993 8 (1400)	1	0.41	15.71	0.20	46.45	2.81	10.43	12.13	0.01	3070.11	147.77	14.07	0.88	0.00	11.52
November 2, 1993 9 (1500)	1	0.43	15.42	0.22	46.48	2.94	10.57	12.15	0.01	2316.42	147.96	14.86	0.88	0.00	11.52
November 4, 1993 9 (1800)	1	0.41	14.85	0.18	47.26	2.89	10.06	12.34	0.01	2673.53	182.97	11.22	1.41	0.00	11.62
November 4, 1993 10 (0300)	2	0.27	13.03	0.17	45.44	3.83	5.23	14.31	0.01	4016.07	183.47	23.29	0.25	7.48	16.83
November 4, 1993 11 (0800)	2	0.27	14.32	0.30	44.16	3.88	7.19	13.08	0.02	3048.82	111.75	6.10	1.87	0.00	16.48
November 4, 1993 12 (0810)	2	0.25	15.25	0.12	45.59	4.42	7.09	13.07	0.03	2712.70	148.68	0.00	1.08	0.00	11.58
November 4, 1993 13 (0900)	2	0.25	14.06	0.12	49.82	4.04	7.09	12.55	0.02	2643.06	143.52	4.80	0.35	0.00	11.82
November 4, 1993 14 (1022)	2	0.25	13.92	0.12	51.59	3.83	6.50	12.62	0.04	1455.90	104.86	7.87	0.54	0.00	10.61
November 4, 1993 15 (1102)	2	0.30	15.36	0.18	46.84	4.48	7.89	13.80	0.04	3136.12	160.84	9.32	0.36	1.88	10.40
November 4, 1993 16 (1202)	2	0.29	15.63	0.29	46.03	4.79	8.44	13.79	0.03	2521.23	133.94	5.74	0.63	0.00	10.35
November 4, 1993 17 (1200)	2	0.31	16.13	0.22	45.57	4.76	8.23	14.08	0.04	2814.1	181.81	4.04	2.51	0.00	10.30
November 4, 1993 18 (1410)	2	0.38	15.29	0.22	44.43	4.40	7.43	13.77	0.03	4556.56	195.15	5.68	1.99	0.00	13.57
November 4, 1993 19 (1500)	2	0.40	15.53	0.22	44.40	4.57	8.01	13.23	0.03	2517.97	120.55	5.63	0.95	0.43	13.46
November 4, 1993 20 (1700)	2	0.41	15.23	0.14	44.89	4.51	7.12	13.68	0.03	3952.81	212.11	8.56	1.04	1.12	13.57
November 4, 1993 21 (2100)	2	0.31	14.75	0.22	45.51	4.60	6.93	13.79	0.03	1794.83	113.15	11.40	0.78	0.00	13.62
November 5, 1993 22 (0115)	3	0.01	1.88	7.28	70.58	0.66	0.97	2.65	0.01	0.00	24.54	12.94	0.59	0.00	15.96
November 5, 1993 23 (0200)	3	0.25	13.91	0.13	45.37	4.46	6.75	13.85	0.03	2017.04	168.17	6.56	0.60	0.00	14.82
November 5, 1993 24 (0300)	3	0.24	14.25	0.17	44.77	4.25	7.23	13.86	0.03	2858.13	133.79	1.53	1.38	0.00	14.78
November 5, 1993 25 (0400)	3	0.24	14.03	0.07	45.87	4.12	6.48	13.39	0.03	2447.33	123.47	9.80	0.00	0.00	14.79
November 5, 1993 26 (0500)	3	0.01	14.97	0.49	43.76	4.33	7.08	13.47	0.03	2812.00	92.91	1.88	0.43	0.00	14.78
November 5, 1993 27 (0600)	3	0.00	14.05	0.46	42.04	4.19	6.87	13.60	0.02	2597.50	135.86	7.84	1.14	0.00	18.69
November 5, 1993 28 (0700)	3	0.00	14.26	0.47	41.77	4.19	6.50	13.77	0.02	3296.19	149.08	4.88	0.57	0.00	18.69

(Cont'd) Product Gas Analysis

Test No. 92FBC06

10" Fluid Bed Gasifier

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

Date/ Sample ID (Time Taken)	Test Period #	Ar %	H2 %	O2 %	N2 %	CH4 %	CO %	CO2 %	C2H6 %	H2S PPM	COS PPM	SO2 PPM	CS2 PPM	C4H8S PPM	H2O* %
November 5, 1993 29 (0800)	3	0.38	14.23	0.12	41.89	4.15	6.48	13.67	0.02	3372.83	151.83	8.70	0.57	0.00	18.70
November 5, 1993 30 (0900)	3	0.32	13.80	0.15	42.20	4.41	6.18	13.86	0.03	2623.87	135.01	6.25	1.08	0.00	18.77
November 5, 1993 31 (1300)	3	0.33	13.19	0.18	45.52	4.79	6.37	15.24	0.04	2993.18	113.30	11.35	0.97	1.58	12.03
November 5, 1993 32 (1700)	3	0.30	14.45	0.20	43.58	4.51	6.11	13.47	0.04	3013.10	135.55	8.71	0.50	1.58	17.04
November 5, 1993 33 (2100)	3	0.30	14.05	0.13	44.01	4.82	5.88	13.82	0.04	2639.19	156.54	9.90	0.33	0.50	16.78
November 6, 1993 34 (0100)	3	0.00	13.87	0.48	42.51	4.35	5.75	13.30	0.04	2710.54	209.20	11.12	0.48	2.01	19.42
November 6, 1993 35 (0500)	3	0.00	14.55	0.51	44.85	4.82	6.11	14.07	0.04	4145.28	237.45	9.80	0.43	1.19	14.80
November 6, 1993 36 (0900)	3	0.00	13.59	0.50	44.01	4.55	5.94	13.31	0.04	2820.17	191.08	7.73	0.68	0.68	17.78
November 6, 1993 37 (1300)	3	0.00	14.51	0.51	43.58	4.57	6.03	13.91	0.04	2976.87	215.67	8.10	0.42	1.34	16.54
November 6, 1993 38 (1700)	3	0.42	13.86	0.21	44.72	4.23	6.88	13.35	0.04	3329.91	280.85	8.70	0.25	0.00	16.31
November 6, 1993 39 (2100)	3	1.06	11.10	1.06	46.27	4.05	6.72	12.51	0.03	2337.24	113.62	28.88	0.25	0.00	15.59
November 7, 1993 40 (0100)	3	0.44	12.96	0.30	44.93	4.10	6.08	13.02	0.04	2471.60	109.38	19.54	0.00	0.00	17.88
November 7, 1993 41 (0500)	3	0.40	12.96	0.20	43.48	4.21	6.53	12.91	0.03	2895.80	164.85	26.72	0.00	0.00	18.03
November 7, 1993 42 (0900)	3	0.36	13.11	0.18	42.02	4.07	5.80	12.89	0.04	2844.30	120.13	14.49	0.32	0.00	18.03
November 7, 1993 43 (2100)	4	0.31	12.15	0.13	43.20	4.04	5.68	12.57	0.04	1730.42	129.14	8.23	3.63	0.53	21.64
November 8, 1993 44 (0500)	5	0.00	12.95	0.52	48.19	4.54	5.46	13.91	0.05	4240.18	175.13	9.04	0.28	0.77	13.94
November 8, 1993 45 (1300)	6	0.00	12.18	0.48	46.70	4.14	4.17	13.48	0.08	4098.63	140.89	12.82	0.00	2.93	13.93
November 8, 1993 46 (1900)	6	0.00	12.73	0.47	45.91	3.96	4.54	12.95	0.07	2883.80	137.52	8.76	0.57	0.57	18.14
November 8, 1993 47 (2300)	6	0.00	12.65	0.43	47.30	3.70	4.70	12.68	0.07	3130.32	157.65	10.80	0.33	0.98	18.15
November 9, 1993 48 (0300)	6	0.30	12.20	0.17	45.41	3.73	4.36	12.66	0.07	2224.99	107.15	15.91	0.00	1.58	20.86
November 9, 1993 49 (0700)	6	0.28	8.83	0.11	58.96	2.80	2.47	9.95	0.07	1284.57	46.32	5.38	0.33	1.14	18.60
November 9, 1993 50 (0900)	6	0.01	10.37	0.38	46.40	3.18	3.86	10.69	0.05	1673.73	67.83	14.87	0.00	0.45	24.89

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

e. Summary of Clean Up Rig Conditions

Test No. 93MGC06

Steady - State			Test Mode*	Coal Type	Gas Flow Rates	Filter Temperatures		Filter Operating Pressure	Single Filter Differential Pressure	Filter Assembly Differential Pressure	Filter Blowback Pressure	
Period #"	Date (Time)											
	Start	End	Duration, hrs.				Inlet TIR-248 (deg F)	Outlet TIR-224 (deg F)				
1	11/01 (18:00)	11/02 (18:25)	24.42	F, P, A, S	M6	1748.7	1066.4	1114.7	299.9	488.1	8.04	488.06
2	11/04 (02:25)	11/04 (21:00)	18.58	F, P, A, S	M6	1845.7	1003.2	1069.2	298.2	479.1	7.28	479.11
3	11/05 (01:20)	11/07 (13:15)	60.92	F, P, A, S	M6	1801.6	1117.8	1115.8	298.7	486.6	7.41	486.62
4	11/07 (20:07)	11/07 (23:02)	2.92	F, P, S	M6	1546.4	1090.3	1122.6	293.5	493.8	6.61	493.77
5	11/08 (06:00)	11/08 (07:40)	1.67	F, P, S	M6	1760.4	1011.1	1040.6	289.9	494.7	6.23	494.67
6	11/08 (11:30)	11/09 (09:10)	21.67	F, P, A, S	M6	1957.5	1116.6	1104.0	297.8	494.2	7.67	494.21
Average	Values	130.18*				1817.7	1089.6	1106.2	298.5	487.3	7.52	487.34

* 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)
- Cloride Salt with Montana #6 (CL/M6)
- Illinois #6 (I6)

D. 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 3 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

10" Fluid Bed Gasifier

Test No. 94FBG07

(06/06 - 06/15/94)

Test																
Period #	Date (Time)		Duration hrs	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		Press. psig (1)	Temp. oF (2)		(4) scfh	(5) oF	(6) scfh	(7) oF	(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. 94F8607 (1816-9115194)

10" Fluid Bed Gasifier

B. Mole Percent (Wet Basis)																
Date Sample I.D. (Time Taken)	Test Period #	Ar %	H2 %	O2 %	N2 %	CH4 %	CO %	CO2 %	C2H6 %	H2S PPM	COS PPM	S02 PPM	CS2 PPM	CH4S PPM	H2O* %	Total %
June 8, 1994																
1 (1850)	1	0.47	14.54	0.84	48.82	4.01	7.48	13.99	0.14	1833.50	258.88	3.82	1.81	27.88	9.73	100.00
2 (2030)	1	0.42	0.51	0.36	84.48	0.38	0.32	3.87	0.04	744.22	133.34	1.07	0.00	5.84	9.73	100.00
3 (2130)	1	0.43	12.69	0.35	50.14	5.81	5.77	14.42	0.08	5695.88	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	8.11	12.08	0.02	2848.83	188.43	6.20	0.84	2.10	9.73	100.00
June 7, 1994																
5 (0230)	1	0.45	13.82	0.16	51.89	2.77	8.61	12.26	0.00	4753.38	228.78	4.75	0.55	0.00	9.73	100.00
June 8, 1994																
6 (1830)	2	0.17	8.80	0.20	72.48	2.18	2.57	6.64	0.07	1501.81	71.55	5.78	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	2582.67	180.47	5.21	0.28	8.70	8.72	100.00
8 (2230)	2	0.46	16.89	0.11	44.38	4.52	8.71	15.89	0.03	4981.65	224.03	2.40	0.37	8.40	8.72	100.00
June 9, 1994																
9 (0230)	2	0.46	15.88	0.15	48.16	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	4.78	8.68	14.82	0.03	5034.04	103.01	6.84	0.00	10.50	8.72	100.00
11 (1030)	2	0.41	15.78	0.21	48.02	4.82	7.25	14.73	0.02	2554.44	70.53	9.48	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	3598.53	86.42	5.78	5.81	8.25	9.13	100.00
13 (1830)	2	0.39	15.55	0.08	48.66	4.38	7.55	13.85	0.02	2742.57	118.25	3.54	4.38	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	8.41	0.45	5.78	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	3323.85	158.93	6.67	0.72	7.88	9.13	100.00
16 (0630)	2	0.41	15.83	0.07	48.18	4.18	7.40	14.84	0.03	3342.75	155.48	5.55	2.08	4.20	9.13	100.00
17 (1030)	2	0.40	16.59	0.07	48.18	4.36	7.83	14.29	0.03	3157.72	189.56	11.80	0.83	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	8.28	0.72	8.75	9.13	100.00
19 (1830)	2	0.42	15.38	0.14	48.39	4.48	7.38	14.31	0.05	3773.21	215.78	4.42	0.83	7.47	9.13	100.00
20 (2230)	2	0.39	15.28	0.08	48.08	3.88	6.88	14.39	0.06	7335.94	124.85	5.81	0.84	5.43	9.13	100.00
June 11, 1994																
21 (0230)	2	0.40	15.29	0.18	48.75	4.29	7.38	14.16	0.06	3783.27	165.81	6.33	0.55	10.84	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	0.84	6.05	9.13	100.00
23 (1030)	2	0.43	15.88	0.11	48.23	4.04	7.53	14.11	0.05	4898.07	211.83	18.38	0.00	8.05	9.13	100.00
24 (1430)	2	0.44	14.80	0.06	50.55	3.70	8.89	13.82	0.04	4525.31	111.25	5.57	0.85	8.26	9.13	100.00
25 (1830)	2	0.42	15.80	0.04	48.88	3.85	7.68	14.02	0.03	3481.28	194.88	6.15	1.22	7.78	9.13	100.00
26 (2230)	2	0.00	8.59	10.04	83.89	1.86	3.10	5.87	0.02	880.88	78.21	28.32	0.18	1.38	9.13	100.00

d. (Cont'd) Product Gas Analysis

Test No. 9459007 (08-01/1984)

10" Fluid Bed Gasifier

Data/ Sample I.D. (Time Taken)	Test Period f	B. (Cont'd) Mole Percent (Wat Basis)														Total %
		Ar	H ₂	O ₂	N ₂	CH ₄	CO	CO ₂	C ₂ H ₆	H ₂ S	COS	SO ₂	CS ₂	CAH ₄ S	H ₂ O*	
		%	%	%	%	%	%	%	%	PPM	PPM	PPM	PPM	PPM	%	%
June 12, 1984																
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	13.78	68.64	0.78	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	2.78	0.00	0.00	27.78	3.82	0.00	0.28	9.13	100.00
June 13, 1984																
30 (1800)	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	8.40	100.00
31 (2000)	3	0.50	2.93	14.22	67.30	0.78	1.47	3.33	0.06	144.81	43.58	12.78	0.00	1.38	8.40	100.00
32 (2100)	3	0.45	14.74	0.17	49.81	3.78	8.99	14.45	0.07	3021.71	136.60	12.54	0.48	4.89	8.40	100.00
33 (2300)	3	0.45	14.73	0.08	50.24	3.80	8.25	14.81	0.05	4028.28	187.70	8.03	0.48	4.47	8.40	100.00
34 (2400)	3	0.44	14.54	0.05	50.08	4.11	6.78	14.28	0.04	2805.17	130.43	6.22	0.00	1.10	9.40	100.00
June 14, 1984																
35 (0100)	3	0.43	13.68	0.12	49.39	4.24	6.73	14.21	0.04	124.78	81.59	1.35	0.00	0.81	10.84	100.00
36 (0200)	3	0.43	13.42	0.45	50.15	3.95	6.38	14.08	0.04	2777.88	80.83	15.93	0.00	3.87	10.84	100.00
37 (0300)	3	0.40	14.29	0.09	49.24	3.97	8.81	14.08	0.03	2381.31	143.01	8.22	0.53	1.68	10.84	100.00
38 (0400)	3	0.40	14.57	0.07	48.46	4.13	8.94	14.32	0.04	2308.85	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	1888.55	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	6.58	14.12	0.03	2728.80	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	8.89	13.99	0.04	1822.86	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	1888.75	85.80	4.32	0.00	0.87	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	2397.48	103.08	8.28	0.00	0.97	10.84	100.00
46 (1700)	3	0.42	14.06	0.18	48.88	3.50	6.95	13.61	0.02	4011.27	128.86	7.46	0.00	8.28	12.00	100.00
47 (1800)	3	0.39	13.82	0.25	48.98	3.45	7.07	13.92	0.02	3929.85	95.81	12.11	0.00	9.78	12.00	100.00
48 (1800)	3	0.37	14.18	0.08	48.36	3.49	7.37	13.45	0.02	3375.75	187.92	8.73	0.00	4.45	12.30	100.00
48 (2000)	3	0.39	14.67	0.07	47.23	3.73	8.16	13.10	0.02	3148.83	127.51	10.37	0.00	5.59	12.30	100.00
50 (2100)	3	0.40	14.87	0.08	47.84	3.60	8.00	13.08	0.02	2178.85	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	48.08	3.68	7.92	13.11	0.03	2055.37	112.33	8.57	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	2084.88	88.40	7.35	0.00	1.24	12.30	100.00
June 15, 1984																
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	3.58	7.89	13.13	0.02	2118.40	93.57	7.39	0.00	5.13	11.75	100.00

d. (Cont'd) Product Gas Analysis

Test No. 84F8607 (8/8-9/15/84)

10" Fluid Bed Gasifier

Date/ Sample I.D. (Time Taken)	Test Period #	B. (Cont'd) Mole Percent (Wet Basis)														Total %
		Ar %	H ₂ %	O ₂ %	N ₂ %	CH ₄ %	CO %	CO ₂ %	C ₂ H ₆ %	H ₂ S PPM	COS PPM	SO ₂ PPM	CS ₂ PPM	CAHAS PPM	H ₂ O* %	
June 15, 1984																
56 (0300)	3	0.42	14.71	0.06	47.73	3.78	8.08	13.25	0.02	1971.14	93.67	8.65	0.00	5.80	11.75	100.00
57 (0400)	3	0.44	14.31	0.11	48.88	3.50	7.84	13.01	0.02	2876.20	121.36	11.42	0.00	7.41	11.75	100.00
58 (0500)	3	0.43	14.39	0.18	48.88	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	3.68	7.84	12.92	0.03	2218.93	112.20	4.15	0.00	1.89	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	84.08	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	123.08	10.15	0.00	8.20	11.75	100.00
62 (0900)	3	0.43	14.79	0.08	47.88	3.83	8.24	12.88	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	8.82	12.88	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	12.84	0.03	2872.41	128.89	10.29	0.17	5.36	11.75	100.00
65 (1200)	3	0.42	14.87	0.08	47.77	3.83	8.70	12.82	0.02	1378.47	88.97	7.82	0.00	0.00	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 Conditions

Test No. 93MGC07

Steady - State				Test Mode*	Coal Type*	Gas Flow Rates	Filter Temperatures		Filter Operating Pressure	Single Filter Differential Pressure	Filter Assembly Differential Pressure	Filter Blowback Pressure
Period #"	Date (Time)		Inlet TIR-248 (deg F)				Outlet TIR-224 (deg F)					
	Start	End										
2A	06/08 21:15	06/09 22:20	25.08	F	M6	1837.2	1105.3	1055.9	PIR-247 (psig)	PDIR-459 (psig)	PDIR-155 (psig)	PIR-458 (psig)
2B	06/10 00:40	06/11 03:50	27.17	F	M6	1723.1	1102.7	1042.1	289.2	2.094	3.775	475.5
2C	06/11 04:48	06/12 11:30	30.42	F	M6	1601.6	1080.2	1029.0	291.93	2.024	3.60	444.57
3A	06/13 19:22	06/13 19:51	0.48	F, P, S	M6	1809.8	796.17	926.59	274.92	1.74	2.64	494.26
3B	06/13 22:05	06/14 13:05	16.0	F, P, S	M6	1799.1	1075.7	1075.4	291.80	2.201	3.35	492.6
3C	06/14 17:05	06/15 12:47	19.7	F	M6	1717.8	1082.9	1048.9	290.28	1.974	2.778	491.16
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)
- Chloride Salt with Montana #6 (CL/M6)
- Illinois #6 (I6)

E. 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 3 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

10" Fluid Bed Gasifier

Test No. 94F8608 (07/18 - 07/27/94)

Period #	Steady-State		Reactor		Coal Feed lb/h (3)	Convey Air		Reactor Air		Steam		Underflow N ₂		Air/H ₂ O (12) lb / lb	H ₂ O/Coal (13)	
	Date (Time)		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
	Start	End														
1	07/18 (18:30)	07/20 (12:45)	44.25	425	1484.5	70.0	1804.1	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	1802.4	67	532.2	740	54.8	740	398.3	495	3.0	0.78
Total:			200.08	Avg:	1442.8	69.8	1810.4	67	529.8	738	54.8	738	400.5	485	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)+(8)]*0.0765/(6)
- (13): (8)/(3)

d. Product Gas Analysis
Test No. 94F8008 (7/16-7/27/84)

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 PPM	H2S PPM	COS PPM	CS2 PPM	CAH4S PPM	H2O* %		
July 18, 1984																
1 (1830)	1	0.44	12.34	0.45	48.57	2.91	5.49	12.87	0.10	2205.83	212.23	5.03	0.00	4.31	18.80	100.00
2 (1720)	1	0.38	11.88	0.39	48.50	2.77	5.85	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	5.81	11.08	0.02	75.04	8.70	0.87	0.00	0.58	18.50	100.00
4 (1930)	1	0.45	14.08	0.44	47.92	3.19	8.81	13.24	0.05	2840.03	257.07	9.30	0.00	2.54	13.70	100.00
5 (2155)	1	0.44	14.48	0.45	48.50	4.03	7.04	13.14	0.06	1819.70	124.41	4.40	0.00	1.01	13.70	100.00
6 (2230)	1	0.44	13.78	0.50	47.89	3.82	8.54	13.20	0.04	2534.58	171.31	18.72	0.28	1.57	13.70	100.00
7 (2330)	1	0.48	13.89	0.48	47.57	3.99	8.58	13.08	0.03	2028.80	158.94	15.31	0.00	0.81	13.70	100.00
July 18, 1984																
8 (0030)	1	0.43	13.26	0.50	48.84	3.85	5.85	13.20	0.04	3082.12	182.69	16.15	0.00	1.48	13.80	100.00
9 (0130)	1	0.44	13.81	0.52	49.48	3.98	6.17	13.60	0.05	2846.53	177.57	18.54	0.88	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	2258.25	185.04	12.81	0.00	1.02	15.32	100.00
11 (0330)	1	0.43	13.40	0.50	49.41	3.83	5.87	13.13	0.04	2758.87	188.95	18.81	0.17	1.39	13.10	100.00
12 (0430)	1	0.44	13.58	0.48	48.43	3.98	6.25	13.22	0.04	2100.88	125.60	9.53	0.00	0.95	13.40	100.00
13 (0430)	1	0.45	14.51	0.52	50.01	4.08	8.51	14.28	0.04	3358.11	158.81	5.88	0.38	1.83	9.27	100.00
14 (1230)	1	0.43	13.77	0.49	48.54	3.90	8.29	13.24	0.03	3459.98	178.83	22.44	0.00	1.48	12.93	100.00
15 (1830)	1	0.44	14.11	0.51	48.08	4.19	8.58	13.57	0.04	2453.02	129.83	5.52	0.38	0.80	12.24	100.00
16 (2030)	1	0.44	13.72	0.50	48.77	3.72	8.68	13.04	0.03	2487.50	170.80	7.15	0.17	1.03	14.84	100.00
July 20, 1984																
17 (0030)	1	0.44	13.75	0.50	47.29	3.93	6.76	13.02	0.05	2865.18	141.00	7.75	0.00	0.87	13.87	100.00
18 (0430)	1	0.44	13.52	0.68	48.14	4.05	7.07	12.89	0.05	1280.38	100.33	15.54	0.00	0.70	12.93	100.00
19 (0830)	1	0.44	13.86	0.48	47.25	4.12	8.83	13.72	0.04	1172.75	80.18	4.18	0.00	0.81	12.93	100.00
20 (1030)	1	0.44	13.93	0.50	47.83	4.02	8.79	13.56	0.03	1580.81	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	8.00	12.12	0.05	1595.10	83.61	2.63	0.00	0.70	19.87	100.00
22 (1230)	1	0.43	12.99	0.47	44.77	3.63	8.44	13.28	0.05	2458.28	114.96	4.28	0.08	1.15	17.02	100.00
23 (1330)	2	0.41	12.44	0.47	48.57	3.65	5.81	13.38	0.03	2302.94	134.84	20.24	0.00	0.88	17.02	100.00
24 (1430)	2	0.43	12.55	0.48	47.25	3.59	5.80	12.88	0.02	2187.44	123.36	5.70	0.08	1.98	17.02	100.00
25 (1530)	2	0.43	12.84	0.50	49.83	3.71	5.80	13.35	0.02	2882.52	143.30	14.02	0.00	1.19	13.63	100.00
26 (1630)	2	0.44	12.80	0.52	50.81	3.44	5.85	14.27	0.00	3833.83	183.88	8.00	1.12	2.24	12.08	100.00
27 (1730)	2	0.45	13.04	0.50	49.01	3.68	8.10	13.83	0.00	2904.54	188.84	5.12	0.43	1.71	12.87	100.00
28 (1830)	2	0.44	13.33	0.51	47.39	3.78	8.51	13.02	0.00	1845.85	108.84	8.44	0.08	0.85	14.80	100.00
29 (1930)	2	0.42	13.60	0.73	51.08	3.83	8.48	13.23	0.00	1108.53	118.08	8.05	0.09	1.38	10.45	100.00
30 (2030)	2	0.43	13.68	0.52	52.59	3.85	8.41	13.83	0.00	1808.78	131.83	3.87	0.00	1.47	8.50	100.00
31 (2130)	2	0.44	13.38	0.50	49.28	3.84	8.41	13.17	0.00	2052.28	120.21	15.73	0.18	0.88	12.78	100.00
32 (2230)	2	0.44	13.48	0.51	49.18	3.78	8.40	13.19	0.03	2251.48	120.87	15.81	0.00	0.70	12.77	100.00

d. (Cont'd) Product Gas Analysis

Test No. 84FB08 (7/18-7/27/84)

10" Fluid Bed Gasifier

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

Date/ Sample I.D. (Time Taken)	Test Period f	Ar %	H ₂ %	O ₂ %	N ₂ %	CH ₄ %	CO %	CO ₂ %	C ₂ H ₆ %	H ₂ S PPM	COS PPM	SO ₂ PPM	CS ₂ PPM	C ₄ H ₁₀ PPM	H ₂ O* %	Total %
July 21, 1984																
33 (0030)	2	0.42	12.93	0.51	45.65	3.74	6.41	12.45	0.02	1250.20	83.76	10.15	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	18.87	100.00
35 (0230)	2	0.41	12.86	0.50	46.77	3.61	6.22	12.65	0.02	1520.09	86.73	12.75	0.00	1.08	18.78	100.00
36 (0330)	2	0.45	12.41	0.50	47.10	3.29	5.84	12.99	0.01	3711.78	197.03	10.65	0.08	2.15	16.93	100.00
37 (0430)	2	0.42	13.07	0.47	48.89	3.69	6.62	12.14	0.00	1980.34	127.37	15.22	0.00	0.91	18.88	100.00
38 (0530)	3	0.44	12.56	0.50	47.45	3.03	5.89	12.71	0.00	4992.97	253.28	32.81	0.00	1.16	18.80	100.00
39 (0630)	3	0.42	13.71	0.48	46.73	3.89	7.15	13.17	0.04	2791.05	140.31	11.48	0.00	0.86	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	13.81	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 (11830)	3	0.46	14.19	0.53	48.85	3.57	6.84	13.65	0.03	4688.12	185.12	8.65	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	0.88	0.59	16.57	100.00
July 22, 1984																
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	1862.88	83.98	10.80	0.00	1.00	23.10	100.00
46 (0830)	3	0.41	13.68	0.46	45.20	3.86	7.11	13.10	0.05	1874.30	109.50	17.95	0.17	0.78	15.82	100.00
47 (1230)	3	0.43	13.53	0.48	45.11	3.58	6.98	12.65	0.03	2095.50	111.53	7.88	0.00	1.43	17.02	100.00
48 (1830)	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	3.84	6.84	12.80	0.03	2395.55	140.01	9.85	0.42	1.34	16.78	100.00
July 23, 1984																
50 (0030)	3	0.38	13.53	0.49	44.50	3.53	6.32	12.38	0.03	2234.42	119.58	23.38	0.16	0.97	18.81	100.00
51 (0430)	3	0.40	12.49	0.48	43.64	3.63	6.41	12.18	0.03	1871.33	88.42	21.49	0.32	1.84	20.52	100.00
52 (0830)	3	0.42	13.11	0.48	45.58	3.81	6.75	12.89	0.03	1849.23	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	6.53	12.77	0.03	2778.00	113.51	11.27	0.25	0.81	17.83	100.00
54 (1830)	3	0.42	13.59	0.48	45.57	3.80	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	13.06	0.50	47.02	3.43	6.52	13.01	0.03	3719.08	180.93	21.11	0.89	1.80	15.57	100.00
July 24, 1984																
56 (0030)	3	Bottle broken at sample station														
57 (0430)	3	Bottle broken at sample station														
58 (0830)	3	0.42	12.81	0.48	45.21	3.68	6.73	12.11	0.03	2399.37	119.81	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	2152.78	124.56	7.01	0.08	0.93	18.31	100.00
60 (2030)	3	0.44	13.83	0.49	48.33	3.87	6.84	13.16	0.03	3065.75	186.19	8.45	0.89	5.96	11.90	100.00

d. (Cont'd) Product Gas Analysis
 Test No. 94F5008 (7/18-7/27/84)

10" Fluid Bed Gasifier

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

Date/ Sample I.D. (Time Taken)	Test Period #	Ar %	H ₂ %	O ₂ %	N ₂ %	CH ₄ %	CO %	CO ₂ %	C ₂ H ₆ %	H ₂ S PPM	COS PPM	SO ₂ PPM	CS ₂ PPM	C ₄ H ₁₀ PPM	H ₂ O* %	Total %
July 25, 1984																
61 (0030)	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	11.95	100.00
62 (0430)	3	0.38	12.57	0.48	45.19	3.52	6.16	12.15	0.04	1813.54	121.98	8.30	0.33	4.64	18.34	100.00
63 (0830)	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
64 (1230)	3	0.40	13.52	0.46	45.86	3.95	7.04	12.28	0.03	1053.71	78.81	19.15	0.25	0.67	16.34	100.00
65 (1630)	3	0.42	13.62	0.47	45.49	3.87	8.99	12.58	0.03	1601.43	92.17	8.68	0.33	1.87	16.38	100.00
66 (2030)	3	0.43	13.18	0.52	45.79	3.62	6.73	12.64	0.03	2555.70	125.85	10.43	0.33	2.17	18.80	100.00
July 26, 1984																
67 (0030)	3	0.42	13.34	0.48	45.88	3.73	6.81	12.28	0.04	1351.11	118.99	5.90	0.00	0.81	17.07	100.00
68 (0430)	3	0.44	14.18	0.53	48.87	4.12	7.14	13.11	0.05	1932.22	75.68	15.85	0.18	0.80	10.37	100.00
69 (0830)	3	0.39	12.81	0.47	45.14	3.74	6.83	11.97	0.03	1156.19	81.57	8.08	0.00	0.82	16.60	100.00
70 (1230)	3	0.43	13.64	0.47	46.00	3.94	7.08	12.31	0.03	1181.00	89.45	5.20	0.00	0.67	18.00	100.00
71 (1630)	3	0.39	12.44	0.48	41.59	3.59	6.55	11.49	0.05	1075.87	69.56	8.51	0.08	0.62	23.31	100.00
72 (2030)	3	0.56	2.82	10.72	81.80	1.16	2.14	4.02	0.01	237.81	25.42	22.14	0.00	0.00	18.82	100.00
July 27, 1984																
73 (0030)	3	0.46	13.11	1.32	48.71	3.60	7.32	11.92	0.03	1047.43	80.03	8.03	0.00	0.00	15.41	100.00
74 (0430)	ShutOff	0.02	0.00	0.11	87.60	0.00	0.00	0.72	0.00	20.14	0.00	1.99	0.00	0.00	18.55	100.00

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

e. Summary of Clean Up Rig Conditions

Test No. 94MGC08

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
Period #"	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	285	0.33	0.45	454
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)
- 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)

F. 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 3 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. Summary of Gasifier Operating Conditions

10" Fluid Bed Gasifier

Test No. 94F8G09

(08/12 - 08/16/94)

Period #	Steady-State		Reactor		Coal Feed (3)	Convey Air		Reactor Air		Steam+		Underflow N2		Air/H2O		H2O/Coal	
	Date (Time)	Duration (hrs)	Press. (psi)	Temp. (°F)		(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)		
1	08/12 (16:22)	08/13 (06:15)	13.88	425	1070.5	68.9	1827.3	52	507.0	635	53.8	635	405.0	493	3.0	0.78	
2	08/13 (06:15)	08/13 (18:00)	11.75	425	1050	68.1	1801.6	65	798.2	641	53.4	641	402.3	493	3.4	0.77	
3*	08/13 (18:00)	08/14 (06:10)	12.17	425	1048	68.1	1824.3	59	1012.3	649	51.8	649	400.7	321	3.9	0.78	
4*	08/14 (06:10)	08/14 (10:22)	4.20	425	995.5	68.1	1585.0	82	1018.0	658	51.1	658	484.0	447	3.9	0.75	
5	08/14 (10:22)	08/14 (18:27)	8.08	425	1002	69.1	1813.9	78	1008.8	658	52.2	658	483.0	NA	3.8	0.78	
6	08/14 (18:27)	08/15 (06:10)	10.72	425	1067.6	76.7	1815.0	65	1011.8	661	51.7	661	402.3	NA	3.8	0.67	
7	08/15 (06:10)	08/15 (16:06)	9.93	425	1107.4	76.7	1802.8	71	1337.7	674	49.5	674	400.2	NA	4.5	0.64	
8	08/15 (16:06)	08/15 (21:12)	5.10	425	1200	78.5	1599.0	NA	1008.0	NA	51.9	NA	400.0	NA	3.8	0.68	
9**	08/15 (21:12)	08/16 (07:00)	8.80	425	1147.7	70.2	1820.3	63	1032.7	639	50.3	639	471.3	437	4.0	0.72	
10***	08/16 (07:00)	08/16 (14:00)	7.00	425	1200.2	72.1	1808.3	70	1145.9	584	50.8	584	403.8	NA	4.1	0.70	
		Total:	83.63	Avg:	1083.4	71.3	1812.8	60	956.7	610	51.8	610	418.0	242	3.8	0.73	

Followings are time-averaged values:

(1): PT-713 reading.

(2): TE-703 reading.

(3): (ST-803 reading in (rpm) x CFC lb/ft³pm)

where: CFC = 2.61 (Montana #7); 2.58 (Cl-doped M&B)

(4): Average of FT-107, -108 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)+(8)]*0.0765/(8)

(13): (8)/(9)

* Cl-doped Montana #8 Coal

** Coke Breeze

*** Illinois #6 Coal

+ Adjusted by reducing 9% wt from measured flow

d. Product Gas Analysis

Test No. 93F8009 (9/12-9/18/94)

10" Fluid Bed Gasifier

B. Mole Percent (Wet Basis)

Date	Sample I.D.	Steady State	Ar	H2	O2	H2	CH4	CO	CO2	C2H6	H2S	COS	SO2	CS2	C4H6	H2O*	Total
		(Time Taken)	%	%	%	%	%	%	%	%	PPM	PPM	PPM	PPM	PPM	%	%
September 12, 1994																	
1	(1800)	1	0.45	13.48	0.03	47.10	3.13	6.23	13.47	0.13	1893.47	205.58	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	15.85	100.00
3	(2000)	1	0.43	14.26	0.04	45.47	3.53	6.14	13.88	0.10	1804.28	136.71	1235.30	0.00	1.43	15.71	100.00
4	(2100)	1	0.44	13.98	0.04	45.93	3.68	6.41	13.63	0.08	1375.05	75.93	5.40	0.00	0.93	15.89	100.00
5	(2200)	1	0.40	14.08	0.06	45.70	3.74	6.98	13.27	0.04	1055.59	120.40	1.60	0.00	0.42	15.83	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	1555.08	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	7.58	12.65	0.03	1228.62	62.89	2.03	0.00	1.01	15.56	100.00
9	(0200)	1	0.41	14.29	0.06	45.32	3.52	8.05	12.56	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	15.58	100.00
11	(0400)	1	0.41	14.32	0.06	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	45.28	3.51	8.47	12.22	0.03	1201.16	86.88	2.45	0.00	0.76	15.48	100.00
13	(0600)	1	0.41	14.32	0.05	45.35	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	1407.78	94.20	3.04	0.00	0.51	15.44	100.00
15	(0800)	2	0.44	14.54	0.05	44.82	3.21	9.99	11.30	0.02	1109.82	72.24	4.55	0.00	0.42	15.41	100.00
16	(0900)	2	0.42	14.81	0.05	44.74	3.18	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	3.29	9.73	11.44	0.02	1243.54	86.30	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	(1200)	2	0.40	14.39	0.08	45.00	3.38	9.17	11.94	0.03	1461.54	83.42	3.04	0.00	0.34	15.48	100.00
20	(1300)	2	0.41	14.50	0.05	44.80	3.49	8.99	12.07	0.02	1072.27	78.11	1.88	0.00	1.27	15.45	100.00
21	(2000)	3	0.43	13.43	0.08	46.88	2.86	8.97	12.08	0.00	2597.59	186.25	5.14	0.00	0.51	15.70	100.00
22	(2400)	3	0.43	13.33	0.08	47.47	2.44	8.23	11.17	0.00	2022.80	169.98	4.47	0.00	0.00	15.84	100.00
September 14																	
23	(0400)	3	0.44	13.16	0.17	48.69	2.39	9.85	10.84	0.00	1715.18	93.59	6.78	0.00	0.59	16.37	100.00
24	(0900)	3	0.43	13.25	0.11	47.03	2.35	9.50	10.81	0.00	1788.48	136.71	10.37	0.00	0.33	16.34	100.00
25	(1000)	4	0.36	8.35	0.06	58.81	1.84	4.21	9.37	0.02	3104.63	181.78	5.61	0.00	2.16	17.05	100.00
26	(1400)	5	0.34	8.84	0.06	60.54	2.27	5.11	9.81	0.03	1164.22	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	9.66	12.11	0.00	3077.42	216.68	5.23	0.00	0.53	11.43	100.00

d. (Cont'd) Product Gas Analysis
Test No. 92F8008

10" Fluid Bed Gasifier

		B. (Cont'd) Mole Percent (Wt Basis)														Total %
Date/ Sample I.D. (Time Taken)	Study State #	Ar	H2	O2	H2	CH4	CO	CO2	C2H6	H2S	COS	SO2	CS2	C4H10	H2O*	
		%	%	%	%	%	%	%	%	PPM	PPM	PPM	PPM	PPM	%	
28 (2200)	6	0.48	15.07	0.04	47.50	3.10	8.80	12.25	0.00	3468.40	237.07	6.91	0.00	0.97	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	1928.35	144.95	7.57	0.00	0.78	12.99	100.00
30 (0800)	8	0.43	13.86	0.31	47.05	2.89	8.74	11.89	0.00	2710.98	182.22	10.85	0.00	2.85	13.23	100.00
31 (1000)	7	0.43	14.66	0.06	48.82	2.58	11.14	10.87	0.00	2891.07	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	1993.20	115.56	2.78	0.00	1.85	13.24	100.00
33 (1800)	8	0.42	14.35	0.08	48.26	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	8.30	11.48	0.00	1063.00	38.77	2.59	0.00	0.00	13.53	100.00
35 (2400)	8	0.52	9.23	0.08	56.54	0.67	5.69	12.85	0.00	1788.30	138.84	4.38	0.00	0.00	14.15	100.00
September, 16																
36 (0400)	8	0.43	3.17	0.06	71.21	0.16	1.47	8.88	0.00	1230.85	59.60	2.88	0.00	0.00	13.38	100.00
37 (0745)	10	0.49	12.84	0.08	51.27	1.88	7.80	11.44	0.00	2887.28	207.18	8.18	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	13.81	100.00
40 (1100)	10	0.47	14.27	0.05	49.89	2.07	8.20	11.11	0.00	3801.83	221.86	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	2992.17	228.18	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	0.08	54.77	1.18	8.89	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. 94MGC09

Steady - State				Test Mode*	Coal Type*	Gas Flow Rates	Filter Temperatures		Filter Operating Pressure	Single Filter Differential Pressure	Filter Assembly Differential Pressure	Filter Blowback Pressure
Period #"	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	289	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

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

G. 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 3 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 SO₂ 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.

Summary of Gasifier Operating Conditions

10" Fluid Bed Gasifier

Test No. 94F6G10 (10/24 - 10/28/84)

Period #	Steady-State		Reactor Press. psig (1)	Temp. of (2)	Coal Feed lb/h (3)	Convey Air (4)	Reactor Air (5)	Steam (6)	Underflow N2 (7)	Core N2 (8)	Air/H2O (9)	H2O/Coal (10)
	Date (Time)	Duration hrs										
1	10/24 (15:00) - 10/24 (23:00)	8.00	425	1243	71.8	1600.6	57	665.0	728	48.1	728	322.1
2	10/24 (23:00) - 10/25 (05:00)	6.00	425	968	71.1	1607.8	48	982.0	744	42.2	744	301.2
3	10/25 (05:00) - 10/25 (17:00)	12.00	425	929	71.6	1607.8	49	985.0	725	42.0	725	302.7
4	10/25 (17:00) - 10/26 (05:00)	12.00	425	939	71.6	1607.8	43	984.0	728	38.0	728	302.3
5	10/26 (05:00) - 10/26 (11:00)	6.00	425	940	71.8	1608.1	42	989.0	744	38.7	744	301.7
6*	10/26 (11:00) - 10/26 (23:00)	12.00	425	944	70.1	1607.8	47	1044.0	744	42.1	744	302.8
7*	10/26 (23:00) - 10/27 (03:00)	4.00	425	945	70.1	1607.6	43	923.0	747	40.9	747	302.5
8	10/27 (03:00) - 10/27 (15:00)	12.00	425	904	74.9	1607.7	42	923.0	750	43.9	750	302.5
9	10/27 (15:00) - 10/27 (21:00)	6.00	425	904	74.2	1607.4	52	993.0	751	42.9	751	301.9
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	302.8
11	10/28 (09:00) - 10/28 (13:00)	4.50	415	928	75.3	1607.0	44	860.0	714	48.1	714	294.1
	Total:	94.50	Avg:	961.7	72.6	1607.2	40	948.6	642	43.3	642	303.7

* Cl-doped Montana #8 Coal

+ Adjusted by reducing 20% wt from measured flow

Followings are time-averaged values:

(1): FT-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#8)

(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-218, -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) + (8)] * 0.0765 / [(8)

(15): (8) / (3)

d. Product Gas Analysis

Test No. 83F8510 (10/24-10/28/94)

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	CH4S PPM	H2O* %	%	
October 24, 1994																	
1 (1600)	1	0.47	18.05	0.00	44.43	3.40	7.30	15.15	0.10	2594.74	289.50	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	12.89	100.00	
3 (1800)	1	0.42	13.28	0.00	50.83	3.41	4.82	13.99	0.07	4838.33	267.11	7.90	0.80	4.28	13.09	100.00	
4 (1900)	1	0.42	14.42	0.02	47.89	3.35	6.78	13.86	0.04	3638.14	330.77	8.48	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	3298.08	189.54	4.78	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	287.84	6.02	0.44	0.00	12.87	100.00	
7 (2200)	1	0.43	14.41	0.01	48.07	2.87	8.89	12.26	0.01	2832.08	262.84	7.65	0.27	0.09	12.84	100.00	
8 (2300)	1	0.42	14.32	0.00	48.34	2.81	9.77	11.51	0.00	2068.38	210.70	6.15	0.18	0.09	12.80	100.00	
9 (2400)	2	0.44	14.80	0.02	48.04	2.50	9.83	11.83	0.00	3208.10	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	0.81	3.33	12.17	100.00	
11 (0200)	2	0.42	14.86	0.02	48.51	2.50	8.88	11.47	0.00	2482.80	223.58	8.98	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	8.85	0.35	0.81	12.11	100.00	
13 (0800)	3	0.45	14.83	0.00	50.03	2.52	10.97	10.81	0.00	1860.05	131.35	3.85	0.83	5.38	10.09	100.00	
14 (1300)	3	0.48	14.87	0.00	49.80	2.84	10.82	11.20	0.01	1711.82	123.33	4.89	1.18	1.80	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	8.77	0.83	0.00	10.08	100.00	
16 (2100)	4	0.48	15.47	0.00	48.78	2.58	11.52	11.28	0.00	2887.74	134.84	5.72	0.84	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	1847.10	187.33	10.80	0.73	0.00	9.55	100.00	
18 (0500)	4	0.48	14.83	0.03	50.10	2.19	11.45	11.09	0.00	2140.83	79.30	13.88	0.63	0.00	9.88	100.00	
19 (0800)	5	0.48	15.43	0.00	48.78	2.31	12.48	10.54	0.00	2043.82	87.38	4.78	0.36	0.00	9.80	100.00	
20 (1100)	5	0.48	15.03	0.00	50.24	2.15	10.97	10.88	0.00	3382.17	271.82	6.05	1.29	2.89	9.87	100.00	

d. (Cont'd) Product Gas Analysis

Test No. 9378G10 (10/24-10/28/84)

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, 1984																	
21 (1500)	8	0.48	15.01	0.00	48.77	2.42	10.80	11.28	0.00	1811.38	78.42	6.98	0.44	1.15	11.27	100.00	
22 (1900)	6	0.49	14.73	0.00	48.83	2.52	10.48	11.37	0.00	1804.11	171.86	9.43	0.82	1.87	11.31	100.00	
23 (2300)	8	0.48	14.23	0.00	50.18	2.10	8.72	11.59	0.00	2708.00	202.90	7.72	0.80	5.41	11.40	100.00	
October 27, 1984																	
24 (0300)	7	0.49	14.48	0.02	49.39	2.35	10.56	11.12	0.00	2425.39	224.81	12.16	0.80	3.47	11.33	100.00	
25 (0700)	8	0.51	14.78	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 (0800)	8	0.46	15.28	0.00	48.23	2.50	11.36	11.04	0.00	2071.88	162.89	4.97	0.88	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	1896.53	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	8.81	12.09	0.00	3539.00	190.20	7.98	0.80	5.41	11.00	100.00	
29 (1800)	9	0.50	15.05	0.00	47.69	2.28	10.45	11.58	0.00	3358.07	237.77	8.88	1.15	8.84	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, 1984																	
31 (0100)	10	0.47	14.44	0.00	50.99	2.07	10.80	11.01	0.00	2184.38	110.50	7.95	0.90	3.81	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	9.81	100.00	
33 (0900)	10	0.51	12.93	0.00	53.18	1.38	13.41	8.44	0.00	2274.18	148.22	4.89	1.17	0.00	9.81	100.00	
34 (1300)	11	0.45	15.55	0.00	48.92	3.01	9.89	11.70	0.01	4038.04	223.84	5.60	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 Conditions

Test No. 93MGC10

Steady - State				Test Mode*	Coal Type*	Gas Flow Rates	Filter Temperatures		Filter Operating Pressure	Single Filter Differential Pressure	Filter Assembly Differential Pressure	Filter Blowback Pressure
Period #"	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)

