DOE/METC-96/1028-Vol.1

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
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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 cooperatation with Shell Synthetic Fuels, Incorporated to obtain data relevent 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% H_2, 10% CO, 49% N_2, 12% H_2O, 2.4% CH_4, 11% CO_2, 0.3% H_2S, 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/Nm^3.

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 relevent 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 relevent 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 intermittenly 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

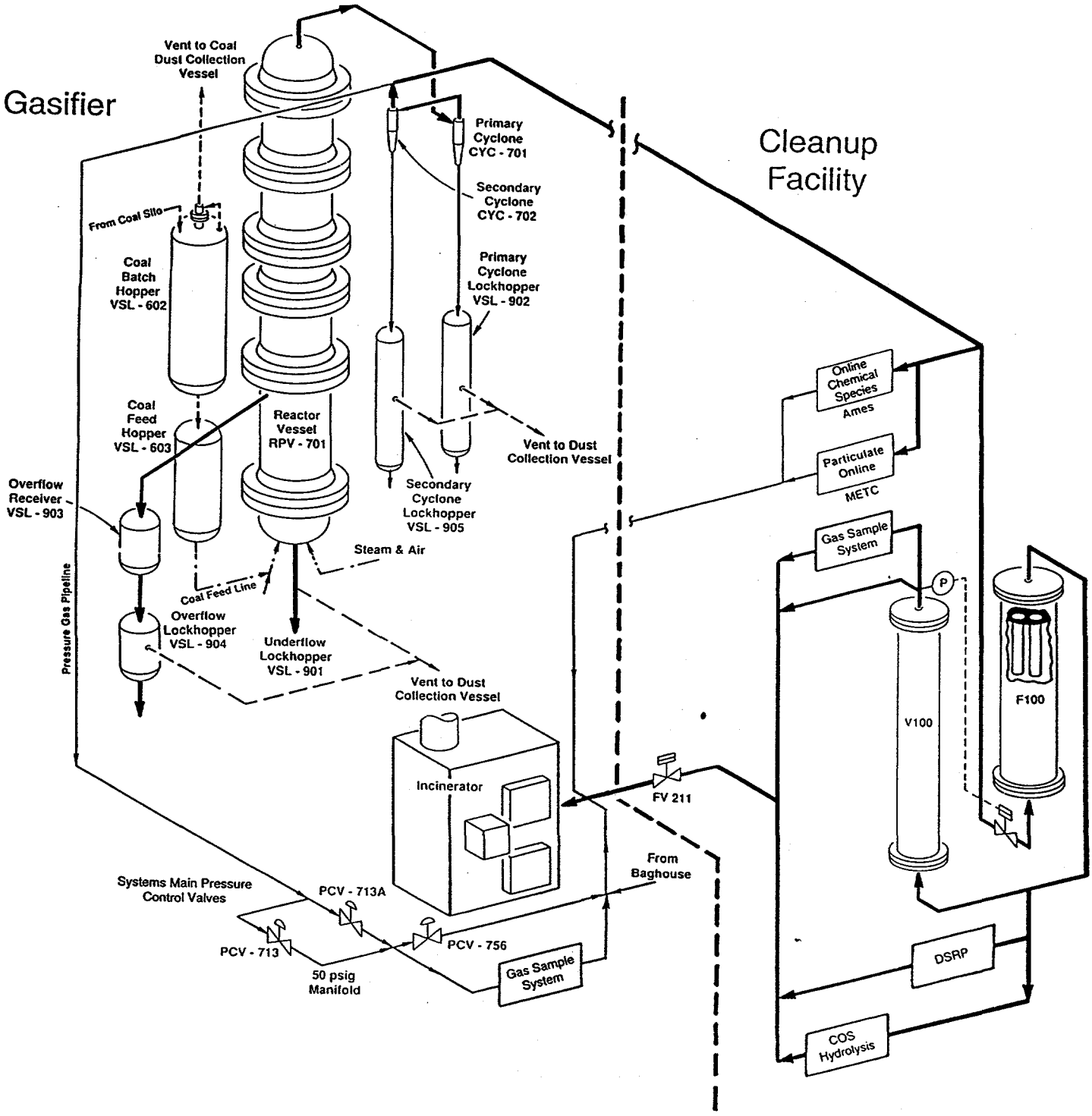

Figure 1. METC Integrated Gasification & Cleanup Facility

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 Passing	Size,mesh Retained	micron	Avg. di	Cumulative %wt	Direct 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 Passing	Size,mesh Retained	micron	Avg. di	Cumulative %wt	Direct 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 PARTICALATE 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 - Particalate
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 Traingle 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	Cl-/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								
Al2O3	NA	NA	24.35	NA	NA	15.63	NA	17.79
CaO	NA	NA	21.3	NA	NA	17.32	NA	3.14
Fe2O3	NA	NA	6.58	NA	NA	8.28	NA	11.74
K2O	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
P2O5	NA	NA	1.31	NA	NA	0.41	NA	0.12
SiO2	NA	NA	32.28	NA	NA	27.24	NA	39.1
TiO2	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 N2 Adsorption	0.0017	NA	0.0294	NA	0.01213	0.013	0.01145	0.006
by N2 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, m2/kg	2000	NA	2855	NA	3167	2843	2558	1728
Ash Fusion Temp., oF:								
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 SO3 formed in ash during analysis.

Revised on: 05/15/95
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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 lenght 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

10" Fluid Bed Gasifier

Test No. 93FBG04

Test Period				Reactor		Coal	Convey Air		Reactor Air		Steam		N2 to Reactor		Air/H2O	H2O/Coal
Period	Date (Time)		Duration	Press.	Temp.	Feed	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
#	Start	End	hrs	psig (1)	oF (2)	lb/h (3)	scfh	oF	scfh	oF	lb/h	oF	scfh	oF	lb/lb	lb/lb
1	5/18 (10:32)	5/19 (12:50)	26.30	425	1517	83.9	810.0	127	1396.8	647	74.7	647	116.1	30	2.3	0.89
2	5/21 (04:10)	5/23 (09:08)	52.60	425	1482	74.4	800.7	113	1252.4	665	68.7	665	40.7	31	2.3	0.92
3	5/23 (19:00)	5/24 (18:00)	23.00	425	1477	74.1	866.8	125	1153.0	646	70.0	646	0.0	-	2.2	0.94
4	5/26 (03:00)	5/26 (16:30)	13.50	425	1400	72.4	889.8	129	1123.6	633	69.8	633	47.4	35	2.2	0.96
		Total:	115.40	Avg:	1479	76.3	826.4	120	1250.4	653	70.5	653	50.6	31	2.3	0.92

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=2.72
(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)+(6)]*0.0765/(8)
(13): (8)/(3)

d. Product Gas Analysis

10" Fluid Bed Gasifier

Test No. 93FBG04

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* %
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	768.84	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	52.52	4.52	5.53	15.12	0.08	1160.74	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	0.67	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	0.62	11.40
5.1 (1000)	2	15.29	0.49	46.73	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	49.63	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				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.			FIR-501 (SCFH)	Inlet TIR-248 (deg F)	Outlet TIR-224 (deg F)	PIR-247 (psig)	PDIR-459 (psig)	PDIR-155 (psig)	PIR-458 (psig)
	Start	End										
1A	05/18 (11:47)	05/18 (16:55)	5.13	F	M5	1895.3	972.3	1019.6	282.6	1.01	5.87	425.0
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

* 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)

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

10" Fluid Bed Gasifier

Test No. 93FBG05

Test Period				Reactor		Coal	Convey Air		Reactor Air		Steam		N2 to Reactor		Air/H2O	H2O/Coal
Period #	Date (Time) Start	End	Duration hrs	Press. psig (1)	Temp. oF (2)	Feed lb/h (3)	(4) scfh	(5) oF	(6) scfh	(7) oF	(8) lb/h	(9) oF	(10) scfh	(11) oF	(12) lb/lb	(13) lb/lb
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	Avg.:	1465	78.4	815.7	64	1551.2	633	60.9	633	81.6	69	3.0	0.77

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 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)]*0.0765/(8)
(13): (8)/(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	0.66	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	4.65	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	2458.9	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	1950.2	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	8.18	12.98
7.1 (1530)	4	13.72	0.54	45.69	3.68	7.75	12.18	0.02	2937.8	144.96	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	120.95	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	2229.3	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.			FIR-501 (SCFH)	Inlet TIR-248 (deg F)	Outlet TIR-224 (deg F)	PIR-247 (psig)	PDIR-459 (psig)	PDIR-155 (psig)	PIR-458 (psig)
	Start	End										
1	08/02 (23:45)	08/03 (05:17)	5.50	F	M6	1928.6	1024.8	1133.6	297.32	0.79	4.76	434.25
2	08/03 (07:12)	08/03 (11:00)	3.77	F, P, S	M6	2085.6	1016.8	1137.5	296.6	0.87	4.66	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	8.33	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	0.79	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	1.05	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	1.21	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	1.49	5.86	431.88
Average Values			145.56*			1710.7	1065.8	1126.1	293.83	1.83	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)
- Cloride 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

10" Fluid Bed Gasifier

Test No. 93FBG06

Test Period				Reactor		Coal	Convey Air		Reactor Air		Steam		N2 to Reactor		Air/H2O	H2O/Coal
Period #	Date (Time) Start	End	Duration hrs	Press. psig (1)	Temp. oF (2)	Feed lb/h (3)	(4) scfh	(5) oF	(6) scfh	(7) oF	(8) lb/h	(9) oF	(10) scfh	(11) oF	(12) lb / lb	(13) 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	226.1	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	867.1	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/h/rpm
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

10" Fluid Bed Gasifier

Test No. 93FBG06

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	SO2 PPM	CS2 PPM	C4H4S PPM	H2O* %
November 1, 1993															
2 (1400)	1	0.37	14.81	0.17	46.34	2.72	10.80	11.70	0.00	2153.39	271.98	6.62	0.78	0.87	12.85
3 (1800)	1	0.39	14.95	0.19	46.46	2.62	9.31	12.56	0.01	5437.48	365.29	8.10	0.44	0.00	12.92
November 2, 1993															
5 (0200)	1	0.39	14.87	0.21	45.08	3.21	9.10	12.47	0.01	2397.80	144.07	11.56	8.30	0.00	14.40
6 (0600)	1	0.41	14.77	0.16	43.38	3.00	9.41	11.75	0.01	2083.70	114.80	4.82	8.81	0.00	16.87
7 (1000)	1	0.39	15.10	0.16	45.70	2.38	9.63	11.51	0.00	3772.47	210.39	8.87	2.13	0.00	14.72
8 (1400)	1	0.41	15.71	0.20	46.45	2.81	10.43	12.13	0.00	3070.11	147.77	14.07	0.88	0.00	11.52
8A (1500)	1	0.43	15.42	0.22	46.46	2.94	10.57	12.15	0.01	2316.42	147.98	14.86	0.88	0.00	11.55
9 (1800)	1	0.41	14.86	0.18	47.26	2.99	10.06	12.34	0.01	2673.53	182.97	11.22	1.41	0.00	11.62
November 4, 1993															
10 (0030)	2	0.22	13.03	0.77	45.44	3.83	5.23	14.21	0.01	4016.07	183.47	23.29	0.25	7.49	16.83
11 (0500)	2	0.27	14.32	0.30	44.16	3.88	7.19	13.06	0.02	3048.62	111.75	6.10	1.67	0.00	16.48
12 (0810)	2	0.36	15.25	0.72	45.59	4.42	7.80	13.97	0.03	2712.70	146.68	0.00	1.06	0.00	11.58
13 (0900)	2	0.25	14.06	0.17	49.92	4.04	7.09	12.55	0.02	2643.06	143.52	4.60	0.35	0.00	11.62
14 (1002)	2	0.00	12.92	1.75	51.59	3.83	6.50	12.62	0.04	1435.90	104.86	7.87	0.54	0.00	10.61
15 (1102)	2	0.30	15.36	0.56	46.84	4.48	7.89	13.80	0.04	3136.12	160.84	9.32	0.36	1.88	10.40
16 (1202)	2	0.39	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
17 (1300)	2	0.01	16.13	0.51	45.57	4.76	8.33	14.06	0.04	2814.13	181.81	4.04	2.51	0.00	10.30
18 (1410)	2	0.38	15.29	0.22	44.43	4.40	7.43	13.77	0.03	4536.56	195.15	9.68	1.99	0.00	13.57
19 (1500)	2	0.00	15.53	0.49	44.40	4.57	8.01	13.23	0.03	2517.97	120.55	5.63	0.95	0.43	13.46
20 (1700)	2	0.41	15.23	0.14	44.89	4.51	7.12	13.68	0.03	3932.61	212.11	8.56	1.04	1.12	13.57
21 (2100)	2	0.35	14.75	0.22	45.51	4.60	6.93	13.79	0.03	1794.88	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
23 (0200)	3	0.35	13.91	0.13	45.37	4.46	6.75	13.95	0.03	2017.04	158.17	6.56	0.60	0.00	14.82
24 (0300)	3	0.34	14.25	0.17	44.77	4.25	7.23	13.86	0.03	2858.13	133.79	1.53	1.36	0.00	14.78
25 (0400)	3	0.34	14.03	0.67	45.87	4.12	6.48	13.39	0.03	2447.33	123.47	9.80	0.00	0.00	14.79
26 (0500)	3	0.01	14.67	0.49	43.76	4.33	7.09	14.57	0.03	2812.00	92.91	1.88	0.43	0.00	14.76
27 (0600)	3	0.00	14.05	0.46	42.04	4.19	6.67	13.60	0.02	2597.50	135.86	7.64	1.14	0.00	18.69
28 (0700)	3	0.00	14.26	0.47	41.77	4.19	6.50	13.77	0.02	3296.19	149.06	4.68	0.57	0.00	18.68

(Cont'd) Product Gas Analysis

10" Fluid Bed Gasifier

Test No. 93FBG06

93FBG06

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* %
November 5, 1993															
29 (0800)	3	0.36	14.23	0.12	41.89	4.15	6.48	13.67	0.02	3372.83	151.63	8.70	0.57	0.00	18.70
30 (0900)	3	0.32	13.80	0.15	42.20	4.41	6.18	13.86	0.03	2623.67	135.01	6.25	1.06	0.00	18.77
31 (1300)	3	0.33	15.19	0.18	45.52	4.79	6.37	15.24	0.04	2993.18	113.30	11.35	0.97	1.58	12.03
32 (1700)	3	0.00	14.45	0.50	43.56	4.51	6.11	13.47	0.04	3013.10	135.55	8.71	0.50	1.58	17.04
33 (2100)	3	0.30	14.03	0.13	44.01	4.62	5.88	13.92	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
35 (0500)	3	0.00	14.55	0.51	44.85	4.62	6.11	14.07	0.04	4145.26	237.45	9.80	0.43	1.19	14.80
36 (0900)	3	0.00	13.59	0.50	44.01	4.55	5.94	13.31	0.04	2620.17	191.08	7.73	0.66	0.66	17.78
37 (1300)	3	0.00	14.51	0.51	43.56	4.57	6.03	13.91	0.04	2976.67	215.67	8.10	0.42	1.34	16.54
38 (1700)	3	0.42	13.68	0.21	44.72	4.23	6.66	13.36	0.04	3329.91	260.85	8.70	0.25	0.00	16.31
39 (2100)	3	0.43	11.10	1.06	46.27	4.05	6.72	12.51	0.03	2337.24	113.62	29.88	0.25	0.00	15.59
November 7, 1993															
40 (0100)	3	0.44	12.96	0.30	44.93	4.10	6.06	13.02	0.04	2471.60	109.38	19.54	0.00	0.00	17.88
41 (0500)	3	0.40	12.91	0.20	43.46	4.21	6.53	12.91	0.03	2895.80	164.85	26.72	0.00	0.00	19.03
42 (0900)	3	0.36	13.11	0.16	42.02	4.07	5.80	12.89	0.04	2844.30	120.18	14.49	0.32	0.00	21.25
43 (2130)	4	0.34	12.15	0.13	43.20	4.04	5.68	12.57	0.04	1780.42	129.14	8.23	3.68	0.55	21.64
November 8, 1993															
44 (0600)	5	0.00	12.95	0.52	48.19	4.54	5.48	13.91	0.05	4240.18	175.13	9.04	0.26	0.77	13.94
45 (1500)	6	0.00	12.18	0.86	50.70	4.21	4.14	13.48	0.08	4098.68	140.89	12.82	0.00	2.93	13.93
46 (1900)	6	0.00	12.73	0.47	45.91	3.96	5.47	12.95	0.07	2883.80	137.52	8.76	0.57	0.57	18.14
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
49 (0700)	6	0.28	8.83	0.11	56.96	2.60	2.47	9.95	0.07	1284.57	46.32	8.38	0.33	1.14	18.60
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)		Duration, hrs.			FIR-501 (SCFH)	Inlet TIR-248 (deg F)	Outlet TIR-224 (deg F)	PIR-247 (psig)	PDIR-459 (psig)	PDIR-155 (psig)	PIR-458 (psig)
	Start	End										
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				Reactor		Coal	Convey Air		Reactor Air		Steam+		Underflow N2		Air/H2O	H2O/Coal
Period	Date (Time)		Duration	Press.	Temp.	Feed	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
#	Start	End	hrs	psig (1)	oF (2)	lb/h (3)	scfh	oF	scfh	oF	lb/h	oF	scfh	oF	lb/lb	lb/lb
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.

(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

*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.

d. Product Gas Analysis

10" Fluid Bed Gasifier

Test No. 94FBG07 (6/6-8/15/94)

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	SO2 PPM	CS2 PPM	C4H4S PPM	H2O* %	Total %
June 6, 1994																
1 (1850)	1	0.47	14.54	0.84	48.62	4.01	7.48	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	3.87	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	5695.88	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	2649.83	188.43	6.20	0.84	2.10	9.73	100.00
June 7, 1994	1															
5 (0230)	1	0.45	13.82	0.18	51.89	2.77	8.61	12.26	0.00	4753.38	228.76	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	1501.91	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	44.38	4.52	8.71	15.89	0.03	4981.65	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 (0830)	2	0.39	15.29	0.08	48.72	4.76	8.68	14.82	0.03	5034.04	103.01	8.94	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	5.78	5.61	6.25	9.13	100.00
13 (1830)	2	0.39	15.55	0.09	48.66	4.36	7.55	13.85	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	3323.85	156.93	8.67	0.72	7.66	9.13	100.00
16 (0830)	2	0.41	15.83	0.07	48.18	4.16	7.40	14.64	0.03	3342.75	155.48	5.55	2.08	4.20	9.13	100.00
17 (1030)	2	0.40	15.59	0.07	48.18	4.36	7.83	14.29	0.03	3157.72	169.56	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	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	6.88	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	7.36	14.16	0.06	3763.27	165.81	8.33	0.55	10.64	9.13	100.00
22 (0830)	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	6.06	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	48.86	3.85	7.68	14.02	0.03	3491.28	194.98	5.15	1.22	7.78	9.13	100.00
26 (2230)	2	0.00	8.59	10.04	63.89	1.86	3.10	5.67	0.02	880.88	78.21	28.32	0.18	1.38	9.13	100.00

d. (Cont'd) Product Gas Analysis

10" Fluid Bed Gasifier

Test No. 94FBG07 (6/6-8/15/94)

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

Data/ 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	21.18	8.59	0.00	0.09	9.13	100.00
28 (0630)	2	0.00	3.10	13.79	68.84	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	49.81	3.79	6.99	14.45	0.07	3021.71	136.60	12.54	0.48	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	3.87	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	2308.86	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	1988.55	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	1822.66	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	13.98	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	14.06	0.16	48.88	3.50	6.95	13.61	0.02	4011.27	129.66	7.48	0.00	9.28	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	95.81	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	14.87	0.08	47.64	3.60	8.00	13.08	0.02	2178.65	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	5.68	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'd) Product Gas Analysis

10" Fluid Bed Gasifier

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

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 %
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	6.65	0.00	5.60	11.75	100.00
57 (0400)	3	0.44	14.31	0.11	48.98	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	48.86	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	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	84.09	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	123.08	10.15	0.00	8.20	11.75	100.00
62 (0900)	3	0.43	14.79	0.08	47.86	3.63	8.24	12.98	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	2184.87	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	1378.47	98.97	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 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)		Duration, hrs.			FIR-501 (SCFH)	Inlet TIR-248 (deg F)	Outlet TIR-224 (deg F)	PIR-247 (psig)	PDIR-459 (psig)	PDIR-155 (psig)	PIR-458 (psig)
	Start	End										
2A	06/08 21:15	06/09 22:20	25.08	F	M6	1837.2	1105.3	1055.9	290.21	2.086	3.85	442.3
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

* 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)

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. 94FBG08 (07/18 - 07/27/94)

Steady-State				Reactor		Coal	Convey Air		Reactor Air		Steam		Underflow N2		Air/H20	H20/Coal
Period	Date (Time)		Duration	Press.	Temp.	Feed	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
#	Start	End	hrs	psig (1)	oF (2)	lb/h (3	scfh	oF	scfh	oF	lb/h	oF	scfh	oF	lb / lb	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	54.8	740	399.3	495	3.0	0.78
		Total:	200.08	Avg:	1442.9	69.8	1610.4	67	529.8	738	54.8	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

10" Fluid Bed Gasifier

Test No. 94FBG08 (7/18-7/27/94)

Date/ Sample I.D. (Time Taken)	Test Period #	B. Mole Percent (Wet Basis) Ar %	H2 %	O2 %	N2 %	CH4 %	CO %	CO2 %	C2H6 %	H2S PPM	COS PPM	SO2 PPM	CS2 PPM	C4H4S PPM	H2O* %	Total %
July 18, 1994																
1 (1630)	1	0.44	12.34	0.45	48.57	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	235.82	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	6.81	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	48.50	4.03	7.04	13.14	0.05	1819.70	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	0.81	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	13.81	0.52	49.48	3.98	6.17	13.80	0.05	2846.53	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	5.87	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	3.98	6.25	13.22	0.04	2100.88	125.60	9.63	0.00	0.95	13.40	100.00
13 (0830)	1	0.45	14.51	0.52	50.01	4.06	6.51	14.28	0.04	3358.11	158.81	5.89	0.38	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	0.38	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	13.87	100.00
18 (0430)	1	0.44	13.52	0.66	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	114.96	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	2187.44	123.38	5.70	0.08	1.98	17.02	100.00
25 (1530)	2	0.43	12.84	0.50	49.83	3.71	5.60	13.35	0.02	2692.52	143.30	14.02	0.00	1.19	13.83	100.00
26 (1630)	2	0.44	12.60	0.52	50.81	3.44	5.85	14.27	0.00	3833.83	193.98	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	13.83	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 (1930)	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	1808.76	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	6.41	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	6.40	13.19	0.03	2251.46	120.87	15.91	0.00	0.70	12.77	100.00

d. (Cont'd) Product Gas Analysis

10" Fluid Bed Gasifier — Test No. 94FBG08 (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	16.67	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	3711.78	197.03	10.65	0.08	2.15	16.93	100.00
37 (0430)	2	0.42	13.07	0.47	46.89	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	4992.97	253.28	32.81	0.00	1.16	16.80	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	0.88	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 (11830)	3	0.46	14.19	0.53	49.85	3.57	6.84	13.65	0.03	4689.12	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	6.96	12.33	0.03	1949.76	94.14	8.41	0.88	0.59	16.57	100.00
July 22, 1994	3															
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	3.86	7.11	13.10	0.05	1874.30	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	6.96	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	3.84	6.84	12.80	0.03	2395.55	140.01	9.88	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	43.84	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	45.59	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	6.53	12.77	0.03	2776.00	113.51	11.27	0.25	0.91	17.83	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	0.48	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	2152.78	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	198.19	8.45	0.89	5.96	11.90	100.00

d. (Cont'd) Product Gas Analysis

10" Fluid Bed Gasifier — Test No. 94FBG08 (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 25, 1994																
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	11.85	100.00
62 (0430)	3	0.38	12.57	0.46	45.19	3.52	6.16	12.15	0.04	1813.54	121.99	8.30	0.33	4.64	19.34	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	45.66	3.95	7.04	12.26	0.03	1053.71	78.81	19.15	0.25	0.67	16.34	100.00
65 (1830)	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	1.87	16.38	100.00
66 (2030)	3	0.43	13.18	0.52	45.79	3.82	6.73	12.64	0.03	2556.70	125.85	10.43	0.33	2.17	16.80	100.00
July 26, 1994																
67 (0030)	3	0.42	13.34	0.48	45.88	3.73	6.81	12.26	0.04	1351.11	118.99	5.90	0.00	0.91	17.07	100.00
68 (0430)	3	0.44	14.18	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
69 (0830)	3	0.39	12.91	0.47	45.14	3.74	6.83	11.97	0.03	1156.19	81.57	8.09	0.00	0.82	18.60	100.00
70 (1230)	3	0.43	13.84	0.47	48.00	3.94	7.08	12.31	0.03	1181.00	89.45	5.20	0.00	0.87	16.00	100.00
71 (1830)	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
72 (2030)	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	16.82	100.00
July 27, 1994																
73 (0030)	3	0.46	13.11	1.32	48.71	3.60	7.32	11.92	0.03	1047.43	80.08	8.03	0.00	0.00	15.41	100.00
74 (0430)	ShutOff	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

* 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				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.			FIR-501 (SCFH)	Inlet TIR-248 (deg F)	Outlet TIR-224 (deg F)	PIR-247 (psig)	PDIR-459 (psig)	PDIR-155 (psig)	PIR-458 (psig)
	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)
- Cloride 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. 94FBG09 (09/12 - 09/16/94)

Period #	Steady-State Date (Time) Start	End	Duration hrs	Reactor Press. psig (1)	Temp. oF (2)	Coal Feed lb/h (3)	Convey Air (4) scfh	(5) oF	Reactor Air (6) scfh	(7) oF	Steam+ (8) lb/h	(9) oF	Underflow N2 (10) scfh	(11) oF	Air/H2O (12) lb/lb	H2O/Coal (13) lb /lb
1	09/12 (16:22)	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 (08:15)	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 (08:10)	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	483.0	NA	3.8	0.76
6	09/14 (19:27)	09/15 (06:10)	10.72	425	1067.6	76.7	1815.0	65	1011.8	661	51.7	661	402.3	NA	3.9	0.67
7	09/15 (06:10)	09/15 (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	09/15 (16:06)	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	1820.3	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	1808.3	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	958.7	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/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): Average of FT-311, -313 readings.
(11): TE-312 reading.
(12): [(4)+(6)]*0.0765/(8)
(13): (8)/(3)

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

d. Product Gas Analysis

10" Fluid Bed Gasifier

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

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	C4H4S PPM	H2O* %	Total %
September 12, 1994																
1 (1800)	1	0.45	13.48	0.03	47.10	3.13	8.23	13.47	0.13	1893.47	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	8.49	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	8.14	13.98	0.10	1804.28	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	8.41	13.63	0.08	1375.05	78.93	5.40	0.00	0.93	15.89	100.00
5 (2200)	1	0.40	14.08	0.06	45.70	3.74	8.98	13.27	0.04	1055.59	120.40	1.80	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	1555.06	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	12.56	0.03	1742.35	118.81	6.08	0.00	1.01	15.55	100.00
10 (0300)	1	0.42	14.14	0.06	45.58	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	1284.72	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	9.89	11.30	0.02	1109.82	72.24	4.65	0.00	0.42	15.41	100.00
16 (0900)	2	0.42	14.61	0.05	44.74	3.18	9.97	11.36	0.02	934.48	58.33	2.45	0.00	1.27	15.37	100.00
17 (1000)	2	0.42	14.52	0.05	45.01	3.28	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	3.38	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	44.80	3.49	8.99	12.07	0.02	1072.27	78.11	1.88	0.00	1.27	15.46	100.00
21 (2000)	3	0.43	13.43	0.08	46.69	2.66	8.67	12.08	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	2022.80	189.98	4.47	0.00	0.00	15.84	100.00
September, 14																
23 (0400)	3	0.44	13.16	0.17	46.69	2.39	9.85	10.94	0.00	1715.18	93.59	8.78	0.00	0.59	16.37	100.00
24 (0800)	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	0.08	58.81	1.84	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	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	9.96	12.11	0.00	3077.42	219.68	5.23	0.00	0.53	11.43	100.00

d. (Cont'd) Product Gas Analysis

10" Fluid Bed Gasifier

Test No. 93FBG09

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	C4H4S PPM	H2O* %	Total %
28 (2200)	6	0.48	15.07	0.04	47.50	3.10	9.80	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	1828.35	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	0.96	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	1.65	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	0.96	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	38.77	2.59	0.00	0.00	13.53	100.00
35 (2400)	9	0.52	9.23	0.08	56.54	0.67	5.69	12.95	0.00	1789.30	138.84	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	8.98	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	2887.26	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	13.81	100.00
40 (1100)	10	0.47	14.27	0.05	49.89	2.07	8.20	11.11	0.00	3601.83	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	2992.17	229.16	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. 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)		Duration, hrs.			FIR-501 (SCFH)	Inlet TIR-248 (deg F)	Outlet TIR-224 (deg F)	PIR-247 (psig)	PDIR-459 (psig)	PDIR-155 (psig)	PIR-458 (psig)
	Start	End										
1, 2	9/12 (20:00)	9/13 (18:45)	22.75	F, P, S	M7	1947	1085	1050	289	5.47	4.33	459
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

* 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)

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 hydroylsis 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_2 DSRP testing were completed.
- The run was shortened by 5 days when an overheated pipe buckeled 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. 94FBG10 (10/24 - 10/29/94)

Steady-State				Reactor		Coal	Convey Air		Reactor Air		Steam+		Underflow N2		Cone N2		Air/H2O	H2O/Coal
Period	Date (Time)		Duration	Press.	Temp.	Feed	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)
#	Start	End	hrs	psig (1)	oF (2)	lb/h (3)	scfh	oF	scfh	oF	lb/h	oF	scfh	oF	scfh	oF	lb/lb	lb /lb
1	10/24 (15:00)	10/24 (23:00)	8.00	425	1243	71.8	1800.6	57	665.0	726	48.1	726	322.1	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	301.2	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	302.7	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	302.3	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	301.7	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	302.9	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	302.5	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	302.5	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	301.9	500	100.8	52	4.6	0.58
10	10/27 (21:00)	10/28 (09:00)	12.00	440-425	960	75.8	1608.0	34	983.0	739	50.5	739	302.9	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	294.1	NA	97.0	44	3.9	0.64
		Total:	94.50	Avg:	961.7	72.6	1607.2	40	948.6	842	43.3	642	303.7	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)]*0.0785/(8)
(15): (8)/(3)

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

d. Product Gas Analysis

10" Fluid Bed Gasifier

Test No. 93FBG10 (10/24-10/28/94)

Date/ Sample I.D. (Time Taken)	Test-Period #	B. Mole Percent (Wet Basis)														
		Ar %	H2 %	O2 %	N2 %	CH4 %	CO %	CO2 %	C2H6 %	H2S PPM	COS PPM	SO2 PPM	CS2 PPM	C4H4S PPM	H2O* %	Total %
October 24, 1994																
1 (1800)	1	0.47	16.05	0.00	44.43	3.40	7.30	15.15	0.10	2584.74	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	12.89	100.00
3 (1800)	1	0.42	13.28	0.00	50.63	3.41	4.82	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	47.98	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	287.84	6.02	0.44	0.00	12.87	100.00
7 (2200)	1	0.43	14.41	0.01	48.07	2.67	8.89	12.26	0.01	2832.09	262.94	7.65	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	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	3871.25	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	8.88	11.47	0.00	2462.80	223.58	6.98	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	0.61	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	0.83	5.38	10.09	100.00
14 (1300)	3	0.48	14.97	0.00	49.80	2.84	10.62	11.20	0.01	1711.82	123.33	4.89	1.16	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	6.77	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	0.48	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	11.08	0.00	2140.83	79.30	13.88	0.83	0.00	9.66	100.00
19 (0900)	5	0.48	15.43	0.00	48.78	2.31	12.48	10.54	0.00	2043.82	87.38	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	271.82	8.05	1.28	2.89	9.87	100.00

d. (Cont'd) Product Gas Analysis

10" Fluid Bed Gasifier

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

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 PPM	COS PPM	SO2 PPM	CS2 PPM	C4H4S PPM	H2O* %	
October 28, 1994																
21 (1500)	6	0.48	15.01	0.00	48.77	2.42	10.80	11.28	0.00	1911.36	78.42	6.99	0.44	1.15	11.27	100.00
22 (1900)	6	0.48	14.73	0.00	48.83	2.52	10.48	11.37	0.00	1804.11	171.88	9.43	0.82	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	2708.00	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	0.48	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	11.80	0.00	1898.53	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	9.81	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	2.28	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	50.89	2.07	10.80	11.01	0.00	2184.38	110.50	7.85	0.90	3.61	9.89	100.00
32 (0500)	10	0.45	14.19	0.08	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	1.38	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	223.84	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 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)		Duration, hrs.			FIR-501 (SCFH)	Inlet TIR-248 (deg F)	Outlet TIR-224 (deg F)	PIR-247 (psig)	PDIR-459 (psig)	PDIR-155 (psig)	PIR-458 (psig)
	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	299	6.63	5.56	449
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)
- Cloride Salt with Montana #6 (CL/M6)
- Illinois #6 (I6)