DOE/PC/90366--715

QUARTERLY PROGRESS REPORT NO. 15
(April - June 1995)

Contract No. DE-AC22-91-PC90366

on

CHARACTERIZATION OF AIR TOXICS FROM A
LABORATORY COAL-FIRED COMBUSTOR AND
UTILITY SCALE POWER PLANTS

to

PITTSBURGH ENERGY TECHNOLOGY CENTER
U.S. DEPARTMENT OF ENERGY
P.O. BOX 10940
PITTSBURGH, PENNSYLVANIA 15236

August 1995

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505 King Avenue
Columbus, Ohio 43201-2693

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MASTER

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(April - June 1995)

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This progress report summarizes technical accomplishments during the second quarter of 1995. Work was performed under Task 3 and Task 4 during this period.

Task 3 - Power Plant Studies

Field sampling was completed in the previous reporting period therefore Task 3 activities in the current reporting period focused on laboratory analysis.

Particulate weights were determined for Method 29 cyclones and used with particulate concentrations determined in other studies to calculate whether sufficient particulate matter had been collected to detect the metals of interest in individual cyclone fractions. These calculations are detailed in Appendix A for cadmium, selenium, arsenic,

and manganese in Unit 7. These metals were expected to represent the worst case analysis based on their low particulate concentrations as determined in other studies. These calculations suggest that most metals will be detected in individual cyclone fractions. Results from these calculations were provided to DOE's Contracting Officer Technical Representative and the decision was made to proceed with individual analysis of Method 29 cyclone fractions.

Analysis of anions in Method 26 impinger samples was completed in the reporting period. Coal and Method 26 filter samples were submitted to Commercial Testing & Engineering Co. (CTE) for ultimate/proximate and related analyses. Results for coal ultimate/proximate analyses are presented in Appendix B.

Analysis of target and nontarget PAH in Modified Method 5 samples continued during the reporting period.

Task 4 - Technical Management and Reporting

Quality Assurance/Quality Control

An external audit of laboratory analysis activities was conducted by International Technology Corporation (IT) on April 4, 1995. The IT auditor observed Modified Method 5 sample extraction, reviewed sample chain-of-custody documentation, and noted operations, procedures, and documentation in metals, anion, and PAH analysis

laboratories. The following audit samples were transferred from the IT auditor to Battelle's Assistant Project Manager, Ms. Karen Riggs, at this audit:

Mercury - ITM
Metals - ITA 1713 and ITA 2713
Metals - ITB 3361 MRS (Coal Fly Ash)
Nitrated PAH - IT 7851 MRS
PAH - ITC 7461 MRS

Instructions for preparation, analysis, and reporting of these audit samples were also provided to Battelle with the samples. These audit samples will be prepared and analyzed with actual samples collected at the host power plant as an external check on laboratory analysis performance. Results from the audit samples will be submitted to IT for evaluation.

Reporting

Information was compiled for a presentation on the contract status at DOE's Eleventh Annual Coal Preparation, Utilization, and Environmental Control Contractors Conference.

APPENDIX A

CALCULATION OF METALS CONCENTRATION IN CYCLONE FRACTIONS

SAMMIS (G2106)

CALCULATION OF ELEMENT LEVELS

PARTICULATE LOADING (g)

	CYCL1 (>7 um)	CYC2 (3.5-7 um)	CYC3 (1-3.5 um)	FHACET	FILTER (<1 um)	TOTAL
S-STACK7-1-M29	0.0313	0.0147	0.0334	0.0062	0.0060	0.0916
S-STACK7-2-M29	0.0192	0.0233	0.0354	0.004	0.0104	0.0923
S-STACK7-3-M29	0.0127	0.0164	0.0154	0.003	0.0024	0.0499 *
S-STACK7-4-M29	0.0178	0.0211	0.0222	0.0028	0.0028	0.0667
S-STACK7-TB-M2	0	0	0	0.0005	0.0002	0.0007

*Method 29 Run 3 at Stack 7 had smaller sample volume than Runs 1, 2, and 4.

PARTICULATE LOADING (g)

	CYCL1 (>7 um)	CYC2 (3.5-7 um)	CYC3 (1-3.5 um)	FHACET	FILTER (<1 um)	TOTAL
S-STACK7-1-M29	0.0313	0.0147	0.0334	0.0062	0.0060	0.0916
S-STACK7-2-M29	0.0192	0.0233	0.0354	0.004	0.0104	0.0923
S-STACK7-3-M29	0.0127	0.0164	0.0154	0.003	0.0024	0.0499 *
S-STACK7-4-M29	0.0178	0.0211	0.0222	0.0028	0.0028	0.0667
S-STACK7-TB-M29	0	0	0	0.0005	0.0002	0.0007

*Method 29 Run 3 at Stack 7 had smaller sample volume than Runs 1, 2, and 4.

CADMIUM

CADMIUM CONCENTRATIONS BY PARTICLE SIZE FROM LAB STUDY (ug/g)
HIGH-FIRE TESTS BY XRF

	A	B	C
	(3.2-6 um)	(0.88-3.2 um)	(<0.88 um)
Cadmium	4.8	8.7	68

TOTAL AMOUNT OF CADMIUM IN M29 PARTICLE FRACTIONS (ug)

	CYCL1	CYC2	CYC3	FILTER
	(>7 um)	(3.5-7 um)	(1-3.5 um)	(<1 um)
S-STACK7-1-M29		0.07056	0.29058	0.408
S-STACK7-2-M29		0.11184	0.30798	0.7072
S-STACK7-3-M29		0.07872	0.13398	0.1632
S-STACK7-4-M29		0.10128	0.19314	0.1904

CONCENTRATION OF CADMIUM IN DIGESTED M29 FRACTIONS (ug/L)
USING 50 mL VOLUME

	CYCL1	CYC2	CYC3	FILTER
	(>7 um)	(3.5-7 um)	(1-3.5 um)	(<1 um)
S-STACK7-1-M29		1.41	5.81	8.16
S-STACK7-2-M29		2.24	6.16	14.14
S-STACK7-3-M29		1.57	2.68	3.26
S-STACK7-4-M29		2.03	3.86	3.81

CADMIUM CONCENTRATIONS BY PARTICLE SIZE FROM NILES STACK (ug/g)

	Large Cyclone	Small Cyclone	Filter	Filter
	(>10 um)	(5-10 um)	(<5 um)	(<5 um)
Cadmium	2	10	6	6

TOTAL AMOUNT OF CADMIUM IN M29 PARTICLE FRACTIONS (ug)

	CYC 1	CYC2	CYC3	FILTER
	(>7 um)	(3.5-7 um)	(1-3.5 um)	(<1 um)
S-STACK7-1-M29	0.0626	0.147	0.2004	0.036
S-STACK7-2-M29	0.0384	0.233	0.2124	0.0624
S-STACK7-3-M29	0.0254	0.164	0.0924	0.0144
S-STACK7-4-M29	0.0356	0.211	0.1332	0.0168

CONCENTRATION OF CADMIUM IN DIGESTED M29 FRACTIONS (ug/L)
USING 50 mL VOLUME

	CYC 1	CYC2	CYC3	FILTER
	(>7 um)	(3.5-7 um)	(1-3.5 um)	(<1 um)
S-STACK7-1-M29	1.25	2.94	4.01	0.72
S-STACK7-2-M29	0.77	4.66	4.25	1.25
S-STACK7-3-M29	0.51	3.28	1.85	0.29
S-STACK7-4-M29	0.71	4.22	2.66	0.34

SELENIUM

SELENIUM CONCENTRATIONS BY PARTICLE SIZE FROM LAB STUDY (ug/g)
HIGH-FIRE TESTS BY XRF

	A	B	C
	(3.2-6 um)	(0.88-3.2 um)	(<0.88 um)
Selenium	22	42	25

TOTAL AMOUNT OF SELENIUM IN M29 PARTICLE FRACTIONS (ug)

	CYCL1	CYC2	CYC3	FILTER
	(>7 um)	(3.5-7 um)	(1-3.5 um)	(<1 um)
S-STACK7-1-M29		0.3234	1.4028	0.15
S-STACK7-2-M29		0.5126	1.4868	0.26
S-STACK7-3-M29		0.3608	0.6468	0.06
S-STACK7-4-M29		0.4642	0.9324	0.07

CONCENTRATION OF SELENIUM IN DIGESTED M29 FRACTIONS (ug/L)
USING 50 mL VOLUME

	CYCL1	CYC2	CYC3	FILTER
	(>7 um)	(3.5-7 um)	(1-3.5 um)	(<1 um)
S-STACK7-1-M29		6.47	28.06	3.00
S-STACK7-2-M29		10.25	29.74	5.20
S-STACK7-3-M29		7.22	12.94	1.20
S-STACK7-4-M29		9.28	18.65	1.40

SELENIUM CONCENTRATIONS BY PARTICLE SIZE FROM NILES STACK (ug/g)

	Large Cyclone (>10 um)	Small Cyclone (5-10 um)	Filter (<5 um)	Filter (<5 um)
Selenium	13	54	57	57

TOTAL AMOUNT OF SELENIUM IN M29 PARTICLE FRACTIONS (ug)

	CYC 1	CYC2	CYC3	FILTER
	(>7 um)	(3.5-7 um)	(1-3.5 um)	(<1 um)
S-STACK7-1-M29	0.4069	0.7938	1.9038	0.342
S-STACK7-2-M29	0.2496	1.2582	2.0178	0.5928
S-STACK7-3-M29	0.1651	0.8856	0.8778	0.1368
S-STACK7-4-M29	0.2314	1.1394	1.2654	0.1596

CONCENTRATION OF SELENIUM IN DIGESTED M29 FRACTIONS (ug/L)
USING 50 mL VOLUME

	CYC 1	CYC2	CYC3	FILTER
	(>7 um)	(3.5-7 um)	(1-3.5 um)	(<1 um)
S-STACK7-1-M29	8.14	15.88	38.08	6.84
S-STACK7-2-M29	4.99	25.16	40.36	11.86
S-STACK7-3-M29	3.30	17.71	17.56	2.74
S-STACK7-4-M29	4.63	22.79	25.31	3.19

ARSENIC

ARSENIC CONCENTRATIONS BY PARTICLE SIZE FROM LAB STUDY (ug/g)
HIGH-FIRE TESTS BY XRF

	A (3.2-6 um)	B (0.88-3.2 um)	C (<0.88 um)
Arsenic	327	643	5450

TOTAL AMOUNT OF ARSENIC IN M29 PARTICLE FRACTIONS (ug)

	CYCL1 (>7 um)	CYC2 (3.5-7 um)	CYC3 (1-3.5 um)	FILTER (<1 um)
S-STACK7-1-M29		4.81	21.48	32.70
S-STACK7-2-M29		7.62	22.76	56.68
S-STACK7-3-M29		5.36	9.90	13.08
S-STACK7-4-M29		6.90	14.27	15.26

CONCENTRATION OF ARSENIC IN DIGESTED M29 FRACTIONS (ug/L) USING 50 mL VOLUME

	CYCL1 (>7 um)	CYC2 (3.5-7 um)	CYC3 (1-3.5 um)	FILTER (<1 um)
S-STACK7-1-M29		96.14	429.52	654.00
S-STACK7-2-M29		152.38	455.24	1133.60
S-STACK7-3-M29		107.26	198.04	261.60
S-STACK7-4-M29		137.99	285.49	305.20

ARSENIC CONCENTRATIONS BY PARTICLE SIZE FROM NILES STACK (ug/g)

	Large Cyclone (>10 um)	Small Cyclone (5-10 um)	Filter (<5 um)	Filter (<5 um)
Arsenic	414	1262	3303	3303

TOTAL AMOUNT OF ARSENIC IN M29 PARTICLE FRACTIONS (ug)

	CYC 1 (>7 um)	CYC2 (3.5-7 um)	CYC3 (1-3.5 um)	FILTER (<1 um)
S-STACK7-1-M29	12.96	18.55	110.32	19.82
S-STACK7-2-M29	7.95	29.40	116.93	34.35
S-STACK7-3-M29	5.26	20.70	50.87	7.93
S-STACK7-4-M29	7.37	26.63	73.33	9.25

CONCENTRATION OF ARSENIC IN DIGESTED M29 FRACTIONS (ug/L) USING 50 mL VOLUME

	CYC 1 (>7 um)	CYC2 (3.5-7 um)	CYC3 (1-3.5 um)	FILTER (<1 um)
S-STACK7-1-M29	259.16	371.03	2206.40	396.36
S-STACK7-2-M29	158.98	588.09	2338.52	687.02
S-STACK7-3-M29	105.16	413.94	1017.32	158.54
S-STACK7-4-M29	147.38	532.56	1466.53	184.97

MANGANESE

MANGANESE CONCENTRATIONS BY PARTICLE SIZE FROM LAB STUDY (ug/g)
HIGH-FIRE TESTS BY XRF

	A	B	C
	(3.2-6 um)	(0.88-3.2 um)	(<0.88 um)
Manganese			78

TOTAL AMOUNT OF MANGANESE IN M29 PARTICLE FRACTIONS (ug)

	CYCL1	CYC2	CYC3	FILTER
	(>7 um)	(3.5-7 um)	(1-3.5 um)	(<1 um)
S-STACK7-1-M29		0	0	0.468
S-STACK7-2-M29		0	0	0.8112
S-STACK7-3-M29		0	0	0.1872
S-STACK7-4-M29		0	0	0.2184

CONCENTRATION OF MANGANESE IN DIGESTED M29 FRACTIONS (ug/L)
USING 50 mL VOLUME

	CYCL1	CYC2	CYC3	FILTER
	(>7 um)	(3.5-7 um)	(1-3.5 um)	(<1 um)
S-STACK7-1-M29		0.00	0.00	9.36
S-STACK7-2-M29		0.00	0.00	16.22
S-STACK7-3-M29		0.00	0.00	3.74
S-STACK7-4-M29		0.00	0.00	4.37

MANGANESE CONCENTRATIONS BY PARTICLE SIZE FROM NILES STACK (ug/g)

	Large Cyclone	Small Cyclone	Filter	Filter
	(>10 um)	(5-10 um)	(<5 um)	(<5 um)
Manganese	75	239	332	332

TOTAL AMOUNT OF MANGANESE IN M29 PARTICLE FRACTIONS (ug)

	CYC 1	CYC2	CYC3	FILTER
	(>7 um)	(3.5-7 um)	(1-3.5 um)	(<1 um)
S-STACK7-1-M29	2.35	3.51	11.09	1.99
S-STACK7-2-M29	1.44	5.57	11.75	3.45
S-STACK7-3-M29	0.95	3.92	5.11	0.80
S-STACK7-4-M29	1.34	5.04	7.37	0.93

CONCENTRATION OF MANGANESE IN DIGESTED M29 FRACTIONS (ug/L)
USING 50 mL VOLUME

	CYC 1	CYC2	CYC3	FILTER
	(>7 um)	(3.5-7 um)	(1-3.5 um)	(<1 um)
S-STACK7-1-M29	46.95	70.27	221.78	39.84
S-STACK7-2-M29	28.80	111.37	235.06	69.06
S-STACK7-3-M29	19.05	78.39	102.26	15.94
S-STACK7-4-M29	26.70	100.86	147.41	18.59

APPENDIX B

COAL ULTIMATE/PROXIMATE ANALYSIS RESULTS

COMMERCIAL TESTING & ENGINEERING CO.

GENERAL OFFICES: 1919 SOUTH HIGHLAND AVE., SUITE 210-B, LOMBARD, ILLINOIS 60148 • TEL: 708-953-9300 FAX: 708-953-9306

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PLEASE ADDRESS ALL CORRESPONDENCE TO:
4665 PARIS, B-200, DENVER, CO 80239
TEL: (303) 373-4772
FAX: (303) 373-4791

July 7, 1995

BATTELLE MEMORIAL INSTITUTE
505 KING AVE.
COLUMBUS, OH 43201
Kevin M. Blann

Sample identification by
BATTELLE

SAMPLE ID: S-UNIT 6-1-MET-COAL

Kind of sample COAL

Sample taken by BATTELLE

Date received June 20, 1995

Analysis report no. 72-309756

PROXIMATE ANALYSIS

	<u>As Received</u>	<u>Dry Basis</u>
% Moisture	2.52	xxxxxx
% Ash	11.41	11.70
% Volatile	33.88	34.76
% Fixed Carbon	<u>52.19</u>	<u>53.54</u>
	100.00	100.00
Btu/lb.	12761	13091
% Sulfur	0.85	0.87

MAF Btu/lb.	14826
% MAF Volatile	39.37
% MAF Fixed Carbon	60.63
Lbs. SO ₂ /Mill. Btu	1.33
% Air Dry Loss	xxxxxx

ULTIMATE ANALYSIS

	<u>As Received</u>	<u>Dry Basis</u>
% Moisture	2.52	xxxxxx
% Carbon	72.33	74.20
% Hydrogen	4.57	4.69
% Nitrogen	1.32	1.35
% Sulfur	0.85	0.87
% Ash	11.41	11.70
% Oxygen (diff)	<u>7.00</u>	<u>7.19</u>
	100.00	100.00
% Chlorine	0.10	0.10
% Fluorine		77

Lbs. Sulfur/Mill. Btu	0.67
As Received Net Sample Wt.	0.00 gr.

Respectfully submitted,
COMMERCIAL TESTING & ENGINEERING CO.

E. Seguint Zano

Manager, Denver Laboratory

COMMERCIAL TESTING & ENGINEERING CO.

GENERAL OFFICES: 1919 SOUTH HIGHLAND AVE., SUITE 210-B, LOMBARD, ILLINOIS 60148 • TEL: 708-953-9300 FAX: 708-953-9306

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July 7, 1995

BATTELLE MEMORIAL INSTITUTE
505 KING AVE.
COLUMBUS, OH 43201
Kevin M. Blann

Sample identification by
BATTELLE

SAMPLE ID: S-UNIT 6-2-MET-COAL

Kind of sample COAL

Sample taken by BATTELLE

Date received June 20, 1995

Analysis report no. 72-309757

PROXIMATE ANALYSIS

ULTIMATE ANALYSIS

	<u>As Received</u>	<u>Dry Basis</u>
% Moisture	2.25	xxxxxx
% Ash	11.77	12.04
% Volatile	34.22	35.01
% Fixed Carbon	<u>51.76</u>	<u>52.95</u>
	100.00	100.00
Btu/lb.	12698	12990
% Sulfur	0.86	0.88

	<u>As Received</u>	<u>Dry Basis</u>
% Moisture	2.25	xxxxxx
% Carbon	71.79	73.44
% Hydrogen	4.56	4.66
% Nitrogen	1.37	1.40
% Sulfur	0.86	0.88
% Ash	11.77	12.04
% Oxygen (diff)	<u>7.40</u>	<u>7.58</u>
	100.00	100.00

% Chlorine	0.11	0.11
% Fluorine		86

MAF Btu/lb.	14768
% MAF Volatile	39.80
% MAF Fixed Carbon	60.20
Lbs. SO ₂ /Mill. Btu	1.35
% Air Dry Loss	xxxxxx

Lbs. Sulfur/Mill. Btu	0.68
As Received Net Sample Wt.	0.00 gr.

Respectfully submitted,
COMMERCIAL TESTING & ENGINEERING CO.

E. Segant Zaro

Manager, Denver Laboratory

SINCE 1908

COMMERCIAL TESTING & ENGINEERING CO.

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July 7, 1995

BATTELLE MEMORIAL INSTITUTE
505 KING AVE.
COLUMBUS, OH 43201
Kevin M. Blann

Sample identification by
BATTELLE

SAMPLE ID: S-UNIT 6-3-MET-COAL

Kind of sample COAL

Sample taken by BATTELLE

Date received June 20, 1995

Analysis report no. 72-309758

PROXIMATE ANALYSIS

	<u>As Received</u>	<u>Dry Basis</u>
% Moisture	2.50	xxxxxx
% Ash	11.58	11.88
% Volatile	33.95	34.82
% Fixed Carbon	<u>51.97</u>	<u>53.30</u>
	100.00	100.00
Btu/lb.	12716	13042
% Sulfur	0.84	0.86
MAF Btu/lb.		14800
% MAF Volatile		39.51
% MAF Fixed Carbon		60.49
Lbs. SO ₂ /Mill. Btu		1.32
% Air Dry Loss		xxxxxx

ULTIMATE ANALYSIS

	<u>As Received</u>	<u>Dry Basis</u>
% Moisture	2.50	xxxxxx
% Carbon	72.53	74.39
% Hydrogen	4.54	4.66
% Nitrogen	1.00	1.03
% Sulfur	0.84	0.86
% Ash	11.58	11.88
% Oxygen (diff)	<u>7.01</u>	<u>7.18</u>
	100.00	100.00
% Chlorine	0.11	0.11
% Fluorine		79
Lbs. Sulfur/Mill. Btu		0.66
As Received Net Sample Wt.		0.00 gr.

Respectfully submitted,
COMMERCIAL TESTING & ENGINEERING CO.

E. Aquino Zano

Manager, Denver Laboratory

COMMERCIAL TESTING & ENGINEERING CO.

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July 7, 1995

BATTELLE MEMORIAL INSTITUTE
505 KING AVE.
COLUMBUS, OH 43201
Kevin M. Blann

Sample identification by
BATTELLE

SAMPLE ID: S-UNIT 6-1-ORG-COAL

Kind of sample COAL

Sample taken by BATTELLE

Date received June 20, 1995

Analysis report no. 72-309759

PROXIMATE ANALYSIS

	<u>As Received</u>	<u>Dry Basis</u>
% Moisture	2.76	xxxxxxx
% Ash	11.52	11.85
% Volatile	33.94	34.90
% Fixed Carbon	<u>51.78</u>	<u>53.25</u>
	100.00	100.00
Btu/lb.	12545	12901
% Sulfur	0.97	1.00

MAF Btu/lb.	14635
% MAF Volatile	39.59
% MAF Fixed Carbon	60.41
Lbs. SO ₂ /Mill. Btu	1.55
% Air Dry Loss	xxxxxxx

ULTIMATE ANALYSIS

	<u>As Received</u>	<u>Dry Basis</u>
% Moisture	2.76	xxxxxx
% Carbon	70.82	72.83
% Hydrogen	4.47	4.60
% Nitrogen	1.05	1.08
% Sulfur	0.97	1.00
% Ash	11.52	11.85
% Oxygen (diff)	<u>8.41</u>	<u>8.64</u>
	100.00	100.00
% Chlorine	0.09	0.09
% Fluorine		71

Lbs. Sulfur/Mill. Btu	0.77
As Received Net Sample Wt.	0.00 gr.

Respectfully submitted,
COMMERCIAL TESTING & ENGINEERING CO.

E. Segund Zano

Manager, Denver Laboratory

COMMERCIAL TESTING & ENGINEERING CO.

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July 7, 1995

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COLUMBUS, OH 43201
Kevin M. Blann

Sample identification by
BATTELLE

SAMPLE ID: S-UNIT 6-2-ORG-COAL

Kind of sample COAL

Sample taken by BATTELLE

Date received June 20, 1995

Analysis report no. 72-309760

PROXIMATE ANALYSIS

	<u>As Received</u>	<u>Dry Basis</u>
% Moisture	2.66	xxxxxx
% Ash	11.13	11.43
% Volatile	33.94	34.87
% Fixed Carbon	<u>52.27</u>	<u>53.70</u>
	100.00	100.00
Btu/lb.	12746	13094
% Sulfur	0.88	0.90

MAF Btu/lb.	14784
% MAF Volatile	39.37
% MAF Fixed Carbon	60.63
Lbs. SO ₂ /Mill. Btu	1.38
% Air Dry Loss	xxxxxx

ULTIMATE ANALYSIS

	<u>As Received</u>	<u>Dry Basis</u>
% Moisture	2.66	xxxxxx
% Carbon	72.70	74.69
% Hydrogen	4.52	4.64
% Nitrogen	1.10	1.13
% Sulfur	0.88	0.90
% Ash	11.13	11.43
% Oxygen (diff)	<u>7.01</u>	<u>7.21</u>
	100.00	100.00
% Chlorine	0.09	0.09
% Fluorine		73

Lbs. Sulfur/Mill. Btu	0.69
As Received Net Sample Wt.	0.00 gr.

Respectfully submitted,
COMMERCIAL TESTING & ENGINEERING CO.

Esequiel Zarco

Manager, Denver Laboratory

COMMERCIAL TESTING & ENGINEERING CO.

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SINCE 1906

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FAX: (303) 373-4791

July 7, 1995

BATTELLE MEMORIAL INSTITUTE
505 KING AVE.
COLUMBUS, OH 43201
Kevin M. Blann

Sample identification by
BATTELLE

SAMPLE ID: S-UNIT 6-3-ORG-COAL

Kind of sample COAL

Sample taken by BATTELLE

Date received June 20, 1995

Analysis report no. 72-309761

PROXIMATE ANALYSIS

ULTIMATE ANALYSIS

	<u>As Received</u>	<u>Dry Basis</u>
% Moisture	2.35	xxxxxx
% Ash	12.15	12.44
% Volatile	33.55	34.36
% Fixed Carbon	<u>51.95</u>	<u>53.20</u>
	100.00	100.00
Btu/lb.	12710	13016
% Sulfur	0.88	0.90

	<u>As Received</u>	<u>Dry Basis</u>
% Moisture	2.35	xxxxxx
% Carbon	72.43	74.17
% Hydrogen	4.57	4.68
% Nitrogen	1.36	1.39
% Sulfur	0.88	0.90
% Ash	12.15	12.44
% Oxygen (diff)	<u>6.26</u>	<u>6.42</u>
	100.00	100.00
% Chlorine	0.10	0.10
% Fluorine		77

MAF Btu/lb.	14865
% MAF Volatile	39.24
% MAF Fixed Carbon	60.76
Lbs. SO ₂ /Mill. Btu	1.38
% Air Dry Loss	xxxxxx

Lbs. Sulfur/Mill. Btu	0.69
As Received Net Sample Wt.	0.00 gr.

Respectfully submitted,
COMMERCIAL TESTING & ENGINEERING CO.

E. J. Zaro

Manager, Denver Laboratory

COMMERCIAL TESTING & ENGINEERING CO.

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July 7, 1995

BATTELLE MEMORIAL INSTITUTE
505 KING AVE.
COLUMBUS, OH 43201
Kevin M. Blann

Sample identification by
BATTELLE

SAMPLE ID: S-UNIT 7-1-MET-COAL

Kind of sample COAL

Sample taken by BATTELLE

Date received June 20, 1995

Analysis report no. 72-309762

PROXIMATE ANALYSIS

	<u>As Received</u>	<u>Dry Basis</u>
% Moisture	2.50	XXXXXX
% Ash	11.81	12.11
% Volatile	33.26	34.11
% Fixed Carbon	<u>52.43</u>	<u>53.78</u>
	100.00	100.00
Btu/lb.	12643	12967
% Sulfur	0.87	0.89
MAF Btu/lb.		14754
% MAF Volatile		38.81
% MAF Fixed Carbon		61.19
Lbs. SO ₂ /Mill. Btu		1.38
% Air Dry Loss		XXXXXX

ULTIMATE ANALYSIS

	<u>As Received</u>	<u>Dry Basis</u>
% Moisture	2.50	XXXXXX
% Carbon	71.64	73.48
% Hydrogen	4.47	4.58
% Nitrogen	1.36	1.39
% Sulfur	0.87	0.89
% Ash	11.81	12.11
% Oxygen (diff)	<u>7.35</u>	<u>7.55</u>
	100.00	100.00
% Chlorine	0.09	0.09
% Fluorine		58
Lbs. Sulfur/Mill. Btu		0.69
As Received Net Sample Wt.		0.00 gr.

Respectfully submitted,
COMMERCIAL TESTING & ENGINEERING CO.

Esequiel Zano

Manager, Denver Laboratory

COMMERCIAL TESTING & ENGINEERING CO.

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July 7, 1995

BATTELLE MEMORIAL INSTITUTE
505 KING AVE.
COLUMBUS, OH 43201
Kevin M. Blann

Sample identification by
BATTELLE

SAMPLE ID: S-UNIT 7-2-MET-COAL

Kind of sample COAL

Sample taken by BATTELLE

Date received June 20, 1995

Analysis report no. 72-309763

PROXIMATE ANALYSIS

ULTIMATE ANALYSIS

	<u>As Received</u>	<u>Dry Basis</u>
% Moisture	2.36	xxxxxx
% Ash	11.75	12.03
% Volatile	33.71	34.52
% Fixed Carbon	<u>52.18</u>	<u>53.45</u>
	100.00	100.00
Btu/lb.	12755	13063
% Sulfur	0.86	0.88

	<u>As Received</u>	<u>Dry Basis</u>
% Moisture	2.36	xxxxxx
% Carbon	72.38	74.13
% Hydrogen	4.53	4.64
% Nitrogen	1.35	1.38
% Sulfur	0.86	0.88
% Ash	11.75	12.03
% Oxygen (diff)	<u>6.77</u>	<u>6.94</u>
	100.00	100.00
% Chlorine	0.11	0.11
% Fluorine		71

MAF Btu/lb.	14849
% MAF Volatile	39.24
% MAF Fixed Carbon	60.76
Lbs. SO ₂ /Mill. Btu	1.35
% Air Dry Loss	xxxxxx

Lbs. Sulfur/Mill. Btu	0.67
As Received Net Sample Wt.	0.00 gr.

Respectfully submitted,
COMMERCIAL TESTING & ENGINEERING CO.

E. Seguin Zano

Manager, Denver Laboratory

COMMERCIAL TESTING & ENGINEERING CO.

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July 7, 1995

BATTELLE MEMORIAL INSTITUTE
505 KING AVE.
COLUMBUS, OH 43201
Kevin M. Blann

Sample identification by
BATTELLE

SAMPLE ID: S-UNIT 7-3-MET-COAL

Kind of sample COAL

Sample taken by BATTELLE

Date received June 20, 1995

Analysis report no. 72-309764

PROXIMATE ANALYSIS

ULTIMATE ANALYSIS

	<u>As Received</u>	<u>Dry Basis</u>
% Moisture	2.30	xxxxxx
% Ash	11.50	11.77
% Volatile	33.76	34.55
% Fixed Carbon	<u>52.44</u>	<u>53.68</u>
	100.00	100.00
Btu/lb.	12757	13057
% Sulfur	0.84	0.86

	<u>As Received</u>	<u>Dry Basis</u>
% Moisture	2.30	xxxxxx
% Carbon	73.23	74.95
% Hydrogen	4.52	4.63
% Nitrogen	1.37	1.40
% Sulfur	0.84	0.86
% Ash	11.50	11.77
% Oxygen (diff)	<u>6.24</u>	<u>6.39</u>
	100.00	100.00
% Chlorine	0.10	0.10
% Fluorine		60

MAF Btu/lb.	14799
% MAF Volatile	39.16
% MAF Fixed Carbon	60.84
Lbs. SO ₂ /Mill. Btu	1.32
% Air Dry Loss	xxxxxx

Lbs. Sulfur/Mill. Btu	0.66
As Received Net Sample Wt.	0.00 gr.

Respectfully submitted,
COMMERCIAL TESTING & ENGINEERING CO.

Eugene J. Zaro

Manager, Denver Laboratory

COMMERCIAL TESTING & ENGINEERING CO.

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July 7, 1995

BATTELLE MEMORIAL INSTITUTE
505 KING AVE.
COLUMBUS, OH 43201
Kevin M. Blann

Sample identification by
BATTELLE

SAMPLE ID: S-UNIT 7-4-MET-COAL

Kind of sample COAL

Sample taken by BATTELLE

Date received June 20, 1995

Analysis report no. 72-309765

PROXIMATE ANALYSIS

ULTIMATE ANALYSIS

	<u>As Received</u>	<u>Dry Basis</u>
% Moisture	2.47	xxxxxx
% Ash	12.20	12.51
% Volatile	33.73	34.58
% Fixed Carbon	<u>51.60</u>	<u>52.91</u>
	100.00	100.00
Btu/lb.	12639	12959
% Sulfur	0.86	0.88

	<u>As Received</u>	<u>Dry Basis</u>
% Moisture	2.47	xxxxxx
% Carbon	72.16	73.99
% Hydrogen	4.53	4.64
% Nitrogen	1.38	1.41
% Sulfur	0.86	0.88
% Ash	12.20	12.51
% Oxygen (diff)	<u>6.40</u>	<u>6.57</u>
	100.00	100.00
% Chlorine	0.10	0.10
% Fluorine		65

MAF Btu/lb.	14812
% MAF Volatile	39.52
% MAF Fixed Carbon	60.48
Lbs. SO ₂ /Mill. Btu	1.36
% Air Dry Loss	xxxxxx

Lbs. Sulfur/Mill. Btu	0.68
As Received Net Sample Wt.	0.00 gr.

Respectfully submitted,
COMMERCIAL TESTING & ENGINEERING CO.

Esequiel Zorco

Manager, Denver Laboratory

COMMERCIAL TESTING & ENGINEERING CO.

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July 7, 1995

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COLUMBUS, OH 43201
Kevin M. Blann

Sample identification by
BATTELLE

SAMPLE ID: S-UNIT 7-5-MET-COAL

Kind of sample COAL

Sample taken by BATTELLE

Date received June 20, 1995

Analysis report no. 72-309766

PROXIMATE ANALYSIS

ULTIMATE ANALYSIS

	<u>As Received</u>	<u>Dry Basis</u>
% Moisture	1.64	xxxxxx
% Ash	6.91	7.03
% Volatile	36.42	37.03
% Fixed Carbon	<u>55.03</u>	<u>55.94</u>
	100.00	100.00
Btu/lb.	13560	13786
% Sulfur	1.87	1.90
MAF Btu/lb.		14828
% MAF Volatile		39.83
% MAF Fixed Carbon		60.17
Lbs. SO ₂ /Mill. Btu		2.76
% Air Dry Loss		xxxxxx

	<u>As Received</u>	<u>Dry Basis</u>
% Moisture	1.64	xxxxxx
% Carbon	77.22	78.51
% Hydrogen	4.83	4.91
% Nitrogen	1.50	1.53
% Sulfur	1.87	1.90
% Ash	6.91	7.03
% Oxygen (diff)	<u>6.03</u>	<u>6.12</u>
	100.00	100.00
% Chlorine	0.12	0.12
% Fluorine		45
Lbs. Sulfur/Mill. Btu		1.38
As Received Net Sample Wt.		0.00 gr.

Respectfully submitted,
COMMERCIAL TESTING & ENGINEERING CO.

Eugene J. Zaro

Manager, Denver Laboratory

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BATTELLE MEMORIAL INSTITUTE
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COLUMBUS, OH 43201
Kevin M. Blann

Sample identification by
BATTELLE

SAMPLE ID: S-UNIT 7-6-MET-COAL

Kind of sample COAL

Sample taken by BATTELLE

Date received June 20, 1995

Analysis report no. 72-303767

PROXIMATE ANALYSIS

	<u>As Received</u>	<u>Dry Basis</u>
% Moisture	2.54	XXXXXX
% Ash	12.22	12.54
% Volatile	33.87	34.75
% Fixed Carbon	<u>51.37</u>	<u>52.71</u>
	100.00	100.00
Btu/lb.	12594	12922
% Sulfur	0.86	0.88
MAF Btu/lb.		14775
% MAF Volatile		39.73
% MAF Fixed Carbon		60.27
Lbs. SO ₂ /Mill. Btu		1.37
% Air Dry Loss		XXXXXX

ULTIMATE ANALYSIS

	<u>As Received</u>	<u>Dry Basis</u>
% Moisture	2.54	XXXXXX
% Carbon	71.84	73.71
% Hydrogen	4.16	4.27
% Nitrogen	1.64	1.68
% Sulfur	0.86	0.88
% Ash	12.22	12.54
% Oxygen (diff)	<u>6.74</u>	<u>6.92</u>
	100.00	100.00
% Chlorine	0.11	0.11
% Fluorine		81
Lbs. Sulfur/Mill. Btu		0.68
As Received Net Sample Wt.		0.00 gr.

Respectfully submitted,
COMMERCIAL TESTING & ENGINEERING CO.

Esequiel Zano

Manager, Denver Laboratory