AP-42 Section 11.10
Reference 2.1
Report Sect.
Reference

ROBERTS & SCHAEFER Company

ENGINEERS & CONTRACTORS
EASTERN OPERATION

WILLIAM PENN PLAZA • 2790 MOSSIDE BLVD. • MONROEVILLE, PA 15146 • PHONE: 412-373-8020 FAX: 412-373-7065

May 7, 1993

Peabody Coal Company
1951 Barrett Court
P.O. Box 1990
Henderson, Kentucky 42420-1990

RECEIVED
MAY 11 1993
N. K. DOSHI

Attn: Mr. Nick Doshi
Project Manager

Subject: Hawthorn Mine Thermal Dryer
Emissions - Compliance Testing
R & S # 9125

Dear Mr. Doshi:

Attached are two (2) copies of the report prepared by Clean Air Engineering on the Compliance and Diagnostic testing performed at the Hawthorn Mine Thermal Dryer on April 8, 1993. Note that 3,625 hours per year were used in calculating the emission rates in tons per year.

If you have any questions concerning the report, please don't hesitate to call.

Sincerely Yours,

Thomas M. Gigliotti
Project Manager

TMG/kaz

cc: Bill McCue

336A

cc: K. LUCKHURST
E. SMITH
R. J. SMITH
A. ZABORAC
} PCC

L. M. BRENNAN / FILE

[redacted]

S. McGARVIE.

Clean Air Engineering

500 W. Wood St • Palatine, IL 60067 • 708-991-3300

REPORT ON COMPLIANCE TESTING

Performed for:
ROBERTS & SCHAEFER COMPANY

Conducted at:
PEABODY COAL COMPANY
HAWTHORNE MINE
CARLISLE, INDIANA

CAE Project No: 6489-1
May 6, 1993

ROBERTS & SCHAEFER COMPANY
CAE Project No: 6489-1

CONTENTS

SUMMARY

INTRODUCTION

Clean Air Engineering was contracted by Roberts & Schaefer Company to determine the levels of Particulate, Sulfer Dioxide, Nitrogen Oxides and Visible Emissions at the Peabody Coal Company, Hawthorne Mine facility located in Carlisle, Indiana for diagnostic purposes.

The testing took place at the Scrubber Stack on April 8, 1993. Coordinating the field testing were:

T. Gigliotti	Roberts & Schaefer Company
A. Casile	Indiana Department of Environmental Management
G. Tumbali	Clean Air Engineering

To the best of our knowledge, the data presented in this report are accurate and complete.

Respectfully submitted,

CLEAN AIR ENGINEERING

William Ansell CC

William Ansell
Project Manager

David G. Perkins
Manager, Technical Communications

ROBERTS & SCHAEFER COMPANY
CAE Project No: 6489-1

SUMMARY OF TEST RESULTS - Table 1

EPA Method 1, 2, 3, 4, 5, 6, 7 and 9
Particulate, Sulfur Dioxide, Nitrogin Oxides and Opacity
Scrubber Stack

Run No.		1	2	3	Average	
Date (1993)		April 8	April 8	April 8		
Start Time (approx.)		12:15	15:00	17:30		
Stop Time (approx.)		13:50	16:33	19:50		
Gas Conditions						
Ts	Temperature (°F)	102	101	99	101	
Bwo	Moisture (volume %)	5.30	3.90	5.30	4.83	
O_2	Oxygen (dry volume %)	19.6	18.4	18.4	18.8	
CO_2	Carbon dioxide (dry volume %)	1.0	2.0	1.8	1.6	
Volumetric Flow Rate						
Qa	Actual conditions (acfm)	82,750	85,470	85,120	84,447	
Qstd	Standard conditions (dscfm)	72,730	76,290	75,170	74,730	68,000
Particulate						
C	Concentration (gr/dscf)	0.0245	0.0072	0.0168	0.0160	0.031
E	Emission rate (lb/hr)	15.2	4.7	10.8	10.24	
E	Emission rate (tons/yr)	27.6	8.5	19.6	18.6	
Sulfur Dioxide						
C	Concentration as SO_2 (lb/dscf)	7.39E-06	5.24E-06	2.88E-06	5.17E-06	
E	Emission rate (lb/hr)	32.25	23.96	12.99	23.07	
E	Emission rate (tons/yr)	58.45	43.43	23.55	41.81	28.25 T/m
Nitrogen Oxides						
C	Concentration as NO_x (lb/dscf)	3.10E-06	2.30E-06	5.70E-06	3.70E-06	
E	Emission rate (lb/hr)	13.53	10.51	25.73	16.59	
E	Emission rate (tons/yr)	24.53	19.05	46.63	30.07	
Visible Emissions						
%	Minimum Reading	0	0	0	0	
%	Maximum Reading	35	35	25	30	
%	Total Average	15	10	10	10	

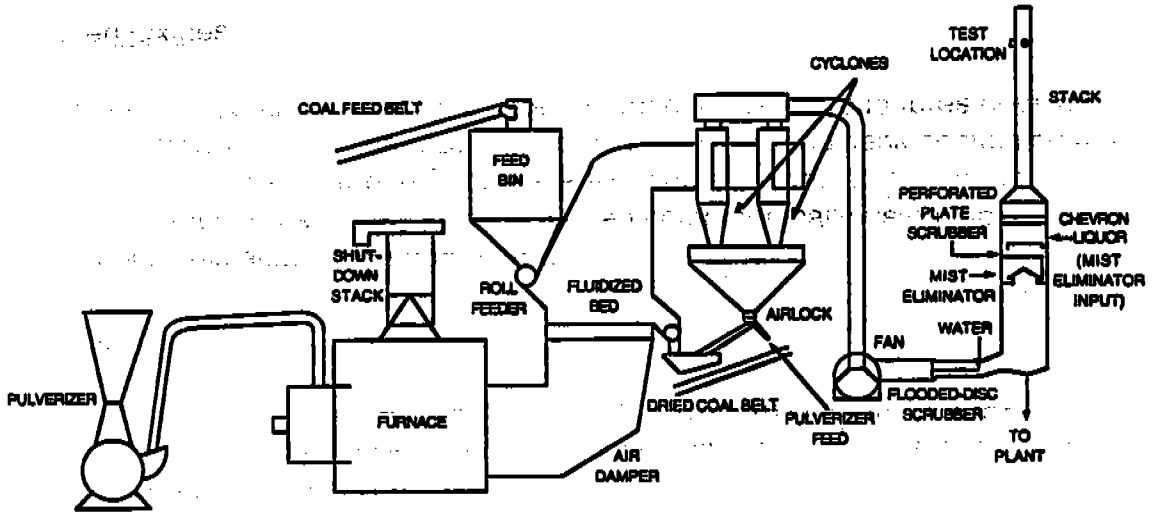
DESCRIPTION OF INSTALLATION

The Peabody Coal Company operates the Hawthorn Coal Mine located near Carlisle, Indiana. The mine is equipped with a pulverized coal fired fluidized bed thermal coal dryer with a through-put capacity of 332 tons of dried coal per hour. The coal blend used for fuel is 30% #6 seam and 70% #7 seam.

Particulate emissions are controlled by two cyclones and one venturi scrubber. SO_2 and NO_x emissions are controlled by a perforated tray scrubber using a sodium hydroxide solution as the scrubbing medium and a venturi scrubber in series.

The testing reported in this document was performed at the Scrubber Stack.

A schematic of the process is shown below.



SUMMARY OF PROCEDURES

SAMPLING PROCEDURES

The sampling followed procedures as detailed in U.S. Environmental Protection Agency (EPA) Methods 1, 2, 3, 4, 5, 6, 7 and 9. These methods are titled:

- Method 1 — "Sample and Velocity Traverses for Stationary Sources;"
- Method 2 — "Determination of Stack Gas Velocity and Volumetric Flow Rate (Type S Pitot Tube);"
- Method 3 — "Gas Analysis for the Determination of Dry Molecular Weight;"
- Method 4 — "Determination of Moisture Content in Stack Gases;"
- Method 5 — "Determination of Particulate Emissions from Stationary Sources;"
- Method 6 — "Determination of Sulfur Dioxide Emissions from Stationary Sources;"
- Method 7 — "Determination of Nitrogen Oxides Emissions from Stationary Sources (Colorimetric);"
- Method 9 — "Visual Determination of the Opacity of Emissions from Stationary Sources."

These methods appear in detail in Title 40 of the Code of Federal Regulations (CFR), Part 60, Appendix A.

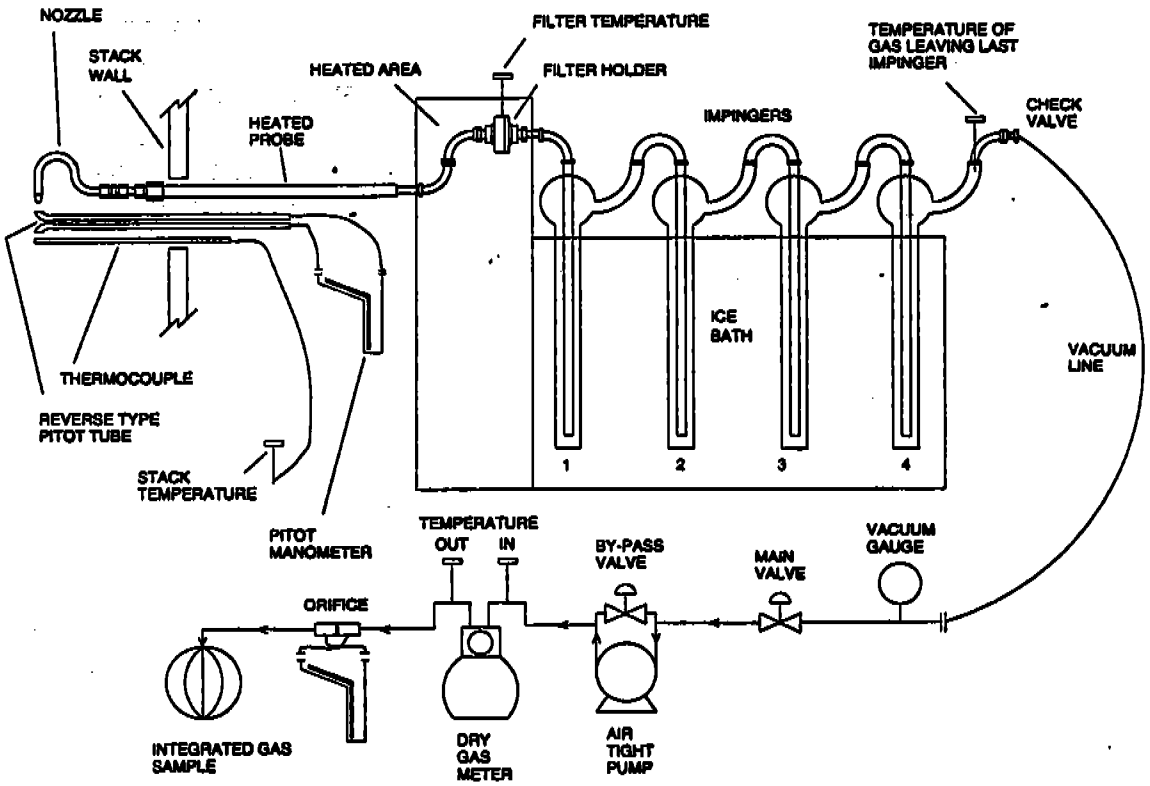
The sampling apparatus is shown in Figures 1 and 2 on pages 3-2 and 3-3. All equipment was calibrated at the Clean Air Engineering laboratory prior to shipment to the job site.

Sampling Locations

For Particulate and Sulfur dioxide sampling six points were sampled per port. The sampling time per point was five minutes for a total sampling time of sixty minutes. For Nitrogen Oxides sampling a flask was obtained at fifteen minute intervals in one port. The sampling locations are shown in Figure 3 on page 3-4.

SUMMARY OF PROCEDURES - Figure 1

The combined EPA Method 5 and 6 sampling apparatus is shown.

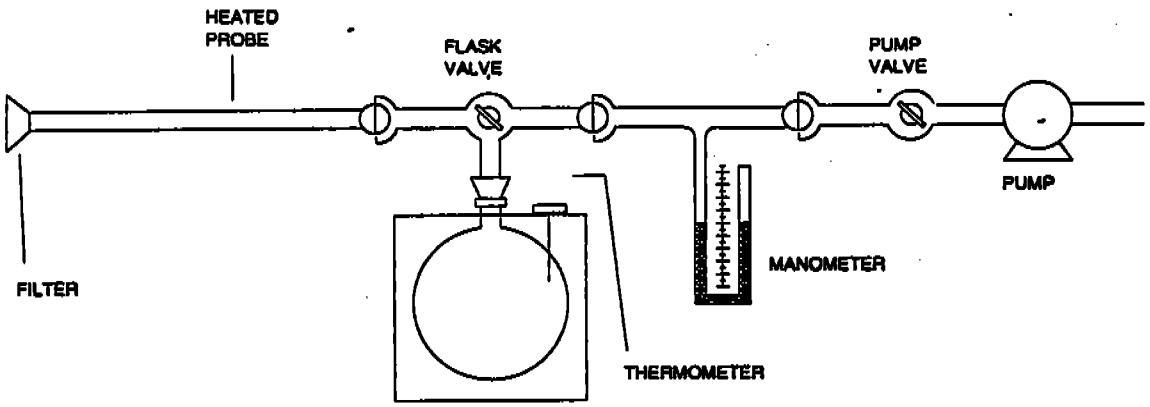


Impinger Contents

1) 80 % isopropyl alcohol, 100 ml
2) 3 % hydrogen peroxide, 100 ml
3) 3 % hydrogen peroxide, 100 ml
4) 300 g silica gel

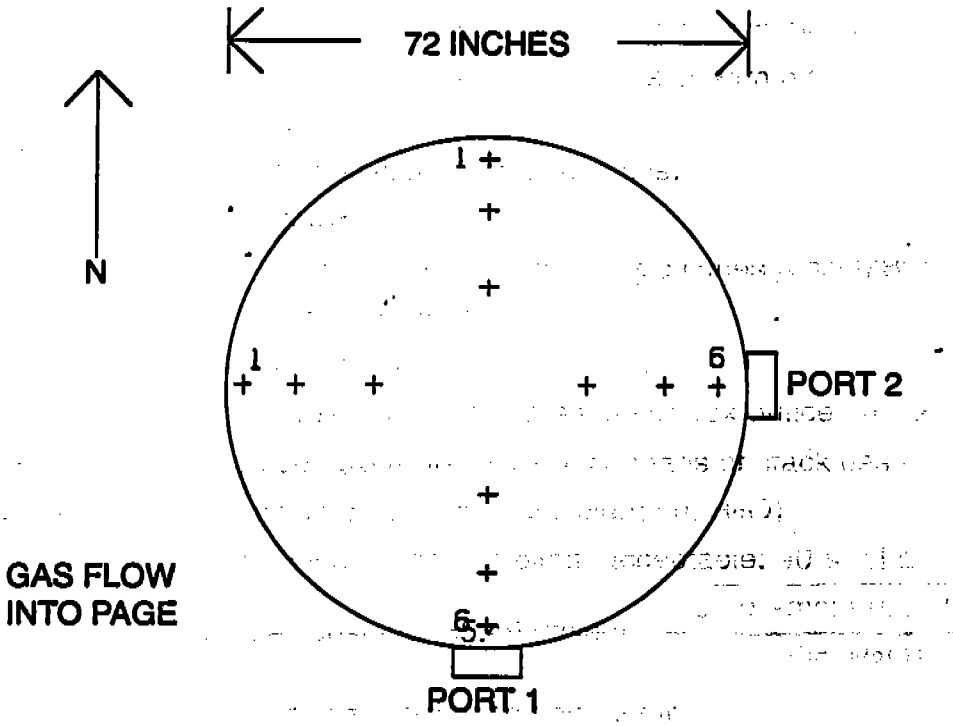
SUMMARY OF PROCEDURES - Figure 2

The EPA Method 7 sampling apparatus is shown.



SUMMARY OF PROCEDURES - Figure 3

The cross section of the Scrubber Stack shows sampling point locations.



TRAVERSE POINT	PORT TO POINT DISTANCE (IN)
1	68.8
2	61.5
3	50.7
4	21.3
5	10.5
6	3.2

SUMMARY OF PROCEDURES

ANALYTICAL PROCEDURES

Particulate

The particulate emissions were determined following procedures detailed in EPA Method 5. Particulate samples collected on Whatman 934 AH glass fiber filters were analyzed gravimetrically. The probe and nozzles were washed with acetone. The wash was transferred to tared beakers and evaporated to dryness. These weight differentials were combined to determine total particulate matter.

Sulfur Dioxide

The sulfur dioxide content was measured following the analysis by titration procedure detailed in EPA Method 6. In this procedure, the sulfur dioxide fraction is measured by barium-thorin titration.

Nitrogen Oxides

The nitrogen oxides emission rate was determined using procedures detailed in EPA Method 7. A sample was collected in an evacuated flask containing a dilute sulfuric acid - hydrogen peroxide absorbing solution. The nitrogen oxides, except nitrous oxide, were measured colorimetrically using the phenoldisulfonic acid (PDS) procedure.

Opacity

The visual opacity was determined following procedures detailed in EPA Method 9. In this procedure, a set of observations taken at 15 second intervals was averaged.

QUALITY CONTROL PROCEDURES

Quality control procedures for all aspects of field sampling; sample preservation and holding time; reagent quality; analytical method; analyst training and safety; and instrument cleaning, calibration and safety were followed. These procedures are generally consistent with EPA guidelines documented in "Quality Assurance Manuals for Air Pollution Measurement Systems," Vol 3, "Stationary Source Specific Methods" (EPA-600/4-77-027b).

COMMENTS

Sampling was stopped in the middle of all three sample runs due to clogged coal and flame outs in the unit. These problems may have had an adverse effect on the reported emission rates.

No other deviations from standard U.S. EPA testing procedures were noted.

APPENDIX

NOMENCLATURE

Nomenclature

A	-	absorbance
A_n	-	cross sectional area of nozzle (ft^2)
A_s	-	cross sectional area of stack (ft^2)
B_{wo}	-	proportion of water vapor in the gas stream by volume
B_{ws}	-	proportion of water vapor in the gas stream by volume at saturated conditions
C_p	-	pitot tube coefficient (dimensionless)
D_f	-	dilution factor
F_d	-	ratio of dry gas generated to gross calories (dscf/MBtu)
F_c	-	ratio of gas generated
GCV	-	gross calorific value of fuel (Btu/lb)
$\overline{DH}$	-	average pressure drop across meter box orifice (in. H_2O)
$\overline{\sqrt{DP}}$	-	average square roots of velocity heads of stack gas ($\sqrt{\text{in. } H_2O}$)
DH@	-	meter orifice calibration coefficient (in. H_2O)
%I	-	percent of isokinetic sampling (acceptable: $90 \le \%I \le 110\%$)
K_p	-	pitot tube constant: 85.49 (ft/sec) $\frac{\sqrt{(lb/lb-mole)(in.\ Hg)}}{\sqrt{(°R)(in\ H_2O)}}$
K_c	-	spectrophotometer calibration factor
M_d	-	dry molecular weight of stack gas (lb/lb-mole)
M_s	-	molecular weight of stack gas, wet basis (lb/lb-mole)
M_n	-	total amount of particulate matter collected (gm)
mmBtu	-	millions of British Thermal Units (Btu)
N	-	normality of titrant (meq/ml)
P_b	-	barometric pressure (in. Hg)
P_f	-	final absolute pressure of flask (in. Hg)
P_i	-	initial absolute pressure of flask (in. Hg)
P_s	-	absolute stack gas pressure (in. Hg)
Q_a	-	volumetric flow rate, actual conditions
Q_{std}	-	volumetric flow rate, standard conditions, dry basis
std	-	standard conditions, 29.92 in. Hg, 68°F
T_b	-	Filter temperature (°F)
T_c	-	Conditioner temperature (°F)

T_f	-	final absolute temperature of flask (°R)
T_m	-	average dry gas meter temperature (°F)
T_s	-	average stack temperature (°F)
T_{std}	-	absolute temperature, standard conditions (528°R)
Θ	-	total sampling time (min)
Vac.	-	Pump vacuum (in.Hg)
V_a	-	volume of aliquot (ml)
V_f	-	volume of flask (ml)
V_{lc}	-	total volume of liquid collected in impingers and silica gel (ml)
V_m	-	volume of gas sample through the dry gas meter at meter conditions (ft^3)
V_{mst}	-	volume of gas sample through the dry gas meter, standard conditions (ft^3)
V_{sc}	-	volume of flask sample, standard conditions (ml)
V_{soln}	-	total volume of solution (ml)
V_t	-	volume of titrant used to titrate aliquot (ml)
V_{tb}	-	volume of titrant used to titrate blank (ml)
V_{wstd}	-	volume of water collected, standard conditions (ft^3)
V_s	-	stack gas velocity (ft/sec)
Y_d	-	gas meter correction factor (dimensionless)

SAMPLE CALCULATIONS

ROBERTS & SCHAEFER COMPANY
CAE Project No : 6489 - 1

SAMPLE CALCULATIONS - SCRUBBER STACK, RUN 1

(Note : results are taken from computer analysis)

1. Volume of water collected

$$V_{wstd} = (0.04707\ ft^3/ml)\ (V_{lc})$$
$$= (0.04707)\ (35.6)$$
$$= 1.68\ wscf$$

2. Volume of gas metered, standard conditions

$$V_{mstd} = \frac{(17.64\ ^\circ R/in.\ Hg)\ (V_m)\left[P_b + \frac{DR}{13.6}\right]}{(460 + T_m)}(Y_d)$$
$$= \frac{(17.64)\ (30.08)\left[29.57 + \frac{0.780}{13.6}\right]}{(460 + 62)}(0.9966)$$
$$= 30.03\ dscf$$

3. Moisture content

$$B_{wo} = \frac{V_{wstd}}{V_{mstd} + V_{wstd}}$$
$$= \frac{1.68}{30.03 + 1.68}$$
$$= 0.0529$$
$$= 5.29\%$$

4. Molecular weight of dry gas stream

$$M_d = 0.44(\%CO_2) + 0.32(\%O_2) + 0.28(\%CO + \%N_2)$$
$$= 0.44(1.0) + 0.32(19.6) + 0.28(79.4)$$
$$= 28.94$$

5. Molecular weight of stack gas

$$M_s = M_d\ (1 - B_{wo}) + 18(B_{wo})$$
$$= 28.94(1 - 0.0529) + 18(0.0529)$$
$$= 28.37$$

6. Stack pressure (in. Hg)

$$P_s = P_b + \left(\frac{STATIC\ P}{13.6}\right)$$
$$= 29.57 + \left(\frac{-0.1}{13.6}\right)$$
$$= 29.56$$

ROBERTS & SCHAEFER COMPANY
CAE Project No: 6489 - 1

SAMPLE CALCULATIONS (Continued)

7. Velocity of stack gas

$$V_s = K_p C_p \overline{(DP)}^{\frac{1}{2}} \frac{[T_s + 460]^{\frac{1}{2}}}{[(M_s)(P_s)]^{\frac{1}{2}}}$$

$$= 85.49\ (0.84)\ (0.831) \frac{[102 + 460]^{\frac{1}{2}}}{[(28.37)\ (29.56)]^{\frac{1}{2}}}$$

$$= 48.87\ \text{ft/sec}$$

8. Total flow of stack gas

$$Q_a = (60)\ (A_s)\ (V_s)$$
$$= (60)\ (28.22)\ (48.87)$$
$$= 82,750\ \text{acfm}$$

$$Q_{std} = \frac{Q_a\ P_s\ (17.64\ ^\circ R/\text{in. Hg})\ (1 - B_{wo})}{T_s + 460}$$

$$= \frac{(82,750)\ (29.56)\ (17.64)\ (1 - 0.0529)}{102 + 460}$$

$$= 72,730\ \text{dscfm}$$

9. Percent Isokinetic

$$\%I = \frac{(0.09450)\ (T_s + 460)\ V_{mstd}}{P_s\ V_s\ A_n\ \Theta\ (1 - B_{wo})}$$

$$= \frac{(0.09450)\ (102 + 460)\ (30.03)}{(29.56)\ (48.87)\ (0.000191)\ (60.0)\ (1 - 0.0529)}$$

$$= 101.8\%$$

10. Particulate

$$\text{gr/dscf} = \frac{(15.43\ \text{gr/g})\ (M_n)}{V_{mstd}}$$

$$= \frac{(15.43)\ (0.0476)}{30.03}$$

$$= 0.0245$$

$$\text{lb/hr} = \frac{(\text{gr/dscf})\ (Q_{std})\ (60)}{7,000\ \text{gr/lb}}$$

$$= \frac{(0.0245)\ (72,730)\ (60)}{7,000}$$

$$= 15.2$$

SAMPLE CALCULATIONS (Continued)

10. Particulate (continued)

$$\text{tons/yr} = \frac{(\text{lb/hr})\,(3,625\ \text{hr/year})}{(2,000\ \text{lb/ton})}$$
$$= \frac{(15.2)\,(3,625)}{(2,000)}$$
$$= 27.6$$

The calculations for tons/yr of sulfur dioxide and nitrogen oxides are performed in a similar manner.

11. Sulfur dioxide

$$\text{lb/dscf} = \frac{(V_t^{30} - V_{tb})\,(N)\,(\frac{V_{soln}}{V_a})\,(K_2)}{(V_{mstd})}$$
$$= \frac{(12.6-0.05)\,(0.01005)\,(25.0)(7.061\times10^{-5}\ \text{lb/meq})}{(30.01)}$$
$$= 7.39\times10^{-6}$$

$$\text{ppm} = (\text{lb/dscf})\left(\frac{(385.3\ \text{ft}^3/\text{lb mole})(10^6)}{\text{MW}}\right)$$
$$= (7.39\times10^{-6})\frac{(385.3)(10^6)}{(64)}$$
$$= 44.44$$

$$\text{lb/hr} = (\text{lb/dscf})\,(\text{dscfm})\,(60)$$
$$= (7.39\times10^{-6})\,(72,730)\,(60)$$
$$= 32$$

12. Nitrogen oxides (Method 7), Run 1, Flask A

Sample volume at standard conditions, dry basis

$$V_{sc} = 17.64\ °\text{R/in. Hg}\,(V_f - 25)\left[\left(\frac{P_f}{T_f}\right) - \left(\frac{P_i}{T_i}\right)\right]$$
$$= 17.64\,(2,088-25)\left[\left(\frac{0.8}{70}\right)-\left(\frac{27.5}{79}\right)\right]$$
$$= 1,931$$

Total NO_2 per sample

$$\mu g = 2(K_c)\,(A)\,(D_f)$$
$$= 2\,(970.78)\,(0.070)\,(1)$$
$$= 135.9$$

ROBERTS & SCHAEFER COMPANY
CAE Project No : 6489 - 1

SAMPLE CALCULATIONS (Continued)

12. Nitrogen oxides (Method 7), Run 1, Flask A (Continued)

Sample concentration

$$lb/dscf = \frac{(6.243 \times 10^{-5} \frac{lb/scf}{\mu g/ml})(\mu g\ NO_2)}{V_{sc}}$$

$$= \frac{(6.243 \times 10^{-5})(135.9)}{1,931}$$

$$= 4.394 \times 10^{-6}$$

$$ppm = (lb/dscf)\left(\frac{(385.3\ ft^3/lb\ mole)(10^6)}{MW}\right)$$

$$= (4.394 \times 10^{-6})\frac{(385.3)(10^6)}{(46)}$$

$$= 36.80$$

$$lb/hr = (lb/dscf)(dscfm)(60)$$

$$= (4.394 \times 10^{-6})(72,730)(60)$$

$$= 19.17$$

PARAMETERS

ROBERTS & SCHAEFER COMPANY
CAE Project No: 6489-1
Scrubber Stack

SULFUR DIOXIDE PARAMETERS

Run No.		1	2	3
Date (1993)		April 8	April 8	April 8
Start Time (approx.)		12:15	15:00	17:30
Stop time (approx.)		13:50	16:33	19:50
Sampling Conditions				
O_2	Oxygen (dry volume %)	19.6	18.4	18.4
V_{mstd}	Volume metered, standard (ft^3)	30.01	48.46	48.35
Q_{std}	Volumetric flow rate, standard (dscfm)	72,730	76,290	75,170
Sulfur Dioxide				
Laboratory Data				
V_t	Volume titrant (ml)	12.55	14.35	7.90
V_{tb}	Volume blank (ml)	0.05	0.05	0.05
N	Normality of titrant (meq/ml)	0.01005	0.01005	0.01005
V_{soln}	Volume solution (ml)	500	500	500
V_a	Volume aliquot (ml)	20	20	20
Calculated Results				
C	Concentration as SO_2 (lb/dscf)	7.39E-06	5.24E-06	2.88E-06
C	Concentration as SO_2 (ppm)	44.44	31.49	17.32
E	Emission rate (lb/hr)	32.25	23.96	12.99
E	Emission rate (tons/hr)	58.45	43.43	23.55

ROBERTS & SCHAEFER COMPANY
CAE Project No: 6489-1
Scrubber Stack
April 8, 1993

NITROGEN OXIDES PARAMETERS

Pbi 29.57 in Hg Pbf 29.36 in Hg

Run	Flask	Time	Flask No.	Vf ml	Ti °F	Pi in Hg	Tf °F	Pf in Hg	Vsc ml
1	A	12:25	1	2088	79	27.5	70	0.8	1931
	B	12:40	11	2059	80	27.5	69	1.0	1922
	C	13:30	214	2019	79	27.2	70	0.4	1820
	D	13:45	8102	1944	83	27.1	70	0.0	1721
2	A	15:05	25	2091	83	27.5	74	0.2	1878
	B	15:20	91	2078	84	27.8	74	0.2	1887
	C	15:55	108	2026	84	27.4	74	0.3	1820
	D	16:10	97	2077	83	27.4	74	0.1	1852
3	A	17:40	8134	1986	84	27.4	60	0.1	1822
	B	18:15	8127	1987	84	27.5	60	0.2	1836
	C	19:10	84	2087	84	27.3	60	0.2	1916
	D	19:25	65	2042	82	27.5	60	0.3	1894

ROBERTS & SCHAEFER COMPANY
CAE Project No: 6489-1
Scrubber Stack
April 8, 1993

NITROGEN OXIDES PARAMETERS

Run	Flask	Q_{std} dscfm	A	Kc	m µg	C lb/dscf	C ppm, dry	E lb/hr	E tons/year
1	A	72,730	0.070	970.78	135.9	4.394E-06	36.80	19.17	34.8
	B	72,730	0.105	970.78	203.9	6.623E-06	55.48	28.90	52.4
	C	72,730	0.005	970.78	9.7	3.329E-07	2.79	1.45	2.6
	D	72,730	0.015	970.78	29.1	1.056E-06	8.85	4.61	8.4
Average for Run 1						3.102E-06	25.98	13.53	24.53
2	A	76,290	0.060	970.78	116.5	3.872E-06	32.43	17.72	32.1
	B	76,290	0.005	970.78	9.7	3.212E-07	2.69	1.47	2.7
	C	76,290	0.070	970.78	135.9	4.662E-06	39.05	21.34	38.7
	D	76,290	0.005	970.78	9.7	3.272E-07	2.74	1.50	2.7
Average for Run 2						2.296E-06	19.23	10.51	19.05
3	A	75,170	0.090	970.78	174.7	5.988E-06	50.16	27.01	49.0
	B	75,170	0.110	970.78	213.6	7.263E-06	60.84	32.76	59.4
	C	75,170	0.050	970.78	97.1	3.163E-06	26.49	14.26	25.9
	D	75,170	0.100	970.78	194.2	6.401E-06	53.62	28.87	52.3
Average for Run 3						5.704E-06	47.78	25.73	46.63
Average for Runs 1, 2 and 3					110.8	3.700E-06	30.99	16.59	30.07

ROBERTS & SCHAEFER COMPANY
CAE Project No: 6489-1
Scrubber Stack
April 8, 1993
Time: 12:15 - 13:43
Run 1

VISIBLE EMISSIONS PARAMETERS

	15"	30"	45"	60"
1	15	15	20	15
2	10	10	10	5
3	5	5	0	5
4	0	0	0	5
5	5	10	10	15
6	20	20	20	15
7	15	20	25	20
8	15	15	15	15
9	20	15	15	10
10	10	15	5	10
11	10	10	15	20
12	10	5	5	5
13	5	5	5	10
14	5	10	25	30
15	35	30	25	10
16	15	20	15	20
17	15	10	10	5
18	15	15	20	15
19	5	5	5	5
20	10	10	20	20
21	20	20	15	10
22	10	10	15	15
23	20	10	10	10
24	15	20	25	10
25	5	0	5	0
26	5	5	5	10
27	5	10	15	20
28	25	20	20	20
29	15	15	20	20
30	20	20	20	15

Average 15

	15"	30"	45"	60"
31	10	20	20	25
32	15	10	5	5
33	5	5	10	5
34	10	0	10	10
35	10	5	10	5
36	10	10	15	20
37	20	25	25	20
38	25	30	20	25
39	25	15	15	10
40	10	5	5	5
41	5	0	0	5
42	5	5	5	5
43	5	5	15	15
44	20	15	25	20
45	20	25	25	30
46	25	15	10	5
47	5	0	5	5
48	15	20	25	15
49	15	20	15	15
50	20	20	15	5
51	5	5	5	5
52	5	0	0	5
53	5	15	15	15
54	25	20	20	15
55	15	15	20	20
56	15	15	15	20
57	15	10	20	20
58	15	10	5	10
59	15	10	10	15
60	15	10	10	15

Average 15

Minimum Reading 0
Maximum Reading 35
Total Average 15

ROBERTS & SCHAEFER COMPANY
CAE Project No: 6489-1
Scrubber Stack
April 8, 1993
Time: 15:00 - 16:22
Run 2

VISIBLE EMISSIONS PARAMETERS

	15	30	45	60
0	15	5	5	5
1	0	5	5	5
2	10	10	5	5
3	20	20	20	25
4	25	20	25	25
5	20	20	25	20
6	10	10	15	15
7	15	10	0	0
8	0	0	5	5
9	0	0	0	5
10	15	25	20	20
11	20	20	20	20
12	25	25	25	25
13	30	25	25	15
14	5	0	0	0
15	0	5	5	5
16	0	0	0	0
17	0	0	15	20
18	30	35	25	20
19	20	20	25	15
20	30	25	15	15
21	10	25	20	5
22	5	5	5	10
23	10	15	10	5
24	0	0	0	0
25	0	0	5	5
26	5	5	0	0
27	0	5	5	10
28	0	5	5	10
29	10	0	0	0

Average 10

	15	30	45	60
30	5	0	0	0
31	5	10	10	15
32	20	20	15	25
33	20	20	25	20
34	15	10	0	10
35	15	5	5	5
36	10	10	10	0
37	5	0	0	0
38	5	5	0	0
39	0	10	10	15
40	15	10	10	5
41	15	10	15	10
42	5	10	10	10
43	5	5	5	5
44	15	5	0	0
45	10	10	5	5
46	5	0	0	0
47	5	0	5	15
48	15	20	15	10
49	5	15	15	20
50	20	20	20	25
51	20	15	15	15
52	25	30	15	15
53	15	15	5	5
54	0	0	5	5
55	10	5	5	10
56	15	20	20	15
57	25	20	25	20
58	15	10	15	20
59	15	10	10	5

Average 10

Minimum Reading 0
Maximum Reading 35
Total Average 10

ROBERTS & SCHAEFER COMPANY
CAE Project No: 6489-1
Scrubber Stack
April 8, 1993
Time: 17:30 - 19:45
Run 3

VISIBLE EMISSIONS PARAMETERS

	15"	30"	45"	60"
1	15	20	20	15
2	25	20	25	15
3	10	5	5	5
4	10	0	5	0
5	5	5	5	0
6	5	0	5	5
7	5	5	5	5
8	20	15	15	15
9	15	10	15	5
10	5	0	15	20
11	20	25	15	15
12	10	15	10	10
13	5	5	0	5
14	0	0	5	5
15	10	10	5	10
16	15	20	20	25
17	20	20	15	15
18	15	15	5	5
19	5	0	15	5
20	5	10	15	10
21	10	20	20	20
22	15	15	15	20
23	25	15	15	15
24	10	20	5	5
25	10	5	5	5
26	5	10	5	15
27	10	10	20	10
28	10	15	15	15
29	20	5	5	10
30	5	0	0	0

Average 10

	15"	30"	45"	60"
31	5	10	10	15
32	5	5	10	5
33	10	0	0	0
34	0	5	0	5
35	5	5	5	5
36	10	5	5	10
37	0	0	5	10
38	10	15	15	10
39	10	5	10	10
40	5	5	5	5
41	5	0	0	5
42	5	0	5	5
43	10	0	15	10
44	15	25	25	20
45	20	25	15	20
46	10	25	20	15
47	15	15	10	5
48	0	5	5	10
49	10	0	5	0
50	0	0	5	0
51	10	15	15	25
52	20	15	25	25
53	20	15	10	10
54	0	10	5	15
55	20	25	25	20
56	25	20	15	15
57	20	10	5	10
58	5	5	0	0
59	0	5	10	15
60	0	15	20	15

Average 10

Minimum Reading 0
Maximum Reading 25
Total Average 10

ROBERTS & SCHAEFER
CAE Project No: 6489

PARAMETERS

COAL DRYER SCRUBBER STACK

Run No.	1	2	3
A_n	.000191	.000322	.000322
A_s	28.22	28.22	28.22
B_{wo}	.0529	.0393	.0535
$\%CO_2$	1.0	2.0	1.8
C_p	.840	.840	.840
$\overline{DH}$	.780	2.28	2.23
DH@	1.702	1.702	1.702
$\overline{(DP)^{1/2}}$	.831	.863	.859
%I	101.8	92.7	93.9
M_d	28.94	29.06	29.02
M_n	.0476	.0226	.0526
M_s	28.37	28.62	28.43
$\%O_2$	19.6	18.4	18.4
P_b	29.57	29.57	29.57
P_s	29.56	29.56	29.56
θ	60.0	60.0	60.0
$\overline{T_m}$	62	68	71
$\overline{T_s}$	102	101	99
V_{lc}	35.6	42.1	58
V_m	30.08	48.94	49.12
V_{mstd}	30.03	48.42	48.32
V_s	48.87	50.48	50.27
V_{wstd}	1.68	1.98	2.73
Y_d	.9966	.9966	.9966

CALIBRATION DATA

Pyrometer Calibration Data Sheet

H.C.B.
~~Pyrometer~~ #: 66-C5 Office: PALATINE

Calibrated By: DEVIN Date: 12/30/92

Recalibration Due: 6/93 Battery Replaced: Yes (NO)

Calibration Reference Setting	Pyrometer Reading
50°F	50°F
100°F	100°F
150°F	150°F
200°F	201°F
250°F	250°F
300°F	300°F
350°F	349°F
400°F	398°F
450°F	446°F
500°F	497°F
550°F	548°F
600°F	598°F

Calibration Reference Information (from calibration seal on reference)

Reference Used: (Digimite) Other: _____

Serial Number: _____

Calibrated By: _____ Date Calibrated: _____

Calibration Report Number: _____

NOZZLE CALIBRATION DATA

CLIENT Roberts & Schafer	DATE 4/8/97
PLANT Peabody Hawthorne	CALIBRATED BY GT
UNIT NUMBER Scrubber	
RUNS 4	

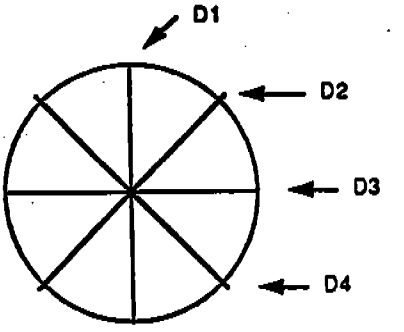
NOZZLE Identification	D1 (inches)	D2 (inches)	D3 (inches)	D4 (inches)	ΔD (inches)	ΔDavg (inches)
.187	.187	.187	.187	.187	0	.187
.250	.242	.244	.243	.243	.002	.243

Where:

D1, D2, D3, D4 = four nozzle diameter measurements

ΔD = maximum difference between any two diameters $\Delta D \leq 0.004$ inches

ΔDavg = average of D1, D2, D3, D4



Date: 4.16.1912 Operator: K

Meter Box No.: 66-1	Meter Box ΔH@: 1.7018	Meter Box Yd: 0.9966	Barometric Pressure: 29.35-15

				Standard Meter Gas Volume ft³			Meter Box Gas Volume ft³			Std. Meter Temperature °F			Meter Box Temperature °F					
Q	ΔH	ΔP	Yds	Initial	Final	Vds Net	Initial	Final	Vds Net	In	Out	Tds Avg	In	Out	Tds Avg	Time 0	Yd	ΔH@
.40	.5	-2.9	1.000	Ø	5.004	5.004	069.262	074.538	5276	68	68	68	110	94	102	12.11	1.0009	1.5689
.40	.5	-2.9	1.000	Ø	5.003	5.003	074.538	079.800	5.262	68	68	68	109	95	92	12.10	1.0025	1.5683
.65	1.5	-3.3	1.000	Ø	10.003	10.003	115.649	126.264	10.615	70	70	70	120	94	107	14.73	.9963	1.7509
.65	1.5	-3.3	1.000	Ø	10.005	10.005	126.264	136.849	10.585	70	70	70	118	94	106	14.73	.9972	1.7547
.92	3.0	-3.7	1.000	Ø	10.008	10.008	032.823	043.487	10.664	68	68	68	124	92	108	10.60	.9927	1.7840
.92	3.0	-3.7	1.000	Ø	10.008	10.008	042.487	054.196	10.709	68	68	68	124	94	109	10.61	.9903	1.7842

Nomenclature

Pb	Barometric Pressure
Q	Flow Rate (cfm)
ΔH	Orifice Pressure Differential ("H_2O)
ΔP	Inlet Pressure Differential ("H_2O)
Vd	Volume Dry Gas Meter (ft^3)
Vds	Volume Dry Standard (ft^3)
Yd	Meter Correction Factor (unitless)
Yds	Standard Meter Correction Factor (unitless)
ΔH@	Orifice Pressure Differential that gave 0.75 cfm of air at 70°F and 29.92 "Hg ("H_2O)

Calculations

$$Yd = (Yds)\left[\frac{Vds}{Vd}\right]\left[\frac{Td + 460}{Tds + 460}\right]\left[\frac{Pb + \Delta P/13.6}{Pb + \Delta H/13.6}\right]$$

$$\Delta H@ = \frac{0.0317\,\Delta H}{Pb(Td + 460)}\left[\frac{(Tds + 460)0^2}{(Vds)(Yds)}\right]$$

$$Q = \frac{17.64\,(Vds)(Pb)}{(Tds + 460)0}$$

Vacuum Gauge Calibration

Standard (Hg)	Vacuum Gauge
5	5.1
10	10.3
15	15.2
20	20.5
25	25.3
26 MAX	26.4

Thermometer Calibration

Standard	Inlet	Outlet
32	32	32
50	50	50
70	70	70
120	120	120
150	150	150
200	200	200

POST TEST CALIBRATION CHECK

Client/Owner: _____ Project Number: _____

Operator: M. KUBERA Date: 4-12-93

Meter Box No.: 66-1	Meter Box Vacuum: 2.5	Meter Box Yd: 0.9966	Barometric Press.: 29.41

				Standard Meter Gas Volume ft^3			Meter Box Gas Volume ft^3			Std. Meter Temperature °F			Meter Box Temperature °F					
Q	ΔH	ΔP	Yds	Initial	Final	Vds Net	Initial	Final	Vd Net	In	Out	Tds Avg	In	Out	Td Avg	Time θ	Yd	ΔH@
0.67	1.5	-3.4	1.0000	0	10.004	10.004	605.430	615.415	9.985	67	67	67	96	76	86	14.59	1.0253	1.7492
0.67	1.5	-3.4	1.0000	0	10.126	10.126	615.415	625.629	10.214	67	67	67	102	82	92	14.87	1.0257	1.7542
0.67	1.5	-3.4	1.0000	0	10.004	10.004	625.629	635.787	10.158	67	67	67	104	86	95	14.69	1.0245	1.7445

Nomenclature

Pb	Barometric Pressure
Q	Flow Rate (cfm)
ΔH	Orifice Pressure Differential ("H_2O)
ΔP	Inlet Pressure Differential ("H_2O)
Vd	Volume Dry Gas Meter (ft^3)
Vds	Volume Dry Standard (ft^3)
Yd	Meter Correction Factor (unitless)
Yds	Standard Meter Correction Factor (unitless)
ΔH@	Orifice Pressure Differential that gave 0.75 cfm of air at 70° F and 29.92 "Hg ("H_2O)

Calculations

$$Yd = (Yds)\left[\frac{Vds}{Vd}\right]\left[\frac{Td + 460}{Tds + 460}\right]\left[\frac{Pb + \Delta P/13.6}{Pb + \Delta H/13.6}\right]$$

$$\Delta H@ = \frac{0.0317\,\Delta H}{Pb\,(Td + 460)}\left[\frac{(Tds + 460)\,\theta}{(Vds)\,(Yds)}\right]^2$$

$$Q = \frac{17.64\,(Vds)\,(Pb)}{(Tds + 460)\,\theta}$$

WEIGHT SHEETS

Particulate Testing
Weight Sheet

Client Roberts & Schafer	Project Number 66-6489	Analyst J.V. - JLP
Plant	Unit Stack	Balance GA200D | GA110
Test Date 4/8/93		

Description	Wt. No.	I.D. and Sample Description[1]	Sample volume (ml)[2]	Date/ Time	Gross Weight (g)	Tare Weight (g)	Date/ Time	Net Weight (g)
Type Filter	1	#20612		4/6 8:55	.3908	.3410	3/4 1550	
Run Blank		CLEAN		4/21 1535	.3410			
Location Stack		26314-01	T (F) B		.3409	.3410		.0001
Type Filter	3	#20429		4/6 900	.3553	.3392	10/23 0940	
Run 1-Comp		Dark Black Part		4/21 1535	.3553			
Location Stack		26314-03	T (F) B		.3553	.3392		.0161
Type Filter	4	#20434		4/6 900	.3500	.3385	10/23 0940	
Run 2-Comp		Dark Black Part		4/21 1535	.3499			
Location Stack		26319-04	T (F) B		.3500	.3385		.0115
Type Filter	5	#20433		4/6 905	.3589	.3404	10/23 0940	
Run 3-Comp		Dark Black Part.		4/21 1540	.3593			
Location Stack		26314-05	T (F) B		.3591	.3404		.0187
Type Acetone	6	F67	75	4/6 8:40	122.6989	122.6989	4/19 1600	
Run Blank-Sp#19		CLEAN		4/21 1545	122.6985			
Location Stack		26314-06	T F (B)		122.6985	122.6984		.0001
Type F1/2 Ace	8	K8	80	4/21 8:50	90.6624	90.6309	4/19 1030	
Run 1-Comp		Black/Brown Part.		4/21 1540	90.6625			
Location Stack		26314-08	T F (B)		90.6625	90.6309		.0316
Type F1/2 Ace	9	T90	80	4/21 845	109.3978	109.3864	4/19 1025	
Run 2-Comp		Black/Brown Particle		4/21 1540	109.3973			
Location Stack		26314-09	T F (B)		109.3978	109.3864		.0112
Type F1/2 Ace	10	X95	90	4/21 8:40	110.1422	110.1081	4/19 955	
Run 3-Comp		Brown Particle		4/21 1545	110.1419			
Location Stack		26314-10	T F (B)		110.1421	110.1081		.0340

[1] Note appearance of particulate
[2] Two volumes (e.g. 500/100) indicate an aliquot was taken.
Indicate (T)himble, (F)ilter, or (B)eaker in box below.

CAE Project # 64891

WEIGH SHEET # 1 AS ENTERED

R D S	R U N	W T #	IDENTIFIER	F B T	WASH ML	CORR.	GROSS	TARE	NET
		1	BLANK	B	75	0.0000	122.6985	122.6984	0.0001
		2	X68	B	90	0.0001	123.3278	123.2926	0.0351
01	1	3	K8	B	80	0.0001	90.6625	90.6309	0.0315
02	2	4	T90	B	80	0.0001	109.3976	109.3864	0.0111
03	3	5	X95	B	90	0.0001	110.1421	110.1081	0.0339
		6	20431	F	----	------	0.3568	0.3403	0.0165
01	1	7	20429	F	----	------	0.3553	0.3392	0.0161
02	2	8	20434	F	----	------	0.3500	0.3385	0.0115
03	3	9	20433	F	----	------	0.3591	0.3404	0.0187

CAE Project #, 64891

ALL WEIGHTS SORTED BY RDS

R D S	R U N	S H #	W T #	IDENTIFIER	F B T	WASH ML	CORR.	GROSS	TARE	NET
		1	1	BLANK	B	75	0.0000	122.6985	122.6984	0.0001
01	1	1	3	K8	B	80	0.0001	90.6625	90.6309	0.0315
01	1	1	7	20429	F	----	------	0.3553	0.3392	0.0161
				RDS TOTAL						0.0476
02	2	1	4	T90	B	80	0.0001	109.3976	109.3864	0.0111
02	2	1	8	20434	F	----	------	0.3500	0.3385	0.0115
				RDS TOTAL						0.0226
03	3	1	5	X95	B	90	0.0001	110.1421	110.1081	0.0339
03	3	1	9	20433	F	----	------	0.3591	0.3404	0.0187
				RDS TOTAL						0.0526
		1	2	X68	B	90	0.0001	123.3278	123.2926	0.0351
		1	6	20431	F	----	------	0.3568	0.3403	0.0165
		1	10	END	-	----	------	0.0000	0.0000	0.0000

FIELD DATA

Particulate Testing Field Data Sheet

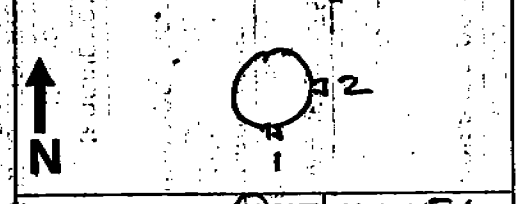
Location: STACK Run: 8-comp

Page 1 of 1

Client R&S	Project Number 6487
Plant Peabody	Unit SCRUBBER
Date 4/6/93	Inlet/outlet/(stack)
Meter Operator GT	
Probe Operator GT/MP	

Sample Box Number 6	Pyrometer Number 66-C5
Meter Box Number 66-1	
Meter ΔH@ 1.7018	Meter Yd .9966
K Factor 3.03	Pitot Cp .84
Pitot Leak Check: Before ✓	After ✓
Leak Rate Before .008 CFM @ 15 "Hg	
Leak Rate After .007 CFM @ 13 "Hg	
Static Pressure (inches H_2O) (+/-) .1	

Schematic of Testing Location



First point all the way (IN) OUT	Method 5,6	
Area (ft^2) 28.22	Port Len. (in.) 4	Gas Flow (IN) OUT

Filter Number	30434
Thimble Number	N/A
Beaker Number	—

Ambient Temp. (°F) 50	Bar. Press. (in. Hg) 29.57
Assumed Moisture (%) 6	

Heater Box Setting 250	Probe Heater Setting 250
Probe Length 6'	Probe Number N-2-92-1
Probe Material S.S.	Acetone Number SP#19
Nozzle Diameter (in.) .243	Nozzle Number 25

IGS Bag ID Number	R2-6
% O_2 18.4	% CO_2 2.0
H_2O (ml) 14	Silica Gel (gm) 26.1
Total Vlc 42.1	(42.1) ✓

Start Time 1500 AM / (PM)	Stop Time 1633 AM / PM

Traverse Point Number	Min/pt 5 Clock time	Pump Vacuum (in. Hg)	Stack Temp. Ts (°F)	Velocity Head ΔPs	Orifice Setting ΔH (in.H_2O)	Initial Volume 463.00 Gas Sample Volume Vm (ft^3)	Gas Sample Temperature at Dry Gas Meter: Inlet Tm in (°F)	Outlet Tm out (°F)	Cond. Temp. Tc (°F)	Filter Temp. Tf (°F)	Probe Temp. (°F)	Notes
1-1	5	6	99	.68	2.1	466.965	64	62	40	252	249	
2	10	7	103	.88	2.7	471.43	68	62	41	247	249	
3	15	7	100	.90	2.7	475.88	71	63	41	241	250	
4	20	7	99	.87	2.5	480.195	73	63	41	249	250	
5	25	6.5	99	.79	2.4	484.36	74	64	42	245	250	
6	30	6	98	.70	2.1	488.29	75	65	42	246	250	← stopped test at 25:44 due to flame out in dryer
a-1	35	5	105	.52	1.6	491.76	65	63	41	247	250	
2	40	5	100	.65	2.0	495.61	69	64	42	247	250	
3	45	6	105	.62	1.9	499.37	52	64	42	249	250	restart at 1550
4	50	7.5	103	.80	2.4	503.58	76	64	42	253	250	
5	55	8	101	.86	2.6	507.785	82	66	43	259	250	
6	60	7.5	103	.77	2.3	511.94	85	67	44	250	250	
Total					2.215							
Average			102	.863	2.44	48.94	68					

C.T.

CAE P2 ver. 1.0
D:\vpforms\m5data-1

Particulate Testing Field Data Sheet

Page 1 of 1

Location: STACK **Run:** 3 - COMP

Client R & S	Project Number 6489
Plant Peabody	Unit Scrubber
Date 4/8/93	Inlet/outlet/(stack)
Meter Operator GT	
Probe Operator GT/MP	

Sample Box Number 6	Pyrometer Number 66-C5
Meter Box Number 66-1	
Meter ΔH@ 1.7018	Meter Yd .9966
K Factor 3.03	Pitot Cp .84
Pitot Leak Check: Before ✓	After ✓
Leak Rate Before .005 CFM @ 15 "Hg	
Leak Rate After .003 CFM @ 13 "Hg	
Static Pressure (inches H_2O) (+/-) .1	

Schematic of Testing Location

First point all the way IN OUT		Method 5,6
Area (ft^2) 28.22	Port Len. (in.) 4	Gas Flow IN (OUT)

Filter Number	20433	
Thimble Number	N/A	
Beaker Number	—	

Ambient Temp. (°F) 50	Bar. Press. (in. Hg) 29.57
Assumed Moisture (%) 6	

Heater Box Setting 250	Probe Heater Setting 250
Probe Length 8'	Probe Number 16-2-92-1
Probe Material SS	Acetone Number SP # 19
Nozzle Diameter (in.) .243	Nozzle Number .25

IGS Bag ID Number R3-COMP	
% O_2 18.4	% CO_2 1.8
H_2O (ml) 53	Silica Gel (gm) 25
Total Vlc 58 ✓	

Start Time 1700 AM / (PM) Stop Time 1750 AM / (PM)

Traverse Point Number	Min/pt 5 / Clock time	Pump Vacuum (in. Hg)	Stack Temp. T_s (°F)	Velocity Head ΔP_s	Orifice Setting ΔH (in.H_2O)	Initial Volume 526.93 / Gas Sample Volume V_m (ft^3)	Gas Sample Temperature at Dry Gas Meter: Inlet $T_{m\,in}$ (°F)	Outlet $T_{m\,out}$ (°F)	Cond. Temp. Tc (°F)	Filter Temp. Tf (°F)	Probe Temp. (°F)	Notes
1-1	5	6.5	101	.73	2.2	~~531.05~~	66	65	42	248	250	
2	10	7	101	.80	2.4	535.29	76	66	43	247	249	
3	15	7.5	99	.88	2.5	539.70	82	66	43	248	250	← stopped at
4	20	7	98	.72	2.2	543.68	72	66	43	260	250	1.2:20 clear
5	25	7.5	100	.79	2.4	547.99	80	68	44	248	245	to clogged
6	30	7	95	.73	2.2	552.02	74	67	45	247	249	← shooting
2-1	35	6	97	.57	1.7	555.62	74	66	45	246	245	restart at 1810
2	40	6	99	.61	1.8	559.32	77	67	44	240	24[illegible]	← stopped at
3	45	7.5	99	.70	2.1	563.38	78	67	45	243	247	21:36 dark to plant
4	50	8.5	99	.80	2.4	567.55	79	66	46	248	244	restart 1905
5	55	8.5	100	.80	2.4	571.78	80	66	46	248	248	
6	60	8.5	99	.80	2.4	576.05	79	66	46	249	250	
Total												
Average			99	.851	2.215	49.12	71					

CAE P2 ver. 1.0
D:\vpforms\m5data-1

Nitrogen Oxide Testing

Raw Data Set

Client/owner Roberts @ Schaffer

Plant B Peabody Coal

City CARLISLE State IND

CAE Project No 6489

Sampling location OUTLET / STACK

Sampling by MAx Phillips

Recovery by MAx Phillips / GT

Sampling Data

Date 4/6/93 Bar. Press. 29.57

Run #	Flask #	Vol ml	Time	Probe Temp	Vacuum Leg A1	Vacuum Leg B1	Vacuum P1	Flask Temp	O2	CO2	BWO
1	1		12:25	246	14.8	12.7	27.5	79			
1	11		12:40	248	14.8	12.7	27.5	80			
1	21A		1:30	250	14.7	12.5	27.2	79			
1	8102		1:45	253	14.6	12.5	27.1	83			
2	Z5		3:05	256	14.9	12.6	27.5	83			
2	91		3:20	254	14.8	13.0	27.8	84			
2	108		3:55	252	14.6	12.8	27.4	84			
2	97		4:10	254	14.7	12.7	27.4	83			
3	8134		5:40	258	14.6	12.8	27.4	84			
3	8127		6:15	256	14.5	13.0	27.5	84			
3	84		7:10	253	14.5	12.8	27.3	84			
3	65		7:25	252	14.5	13.0	27.5	82			

Run 1 STOP at Restart at 1425

Run 2 STOP at 3:30pm

Run 3 STOP at 5:42pm Restart at 6:10pm

Plant ...

Sample Recovery Data

Date 4/6/93 Press. 29.36

Time	Final Press. Leg A1	Leg B1	P1	Flask Temp	pH adj.
7:55	.4	.4	.8	70	yes
7:57	.5	.5	1.0	69	yes
7:59	.2	.2	.4	70	yes
8:00	0	0	0	70	yes
8:32	.1	.1	.2	74	yes
8:34	.1	.1	.2	74	yes
8:35	-.2	.1	.3	74	yes
8:37	0	.1	.1	74	yes
1617	.1	0	.1	60	yes
1625	0	.2	.2	60	yes
1619	0	.2	.2	60	yes
1617	.3	0	.3	60	yes

FIELD DATA PRINTOUTS

RAW DATA SET # 1

1)	Plant	HAWTHORNE MINE	17)	Heater Box Setting	
2)	Location	SCRUBBER STACK	18)	Probe Length',' Ft.	
3)	Operator	G. TUMBALI	19)	Nozzle Diameter',' In.	0.187
4)	Date	4/8/93	20)	Probe Heater Setting	
5)	Run No.	1	21)	% O2	19.6
6)	Sample Box No.	6	22)	% CO2	1.0
7)	Meter Box No.	66-1	23)	Ml. H2O	26.0
8)	Meter H@	1.7018	24)	GM. Silica Gel	9.6
9)	K Factor	1.12	25)	Total	35.6
10)	Pitot Factor	0.84	26)	Start Time	12:15 PM
11)	Leak Rate Before	0.012@15	27)	Finish Time	1:50 PM
12)	Leak Rate After	0.004@07	28)	Yd.	0.9966
13)	Static Pres., in H2O	-0.10	29)	Stack Area	28.22
14)	Ambient Temperature	60	30)	Sampling Time (MIN/PT)	5
15)	Barometric Pressure	29.57	31)	Initial Volume	423.40
16)	Assumed Moisture, %		32)	FILTER & BEAKER #'S	K8B
				20429F	

Pt. #	0	Vac.	Ts	DPs	DH	Vm	Tm in	Tmout	Tc	Tb	%I
0 - 0						423.40					G. TUMBALI
1 - 1	5	3.0	105	0.68	0.76	425.84	60	62	47	255	99.9
1 - 2	5	3.5	101	0.82	0.92	428.57	64	63	47	238	101.0
1 - 3	5	3.5	105	0.75	0.84	431.15	64	63	48	247	100.1
1 - 4	5	3.0	103	0.70	0.78	433.65	64	63	49	248	100.2
1 - 5	5	3.5	101	0.75	0.84	436.22	62	62	49	238	99.7
1 - 6	5	3.0	100	0.66	0.74	438.66	61	61	49	263	101.0
2 - 1	5	3.0	98	0.52	0.58	440.84	58	59	49	255	101.9
2 - 2	5	3.0	103	0.54	0.60	443.04	60	60	50	262	101.1
2 - 3	5	3.5	100	0.65	0.73	445.45	62	60	50	242	100.5
2 - 4	5	3.5	100	0.70	0.78	447.96	63	61	51	244	100.7
2 - 5	5	4.0	102	0.81	0.91	450.65	64	61	51	249	100.4
2 - 6	5	4.0	106	0.75	0.84	453.48	64	61	51	250	110.1 *
	60		102	.831	.78	30.08		62			
	Total		Avg.	Root	Avg.	Volume		Avg.			

RAW DATA SET # 2

1) Plant	HAWTHORNE MINE	17) Heater Box Setting	
2) Location	SCRUBBER STACK	18) Probe Length',' Ft.	
3) Operator	G. TUMBALI	19) Nozzle Diameter',' In.	0.243
4) Date	4/8/93	20) Probe Heater Setting	
5) Run No.	2	21) % O2	18.4
6) Sample Box No.	6	22) % CO2	2.0
7) Meter Box No.	66-1	23) Ml. H2O	16.0
8) Meter H@	1.7018	24) GM. Silica Gel	26.1
9) K Factor	3.03	25) Total	42.1
10) Pitot Factor	0.84	26) Start Time	3:00 PM
11) Leak Rate Before	0.008@15	27) Finish Time	4:33 PM
12) Leak Rate After	0.007@13	28) Yd.	0.9966
13) Static Pres., in H2O	-0.10	29) Stack Area	28.22
14) Ambient Temperature	50	30) Sampling Time (MIN/PT)	5
15) Barometric Pressure	29.57	31) Initial Volume	463.00
16) Assumed Moisture, %		32) FILTER & BEAKER #'S	T90B 20434F

Pt. #	0	Vac.	Ts	DPs	DH	Vm	Tm in	Tmout	Tc	Tb	%I	
0 - 0						463.00					G. TUMBALI	
1 - 1	5	6.0	99	0.68	2.10	466.97	64	62	40	252	94.7	
1 - 2	5	7.0	103	0.88	2.70	471.43	68	62	41	247	93.7	
1 - 3	5	7.0	100	0.90	2.70	475.88	71	63	41	241	91.8	
1 - 4	5	7.0	99	0.82	2.50	480.20	73	63	41	249	93.1	
1 - 5	5	6.5	99	0.79	2.40	484.36	74	64	42	245	91.1	
1 - 6	5	6.0	98	0.70	2.10	488.29	75	65	42	246	91.1	
2 - 1	5	5.0	105	0.52	1.60	491.76	65	63	41	247	94.9	
2 - 2	5	5.0	100	0.65	2.00	495.61	69	64	42	247	93.4	
2 - 3	5	6.0	105	0.62	1.90	499.37	72	64	42	249	93.5	
2 - 4	5	7.5	103	0.80	2.40	503.58	76	64	42	253	91.8	
2 - 5	5	8.0	101	0.86	2.60	507.79	82	66	43	258	87.8	*
2 - 6	5	7.5	103	0.77	2.30	511.94	85	67	44	250	91.2	
	60		101	.863	2.28	48.94		68				
	Total		Avg.	Root	Avg.	Volume		Avg.				

RAW DATA SET # 3

1) Plant	HAWTHORNE MINE	17) Heater Box Setting	
2) Location	SCRUBBER STACK	18) Probe Length',' Ft.	
3) Operator	G. TUMBALI	19) Nozzle Diameter',' In.	0.243
4) Date	4/8/93	20) Probe Heater Setting	
5) Run No.	3	21) % O2	18.4
6) Sample Box No.	6	22) % CO2	1.8
7) Meter Box No.	66-1	23) Ml. H2O	33
8) Meter H@	1.7018	24) GM. Silica Gel	25
9) K Factor	3.03	25) Total	58
10) Pitot Factor	0.84	26) Start Time	5:30 PM
11) Leak Rate Before	0.005@15	27) Finish Time	7:50 PM
12) Leak Rate After	0.003@13	28) Yd.	0.9966
13) Static Pres., in H2O	-0.10	29) Stack Area	28.22
14) Ambient Temperature	50	30) Sampling Time (MIN/PT)	5
15) Barometric Pressure	29.57	31) Initial Volume	526.93
16) Assumed Moisture, %		32) FILTER & BEAKER #'S 20433F	X95B

Pt. #	0	Vac.	Ts	DPs	DH	Vm	Tm in	Tmout	Tc	Tb	%I
0 - 0						526.93					G. TUMBALI
1 - 1	5	6.5	101	0.73	2.20	531.05	66	65	42	248	95.7
1 - 2	5	7.0	101	0.80	2.40	535.27	76	66	43	247	92.7
1 - 3	5	7.5	99	0.82	2.50	539.70	82	66	43	248	95.5
1 - 4	5	7.0	98	0.72	2.20	543.68	72	66	43	260	92.2
1 - 5	5	7.5	100	0.79	2.40	547.99	80	68	44	248	94.7
1 - 6	5	7.0	95	0.73	2.20	552.02	74	67	45	247	92.2
2 - 1	5	6.0	97	0.57	1.70	555.62	74	66	45	246	93.4
2 - 2	5	6.0	99	0.61	1.80	559.32	77	67	44	240	92.6
2 - 3	5	7.5	99	0.70	2.10	563.32	78	67	45	243	93.5
2 - 4	5	8.5	99	0.80	2.40	567.55	79	66	46	248	92.5
2 - 5	5	8.5	100	0.80	2.40	571.78	80	66	46	248	92.5
2 - 6	5	8.5	99	0.80	2.40	576.05	79	66	46	249	93.4
	60		99	.859	2.23	49.12		71			
	Total		Avg.	Root	Avg.	Volume		Avg.			

LABORATORY DATA

Method 6
SO_2 Analysis / Calculations

Client Roberts & Schafer	Project Number 6489	Analyst PM
Plant Peabody Coal	Unit M6 Stack	Date 4/13/93

Calculations

Standardize Titrant

Normality of Titrant (N) = $\frac{\text{(Normality } H_2SO_4 \text{ Standard) x (ml } H_2SO_4 \text{ Standard)}}{\text{(ml Titrant)}}$

$N = \frac{.02 \times 10}{19.9} = .01005$

Volume Metered Standard

$F_d = 9780$

$$V_{msid} = (17.64)\ (Y_d)\ (V_m) \times \frac{P_b + \frac{\Delta H}{13.6}}{(T_m + 460)}$$

SO_2 Concentration

$$\text{Concentration (lb/dscf)} = 7.061 \times 10^{-5} \times \frac{(V_t - V_{tb})\ N \left(\frac{V_{soln}}{V_a}\right)}{V_{msd}}$$ (32.63)

$$\text{Concentration (lb/Mbtu)} = \frac{\text{lb/dscf} \times F_d \times 20.9}{20.9 - \%O_2}$$

$$\text{Concentration (ppm)} = 6.016 \times 10^6 \times \text{lb/dscf}$$

Analysis						Results				
Run No.	V_{soln}	V_a	Trial 1 (ml)	Trial 2 (ml)	Avg(vt)	$\%O_2$	V_{msd}	lb/dscf PM	lb/MBtu	ppmd
Run 1 C	500	20	12.5	12.6	12.55		30.01	7.09×10^{-4}		42.68
Run 2 C	500	20	14.4	14.3	14.35		48.46	5.24×10^{-4}		31.49
Run 3 C	500	20	7.9	7.9	7.9		48.35	2.88×10^{-4}		17.33
								mg/dscm		Actual
Audit: 9932	100	20	14.9	14.9	14.9		21×10^{-3}	1138		1150
Audit:										
Standard	.020	10	19.9	19.9	19.9					
Blank (V_{ib})	500	20	.05	.05	.05					
Blank (V_{tb})	IPA	20	0	0	0					

CUSTOMER:	ROBERTS & SCHAEFER COMPANY		
SAMPLE TYPE:	Liquid	DATE RECIEVED:	4/13/93
PARAMETERS:	NO_x	JOB NUMBER:	6489-1
DETECTION LIMIT:	0.005	DATE REPORTED:	4/29/93

COLORIMETRIC RESULTS

Audit No:	3831
Lot No:	0498
Audit Actual mg/dscm	100
Audit mg/dscm	97.1
%Error	2.9

Standard (µg)	Absorbance
0	0.00
100	0.10
200	0.21
300	0.31
400	0.41

K_c 970.78

Lab Sample ID	Client Sample ID	Sample Description	Absorbance	Total NO_x (µg)
26314-24	1	Run 1 Flask A	0.07	135.9
26314-24	11	Run 1 Flask B	0.105	203.9
26314-24	214	Run 1 Flask C	0.005	9.7
26314-24	8102	Run 1 Flask D	0.015	29.1
26314-25	25	Run 2 Flask A	0.06	116.5
26314-25	91	Run 2 Flask B	0.005	9.7
26314-25	108	Run 2 Flask C	0.07	135.9
26314-25	97	Run 2 Flask D	0.005	9.7
26314-26	8136	Run 3 Flask A	0.09	174.7
26314-26	8127	Run 3 Flask B	0.11	213.6
26314-26	84	Run 3 Flask C	0.05	97.1
26314-26	65	Run 3 Flask D	0.1	194.2

Analyst: Paul McGary - EC

Paul McGary
Analyst

Reviewed By:

STATISTICAL ANALYSIS

STATISTICAL ANALYSIS HAWTHORNE MINE

LOCATION - SCRUBBER STACK

RUN	DATE OF RUN	AVERAGE SQ. RT. VEL PRES	AVERAGE TEMP	STANDARD DEVIATION SQ. RT. VEL PRES	STANDARD DEVIATION TEMP	VARIANCE SQ. RT. VEL PRES	VARIANCE TEMP	RMS DEVIAT SQ. RT. VEL PRES
1	4/8/93	0.831	102.0	0.058	2.4	0.003	6.0	6.921
2	4/8/93	0.863	101.3	0.069	2.5	0.005	6.0	7.970
3	4/8/93	0.859	98.9	0.048	1.7	0.002	2.8	5.619

CHAIN OF CUSTODY