

Note: This is a reference cited in AP 42, *Compilation of Air Pollutant Emission Factors, Volume I Stationary Point and Area Sources*. AP42 is located on the EPA web site at [www.epa.gov/ttn/chief/ap42/](http://www.epa.gov/ttn/chief/ap42/)

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AP-42 Section	<u>11.10</u>
Reference	<u>19</u>
Report Sect.	_____
Reference	_____

# COAL PREPARATION PLANT EMISSION TESTS

EPA TEST NO. 72-CI-13

FINAL

TEST NO. 1281-15

EASTERN ASSOCIATES COAL COMPANY

Keystone, West Virginia

PREPARED FOR

ENVIRONMENTAL PROTECTION AGENCY

Research Triangle Park

North Carolina 27711

Contract No 68-02-0233



**SCOTT RESEARCH LABORATORIES, INC.**

PLUMSTEADVILLE, PENNSYLVANIA 18949

Test No. 1281-15

Eastern Associates Coal Company  
Keystone, West Virginia, Norman R. Troxel

SCOTT RESEARCH LABORATORIES, INC.  
Plumsteadville, Pennsylvania 18949  
68-02-0233



SRL 1281 15 0372

## 1.0 INTRODUCTION

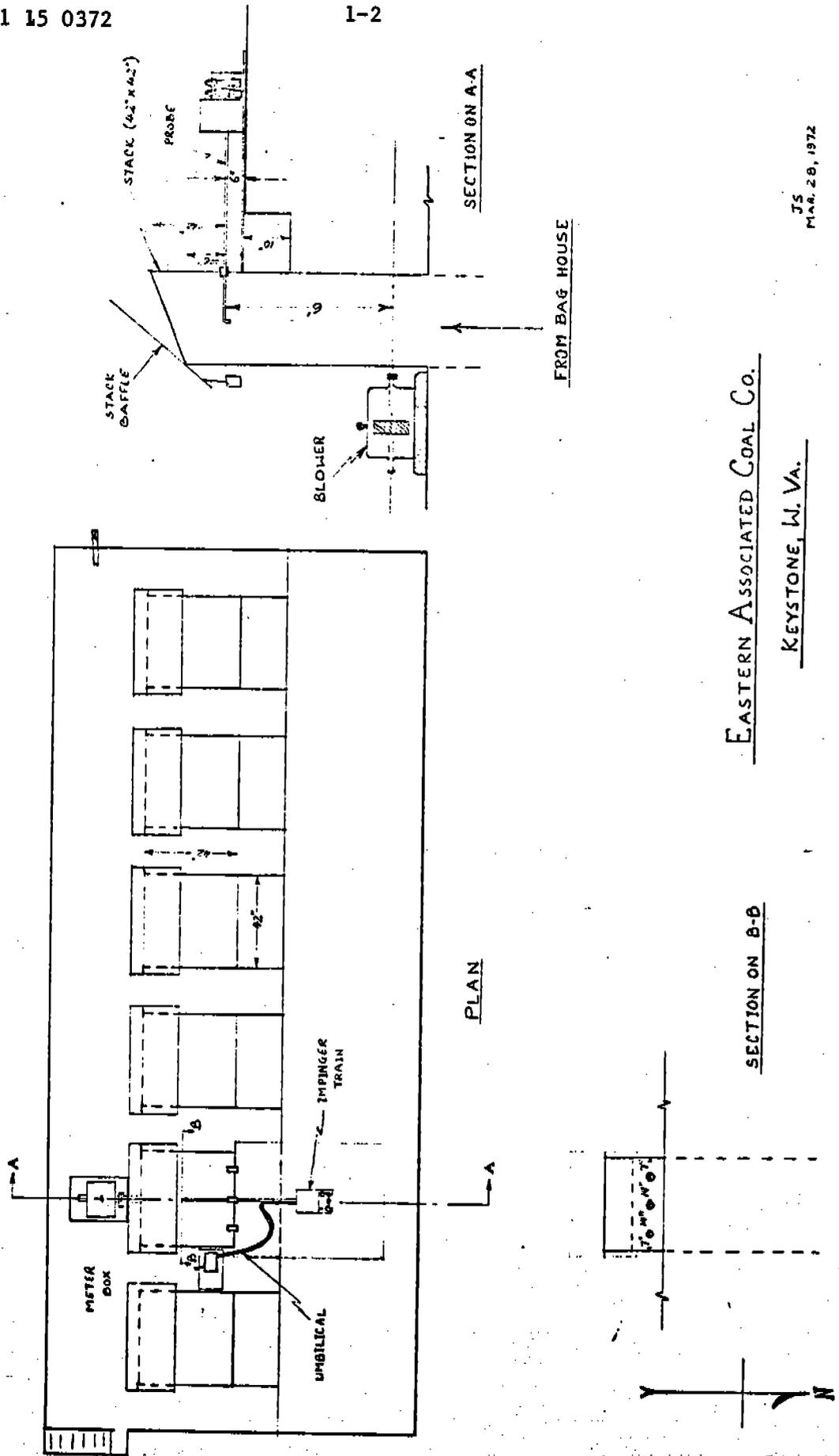
Source sampling tests were performed at the Keystone, West Virginia plant of Eastern Associated Coal Company on February 23 and 24, 1972. The company operates a coal preparation operation at this site. In order to control the emissions to the atmosphere from this operation, the exhaust gases pass through a Pangborn Baghouse collector before entering the atmosphere.

It was the purpose of the test program to determine the quantity of particulate matter being emitted to the atmosphere from the collector. Triplicate tests were performed, running one test the first day and two tests the next day. Figure 1 shows the location of the sampling points.



FIGURE 1

LOCATION OF SAMPLING POINTS



EASTERN ASSOCIATED COAL CO.

KEYSTONE, W. VA.

J.S.  
MAR. 28, 1972



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## 2.0 SUMMARY OF RESULTS

A summary of test results is presented in Table 1. Table 2 presents a summary of the particulate weights. All of the particulate results are included in Appendix A and the raw data sheets are included as Appendix B.

In observing Table 2 it is seen that there is no weight included for Container 5 during Run 1. This was due to the fact that it was discovered that the hydrocarbon stopcock grease used was attacked by acetone. An acceptable type of stopcock grease was obtained and used for the remaining two runs.



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TABLE 1  
SUMMARY OF TEST RESULTS

Run Number:	<u>1</u>	<u>2</u>	<u>3</u>
Sample Gas Vol., scf	55.70	53.71	54.74
Moisture, %	0.886	0.988	1.072
Stack Gas Temp., °F	63	65	65
Stack Gas Vel., fpm	2230	2079	2172
Stack Gas Vol., SCFM	25,918	23,902	24,902
Particulate Collected			
Probe, cyclone, filter, mg.	39.3	6.2	9.5
Total, mg.	54.5	39.5	25.8
Particulate Concentration			
Probe, cyclone, filter, gr/scf	0.011	0.002	0.003
Total, gr/scf	0.015	0.012	0.007
Particulate Emissions			
Probe, cyclone, filter, lb/hr.	2.41	0.36	0.57
Total, lb/hr.	3.35	2.54	1.56



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TABLE 2  
PARTICULATE WEIGHTS SUMMARY

Run Number:	<u>1</u>	<u>2</u>	<u>3</u>
Container 1, mg.	0.5	0.0	0.0
Container 2, mg.	38.8	6.2	9.5
Container 3a, mg.	3.9	0.0**	1.0
Container 3b, mg.	11.3	0.0**	0.0**
Container 5, mg.	*	37.0	15.5
Probe, cyclone, filter, mg.	39.3	6.2	9.5
Total, mg.	54.5	39.5	25.8

\* No sample taken

\*\* Blank was actually higher than sample value.



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### 3.0 PROCESS DESCRIPTION AND OPERATION

The Keystone Preparation Plant of Eastern Associated Coal cleans No. 3 Pocahontas coal for metallurgical use by both wet and dry methods. Minus 3/8 in. coal is processed through air tables with the middlings recombined with plus 3/8 in. raw coal for wet processing. Six R & S Super Airflo tables are used at approximately 30,000 cfm air flow, 40 tons/hr. coal being cleaned per table.

Six Pangborn baghouses clean exhaust air, using 110 bags per baghouse. Dynel bags are currently used in five baghouses. Cotton bags were formerly used, but are gradually being phased out. The unit tested had dynel bags. The bags are cleaned by shakers activated by manual control at 2-3 hour intervals. There was no manual shaking of the bags during any of the test runs.

The only process variables monitored were the coal moisture content to the tables and the table feeder arm speed. The former was measured with a probe developed by Consolidation Coal Company which operates on a flow resistance principle. Assuming the charts were calibrated properly, the moisture content of raw coal feed varied from 3.2 percent to 6.5 percent during the tests. Table feed had been set so that the six tables were fed coal at identical rates.

Loadout of cleaned coal was effected at the same rate as production during the tests. This indicated a cleaned coal rate of 38 tons/hr. per table.

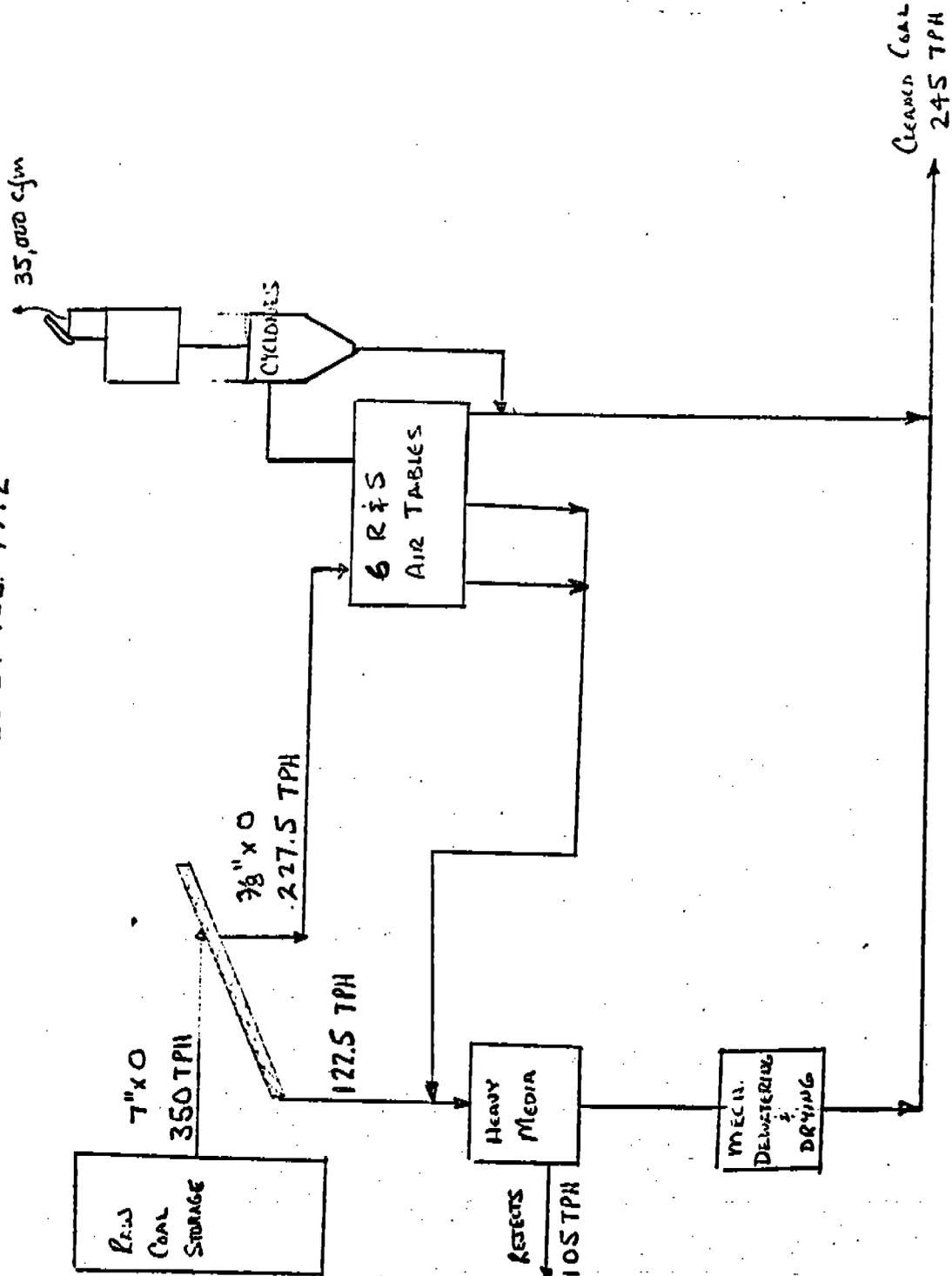


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PLANT: EASTERN ASSOCIATED KEYSTONE

SEAM: POCAHONTAS #3

TEST DATE: 23-24 FEB. 1972



PROCESSING DIAGRAM



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#### 4.0 LOCATION OF SAMPLING POINTS

From the baghouse collector the exhaust gases were emitted to the atmosphere through a 42 in. by 42 in. stack. The sample ports were all located on one side of the stack as shown in Figure 1. There were three ports which were located at the distances shown in Figures 1 and 2. These ports were located approximately 6 feet downstream from a fan and approximately 6 to 12 inches upstream from the outlet of the stack (the top of the stack being inclined rather than flat).

Figure 2 shows the exact location of each sample point in the cross section. Six points were sampled in each port giving a total of eighteen points for the test. The three ports were labeled A, B, and C starting at the east side of the stack and moving to the right. The traverse points were numbered from 1 to 6 starting with 1 being nearest to the port. The distance from the port to the first point was  $3\frac{1}{2}$  in. while the distances between the remaining points were each 7 in.

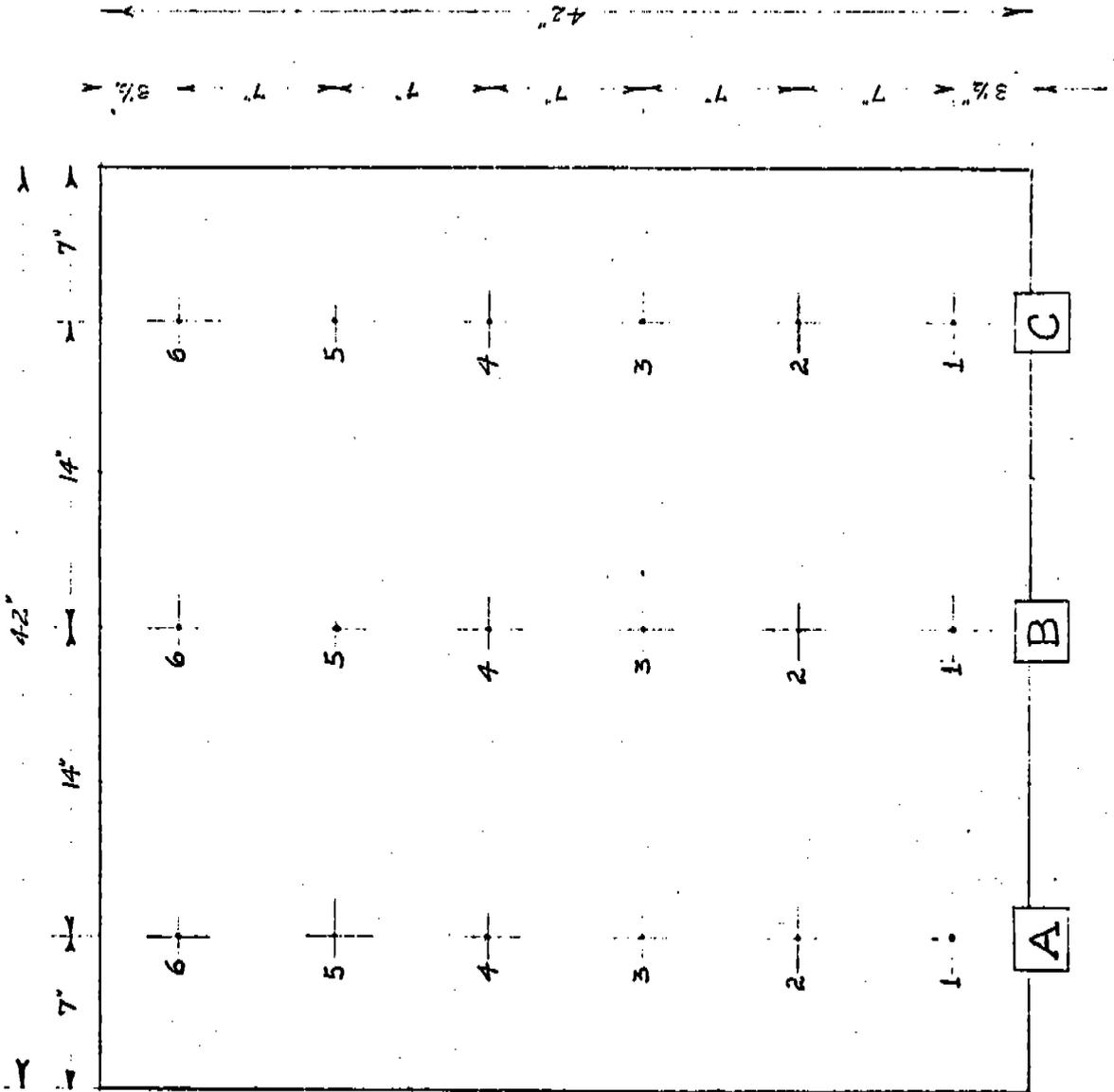
The testing was conducted from the roof of the building. There was no requirement for any special scaffolding or platforms.



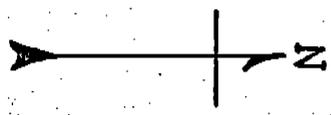
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J.S.  
MAR 25, 72

FIGURE 2  
 EXACT LOCATION OF EACH SAMPLE POINT  
 EASTERN ASSOCIATED COAL CO., KEYSTONE, W. VA.



STACK  
TRAVERSE  
POINTS



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## 5.0 SAMPLING AND ANALYTICAL PROCEDURES

The sampling procedure used was the same as that specified by Method 5 - "Determination of Particulate Emissions From Stationary Sources" and published in the Federal Register, Volume 36, No. 247, Thursday, December, 1971. This method is attached as Appendix E. In addition, the impinger catch was analyzed.

Briefly, the method consists of withdrawing a sample isokinetically from the stack through a heated glass probe into a filter and impinger train. The sample volume is measured with a dry gas meter and isokinetic conditions maintained by monitoring the stack gas velocity with an "S" type pitot tube.

After testing, the train was thoroughly washed including the probe. The washings were evaporated, dried and weighed along with the filter in order to come up with a total weight of particulate matter collected.

The stack gas velocity and flow rate was measured using Method 2 - "Determination of Stack Gas Velocity and Volumetric Flow Rate (Type S Pitot Tube)", and published in the Federal Register. Using both the weight of sample collected and the flow rate determined, a total particulate emission rate was calculated.



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APPENDIX A  
SUMMARY OF PARTICULATE MATTER  
AND SAMPLE CALCULATION



SOURCE TESTING CALCULATION FORMS

Test No. 1 No. Runs 3  
 Name of Firm Eastern Associated Coal Co.  
 Location of Plant Keystone Mines, Keystone, W. Va.  
 Type of Plant Coal cleaning  
 Control Equipment Bag house collectors  
 Sampling Point Locations 42" x 42" square; 3 ports; 6 points each <sup>(\*)</sup>  
 Pollutants Sampled Particulate

Time of Particulate Test:

Run No. 1 Date 2/23/72 Begin 1435 End 1648  
 Run No. 2 Date 2/24/72 Begin 1155 End 1410  
 Run No. 3 Date 2/24/72 Begin 1520 End 1735

PARTICULATE EMISSION DATA

Run No.	1	2	3		
P <sub>b</sub> barometric pressure, "Hg Absolute	28.29	28.11	28.07		
P <sub>m</sub> orifice pressure drop, "H <sub>2</sub> O	.822	.634	.704		
V <sub>m</sub> volume of dry gas sampled @ meter conditions, ft. <sup>3</sup>	61.33	60.46	62.24		
T <sub>m</sub> Average Gas Meter Temperature, °F	93	101	106		
V <sub>m std.</sub> Volume of Dry Gas Sampled @ Standard Conditions, ft. <sup>3</sup>	55.70	53.71	54.74		
V <sub>w</sub> Total H <sub>2</sub> O collected, ml., Impingers & Silical Gel.	10.50	11.30	12.50		
V <sub>w gas</sub> Volume of Water Vapor Collected ft. <sup>3</sup> @ Standard Conditions*	.493	.536	.593		

\* 70°F, 29.92" Hg.

Stack #2E (2<sup>nd</sup> stack from east wing of bldg.)

PARTICULATE EMISSION DATA (cont'd)

Run No.	1	2	3			
$M$ - % Moisture in the stack gas by volume	.886	.988	1.072			
$M_d$ - Mole fraction of dry gas	.991	.990	.989			
% $CO_2$ (dry)	0.03	0.03	0.03	} AIR		
% $O_2$ (dry)	20.99	20.99	20.99			
% $N_2$ (dry)	78.03	78.03	78.03			
$MW_d$ - Molecular weight of dry stack gas	28.966	28.966	28.966			
$MW$ - Molecular weight of stack gas	28.867	28.856	28.845			
$\Delta P_s$ - Velocity Head of stack gas, In. $H_2O$	.4101	.3527	.3844			
$T_s$ - Stack Temperature, $^{\circ}F$	63	65	65			
$\frac{\Delta P_s \times (T_s + 460)}$	14.645	13.608	14.206			
$P_s$ - Stack Pressure, "Hg. Absolute	28.27	28.10	28.05			
$V_s$ - Stack Velocity @ stack conditions, fpm	2230	2079	2172			
$A_s$ - Stack Area, in. <sup>2</sup>	1764	1764	1764			
$Q_s$ - Stack Gas Volume @ Standard Conditions. * SCFM	25,918	23,902	24,202			
$T_t$ - Net Time of Test, min.	126	128	126			
$D_n$ - Sampling Nozzle Diameter, in.	.200	.200	.200			
%I - Percent isokinetic	95.48	98.27	97.66			
$m_f$ - Particulate - probe, cyclone and filter, mg.	39.29	6.19	9.45			
$m_t$ - Particulate - total, mg.	54.52	43.17	25.97			
$C_{an}$ - Particulate - probe, cyclone, and filter, gr/SCF	0.0109	0.0018	0.0021			
$C_{20}$ - Particulate - total, gr/SCF	0.0151	0.0124	0.0073			
$C_{at}$ - Particulate - probe, cyclone, & filter gr/cf @ stack conditions	0.0103	0.0017	0.0025			

Run No.	1	2	3			
C <sub>st</sub> - Particulate, total, -gr/cf @ stack cond.	0.0143	0.0116	0.0068			
C <sub>st</sub> - Particulate, probe, cyclone, and filter, lb/hr.	2.412	0.363	0.568			
C <sub>ax</sub> - Particulate - total, lb/hr.	3.354	2.540	1.560			
% EA - % Excess air @ sampling point	∞	∞	∞			

\* 70°F. 29.92" Hg.

PARTICULATE CALCULATIONS

CALCULATIONS FOR RUN # 1

- 1. Volume of dry gas sampled at standard conditions - 70°F, 29.92" Hg, ft.<sup>3</sup>

$$V_{m\_std} = \frac{17.7 \times V_m \left( P_B - \frac{P_m}{13.6} \right)}{(T_m + 460)} = Ft.^3 = \frac{17.7 \times 61.38 \left( 28.29 + \frac{.822}{13.6} \right)}{553} = 55.70$$

- 2. Volume of water vapor at 70°F & 29.92" Hg, Ft.<sup>3</sup>

$$V_{w\_gas} = 0.0474 \times V_w = Ft.^3 = .0474 \times 10.50 = 0.4977$$

- 3. % moisture in stack gas

$$\%M = \frac{100 \times V_{w\_gas}}{V_{m\_std} + V_{w\_gas}} = \% = \frac{100 \times 0.498}{55.70 + 0.498} = 0.886$$

- 4. Mole fraction of dry gas

$$M_d = \frac{100 - \%M}{100} = \frac{100 - 0.886}{100} = 0.991$$

- 5. Average molecular weight of dry stack gas

$$MW_d = (\%CO_2 \times \frac{44}{100}) + (\%O_2 \times \frac{32}{100}) + (\%N_2 \times \frac{28}{100}) + (\%A \times \frac{39.9}{100}) + (\%H_2 \times \frac{2.016}{100})$$

$$= (0.03 \times 0.44) + (20.99 \times 0.32) + (79.03 \times 0.28) + (.94 \times 0.399)$$

$$= 28.966 \quad (Air) \quad + (.01 \times 0.02016)$$

6. Molecular weight of stack gas A-6

$$M W = M W_d \times M_d + 18(1 - M_d) = (28.966 \times 0.991) + 18(1 - 0.991) = \underline{28.867}$$

7. Stack velocity @ stack conditions, fpm

$$V_s = 4350 \times \sqrt{\frac{1}{A P_s \times (T_s + 460)} \times \frac{1}{P_s \times M W}} = \text{fpm}$$
$$= 4350 \times 14.645 \left[ \frac{1}{28.27 \times 28.867} \right]^{1/2} = \underline{2230.05}$$

8. Stack gas volume @ standard conditions, SCFM

$$Q_s = \frac{0.123 \times V_s \times A_s \times M_d \times P_s}{(T_s + 460)} = \text{SCFM}$$
$$= \frac{0.123 \times 2230 \times 1764 \times 0.991 \times 28.27}{(460 + 63)} = \underline{25918}$$

9. Per cent isokinetic

$$\%I = \frac{1032 \times (T_s + 460) \times V_{m \text{ std}}}{V_s \times T_t \times P_s \times M_d \times (D_n)^2} = \%$$
$$= \frac{1032 (63 + 460) \times 55.70}{2230 \times 12.6 \times 28.27 \times 0.991 \times (20)^2} = \underline{95.48}$$

10. Particulate - probe, cyclone, & filter, gr/SCF

$$C_{an} = 0.0154 \times \frac{M_f}{V_{m \text{ std}}} = \text{gr/SCF}$$
$$= 0.0154 \times \frac{39.29}{55.70} = \underline{0.01086}$$

11. Particulate total, gr/SCF

$$C_{ao} = 0.0154 \times \frac{M_c}{V_{mstd}} = \text{gr/SCF} = \frac{0.0154 \times 54.52}{55.7} = \underline{0.0151}$$

12. Particulate - probe, cyclone & filter, gr/CF at stack conditions

$$C_{at} = \frac{17.7 \times C_{an} \times P_s \times M_d}{(T_s + 460)} = \text{gr/CF} = \frac{17.7 \times 0.01086 \times 28.27 \times 0.99}{(63 + 460)} = \underline{0.0103}$$

13. Particulate - total, gr/CF @ stack conditions

$$C_{au} = \frac{17.7 \times C_{ao} \times P_s \times M_d}{(T_s + 460)} = \text{gr/CF} = \frac{17.7 \times 0.0151 \times 28.27 \times 0.99}{(63 + 460)} = \underline{0.01432}$$

14. Particulate - probe, cyclone, & filter, lb/hr.

$$C_{aw} = 0.00857 \times C_{an} \times Q_s = \text{lb/hr.} = 0.00857 \times 0.01086 \times 25918$$

15. Particulate - total, lb/hr.

$$C_{ax} = 0.00857 \times C_{ao} \times Q_s = \text{lb/hr.} = 0.00857 \times 0.0151 \times 25918 = \underline{3.354}$$

10. % excess air at sampling point

$$\% \text{ EA} = \frac{100 \times \% \text{ O}_2}{0.266 \times \% \text{ N}_2 - \% \text{ O}_2} = \% \quad = \frac{100 \times 20.99}{0.266 \times 78.04 - 20.99}$$

→ (theoretical)

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APPENDIX B  
RAW DATA SHEETS



SCOTT RESEARCH LABORATORIES, INC.

Eastern Assoc Coal Co. Wapitons Mine  
 1 Bagger Stack #2 / Sheet  
 Date 11/11/53

Run

26-11045

Sampling Train (Downstairs)

Sample Point	Time	Vol. (H <sub>2</sub> )	Pitot Tube			Stack Temp.	Cal. Orifice (ΔH in. H <sub>2</sub> O)	T <sub>1</sub> Of	T <sub>2</sub> Of	Draft (Ps in. H <sub>2</sub> O)	Vac. in. Hg.
			Press	Vac.	Total (ΔP in. H <sub>2</sub> O)						
A 1	5	208	178		128	520	4.3			1.25	6
	2	1384			122	520	1.3			1.25	6
2		22246			122	520	1.42	50	52	1.32	7
	3				105	60	.02	65	60		1
4		27587			123	10	1.2	73	65	1.24	2
	5	226.77			5	10	1.40	85	80	.02	2
4		261.934			133	65	1.78	100	95	1.18	3
	1				145	65	1.82	75	95	1.42	4
2		25588			115	65	1.27	100	95	1.37	2
	255125				104	65	1.07	100	95	1.03	1
3		26691			107	65	1.12	100	95	1.07	1
	299135				121	65	1.36	105	100	1.1	2
5		24255			155	65	1.95	115	110	1.29	2
	242758										2

1 11.934  
 2 11.934  
 3 11.934  
 Silica Gel Number #1 511.997  
 Correction Factor 1.0  
 Filter Wgt. g 1  
 Probe Tip Dia. inches 1.200  
12970

Run

Sheet 2

Date 10/1/70

296738

Sampling Train (Downstairs)

Sample Point	Time	Vol. (H)	Pitot Tube			Stack Temp.	Cal. Orifice (ΔH in. H <sub>2</sub> O)	T <sub>1</sub> OF	T <sub>2</sub> OF	Draft (Ps in. H <sub>2</sub> O)	Vac. in. Hg.
			Press	Vac.	Total (ΔP in. H <sub>2</sub> O)						
1		302.70			65	1.8	105	100	1.8	9	
2		308.02			65	1.8	115	110	1.8	7	
3		312.87			70	1.87	110	105	1.8	4	
4		310.24			70	1.80	115	110	1.8	3	
5		310.73			70	1.8	110	105	1.8	3	
6		325.29			70	1.2	120	115	1.8	5	

Silica Gel Number # 151198

Filter Wgt. g # 1.1970

Correction Factor 1.0

Probe Tip Dia. inches 2.00

296  
304  
32

Run Z

Sheet 3

Date 2/21/70

40.185  
325.556

Sample Point	Time	Vol. (H <sup>3</sup> )	Pitot Tube		Stack Temp.	Cal. Orifice (ΔH in. H <sub>2</sub> O)	T <sub>1</sub> OF	T <sub>2</sub> OF	Draft (Ps in. H <sub>2</sub> O)	Vac. in. Hg.
			Press	Vac.						
A 1	7	326.606			65	.13	55	50	.42	0
2	7	309.57			65	.55	70	65	.27	2
3	7	322.93			65	.11	75	70	.10	0
4	7	333.80			65	.20	85	80	.02	0
5	7	336.52			65	.70	80	75	.06	2
6	7	340.185			65	.64	95	90	.15	3
		244.629								
B 1	7	344.25			65	.85	105	100	.35	3
2	7	346.605			65	.28	105	100	.20	1
3	7	347.89			65	.06	105	100	.04	0
4	7	349.54			65	.15	105	100	.01	0
5	7	353.07			65	.32	110	105	.07	2
6	7	356.251			65	.90	120	115	.22	3

Silica Gel Number 2 509.7

Correction Factor 1.05

Filter Wgt. g 2 .2953

Probe Tip Dia. inches 1.200

507

30 16.07

B<sub>0</sub>

1329

Date

Sheet

4

Run

2

356.257

Sampling Train (Downstairs)

Sample Point	Time	Vol. (H)	Pitot Tube			Stack Temp.	Cal. Orifice (ΔH in. H <sub>2</sub> O)	T <sub>1</sub> OF	T <sub>2</sub> OF	Draft (Ps in. H <sub>2</sub> O)	Vac. in. Hg.
			Press	Vac.	Total (ΔP in. H <sub>2</sub> O)						
1	7	362.83			65	2.1	120	115	1.37	7	
2	7	368.79		1.1	65	1.4	120	115	1.50	5	
3	7	374.465		1.76	65	1.80	125	120	1.53	5	
4	7	376.26		1.52	65	1.65	130	125	1.36	3	
5	7	379.75		1.40	65	1.58	130	125	1.27	2	
6	9	386.02		1.35	65	1.3	135	130	1.32	4	
				1.70	65						

Silica Gel Number 2 101.7

Correction Factor 1.05

Filter Wgt. g 2.015

Probe Tip Dia. inches .2

Run 3 Sheet 5 Date 7/2/70

Sampling Train (Downstairs)

Sample Point	Time	Vol. (H <sup>3</sup> )	Pitot Tube			Stack Temp.	Cal. Orifice (ΔH in. H <sub>2</sub> O)	T <sub>1</sub> of	T <sub>2</sub> of	Draft (Ps in. H <sub>2</sub> O)	Vac. in. Hg.
			Press	Vac.	Total (ΔP in. H <sub>2</sub> O)						
A 1	7	391.63			.27	.65	.63	80	80	.13	3
A 2	7	395.34			.32	.65	.63	85	80	.13	2
A 3	7	396.69			.05	.65	.11	95	90	.08	0
A 4	7	398.22			.07	.65	.14	95	90	.05	0
A 5	7	400.39			.15	.65	.27	95	90	.08	0
A 6	7	403.393			.24	.65	.45	100	95	.14	1
B 1		407.49			.50	.65	.12	105	100	.25	0
B 2		410.14			.17	.65	.32	115	110	.22	0
B 3		411.29			.05	.65	.05	115	110	.08	0
B 4		413.16			.09	.65	.17	115	110	.06	0
B 5		418.67			.20	.65	.37	115	110	.13	0
B 6		419.52			.27	.65	.85	115	110	.23	2

Silica Gel Number 3 513.8  
 Correction Factor 1.05  
 Filter Wgt. g 43 2879  
 Probe Tip Dia. inches 1.00

7.0  
 418.67  
 419.52  
 413.16  
 411.29  
 407.49  
 403.393  
 400.39  
 398.22  
 396.69  
 395.34  
 391.63



WATER VOLUME

Run No. 1

DATE 2/23/72

Bubbler # 1 100

Silica Gel No. L Wgt. g 511.9

# 2 100

# 3 \_\_\_\_\_

Bubbler # 4 522.4

Gross

Water Added (-) 200

Gross Wgt. (-) 511.9

Net (A) 0

cc

Net (B) 10.5

g

Net (A) 0

Net (B) (+) 10.5

Total Water 10.5 cc

WATER VOLUME

Run No. 2

DATE Feb 24 1972

Bubbler # 1 100 ml

Silica Gel No. 2 Wgt. g 509.7

# 2 100 ml

# 3 2 ml

Bubbler # 4 519.00

Gross 202 ml

Water Added (-) 200 ml

Gross Wgt. (-) 509.7

Net (A) 2 ml cc

Net (B) 9.30 g

Net (A) 2.0

Net (B) (+) 9.3

Total Water 11.3 cc

WATER VOLUME

Run No. 3

DATE Feb 24 1972

Bubbler # 1 90 ml

Silica Gel No. 3 Wgt. g 513.8

# 2 110 ml

# 3 52 ml

Bubbler # 4 524.3

Gross 202

Water Added (-) 200 ml

Gross Wgt. (-) 513.8

Net (A) 2 ml cc

Net (B) 10.5 g

Net (A) 2

Net (B) (+) 10.5

Total Water 12.5 cc

method(s) prescribed by the manufacturer(s) of such instrument, the instrument shall be subject to manufacturers recommended zero adjustment calibration procedures at least once per 24-hour operating period unless the manufacturer(s) specified or recommends calibration at shorter intervals, in which case such specifications or recommendations shall be followed. The applicable method specified in the appendix of this part shall be the reference method.

(c) Production rate and hours of operation shall be recorded daily.

(d) The owner or operator of any sulfuric acid production unit subject to the provisions of this subpart shall maintain a file of all measurements required by this subpart. Appropriate measurements shall be reduced to the units of the applicable standard daily and summarized monthly. The record of any such measurement and summary shall be retained for at least 2 years following the date of such measurements and summaries.

§ 60.85 Test methods and procedures.

(a) The provisions of this section are applicable to performance tests for determining emissions of acid mist and sulfur dioxide from sulfuric acid production units.

(b) All performance tests shall be conducted while the affected facility is operating at or above the maximum acid production rate at which such facility will be operated and under such other relevant conditions as the Administrator shall specify based on representative performance of the affected facility.

(c) Test methods set forth in the appendix to this part or equivalent methods as approved by the Administrator shall be used as follows:

(1) For each repetition the acid mist and SO<sub>2</sub> concentrations shall be determined by using Method 8 and traversing according to Method 1. The minimum sampling time shall be 2 hours, and minimum sampling volume shall be 40 ft.<sup>3</sup> corrected to standard conditions.

(2) The volumetric flow rate of the total effluent shall be determined by using Method 2 and traversing according to

Method 1. Gas analysis shall be performed by using the integrated sample technique of Method 3. Moisture content can be considered to be zero.

(d) Acid produced, expressed in tons per hour of 100 percent sulfuric acid shall be determined during each 2-hour testing period by suitable flow meters and shall be confirmed by a material balance over the production system.

(e) For each repetition acid mist and sulfur dioxide emissions, expressed in lb./ton of 100 percent sulfuric acid shall be determined by dividing the emission rate in lb./hr. by the acid produced. The emission rate shall be determined by the equation,  $lb./hr. = Q_a \times C$ , where  $Q_a$  = volumetric flow rate of the effluent in ft.<sup>3</sup>/hr. at standard conditions, dry basis as determined in accordance with paragraph (c) (2) of this section, and  $C$  = acid mist and SO<sub>2</sub> concentrations in lb./ft.<sup>3</sup> as determined in accordance with paragraph (c) (1) of this section, corrected to standard conditions, dry basis.

#### APPENDIX—TEST METHODS

##### METHOD 1—SAMPLE AND VELOCITY TRAVERSES FOR STATIONARY SOURCES

###### 1. Principle and Applicability.

1.1 Principle. A sampling site and the number of traverse points are selected to aid in the extraction of a representative sample.

1.2 Applicability. This method should be applied only when specified by the test procedures for determining compliance with the New Source Performance Standards. Unless otherwise specified, this method is not intended to apply to gas streams other than those emitted directly to the atmosphere without further processing.

###### 2. Procedure.

2.1 Selection of a sampling site and minimum number of traverse points.

2.1.1 Select a sampling site that is at least eight stack or duct diameters downstream and two diameters upstream from any flow disturbance such as a bend, expansion, contraction, or visible flame. For rectangular cross section, determine an equivalent diameter from the following equation:

$$\text{equivalent diameter} = 2 \left( \frac{\text{length} \times \text{width}}{\text{length} + \text{width}} \right) \quad \text{equation 1-1}$$

2.1.2 When the above sampling site criteria can be met, the minimum number of traverse points is twelve (12).

2.1.3 Some sampling situations render the above sampling site criteria impractical. When this is the case, choose a convenient sampling location and use Figure 1-1 to determine the minimum number of traverse points. Under no conditions should a sampling point be selected within 1 inch of the stack wall. To obtain the number of traverse points for stacks or ducts with a diameter less than 2 feet, multiply the number of points obtained from Figure 1-1 by 0.67.

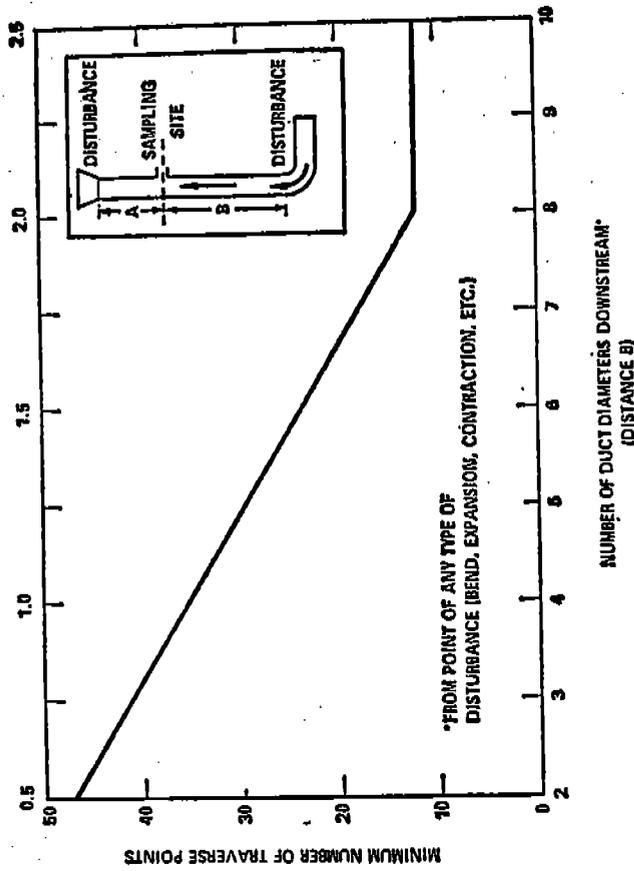
2.1.4 To use Figure 1-1 first measure the distance from the chosen sampling location

to the nearest upstream and downstream disturbances. Determine the corresponding number of traverse points for each distance from Figure 1-1. Select the higher of the two numbers of traverse points, or a greater value, such that for circular stacks the number is a multiple of 4, and for rectangular stacks the number follows the criteria of section 2.1.3.

2.2 Cross-sectional layout and location of traverse points.

2.2.1 For circular stacks locate the traverse points on at least two diameters according to Figure 1-2 and Table 1-1. The traverse axes shall divide the stack cross section into equal parts.

NUMBER OF DUCT DIAMETERS UPSTREAM\*  
(DISTANCE A)



\*FROM POINT OF ANY TYPE OF  
DISTURBANCE (BEND, EXPANSIONS, CONTRACTION, ETC.)

NUMBER OF DUCT DIAMETERS DOWNSTREAM\*  
(DISTANCE B)

Figure 1-1. Minimum number of traverse points.

Table 1-1. Location of traverse points in circular stacks  
(Percent of stack diameter from inside wall to traverse point)

Traverse point number on a diameter	Number of traverse points on a diameter											
	2	4	6	8	10	12	14	16	18	20	22	24
1	14.6	6.7	4.4	3.3	2.5	2.1	1.8	1.6	1.4	1.3	1.1	1.1
2	85.4	25.0	14.7	10.5	8.2	6.7	5.7	4.9	4.4	3.9	3.5	3.2
3		75.0	29.5	19.4	14.6	11.8	9.9	8.5	7.5	6.7	6.0	5.5
4		93.3	70.5	32.3	22.6	17.7	14.6	12.5	10.9	9.7	8.7	7.9
5			85.3	67.7	34.2	25.0	20.1	16.9	14.6	12.9	11.6	10.5
6			95.6	80.6	65.8	35.5	26.9	22.0	18.8	16.5	14.6	13.2
7				89.5	77.4	64.5	36.6	28.3	23.6	20.4	18.0	16.1
8				96.7	85.4	65.0	37.5	29.6	25.0	21.8	19.4	17.4
9					91.8	82.3	73.1	62.5	38.2	30.6	26.1	23.0
10					97.5	88.2	79.9	71.7	61.8	38.8	31.5	27.2
11						93.3	85.4	78.0	70.4	61.2	39.3	32.3
12						97.9	90.1	83.1	76.4	69.4	60.7	39.8
13							94.3	87.5	81.2	75.0	68.5	60.2
14							98.2	91.5	85.4	79.6	73.9	67.7
15								95.1	89.1	83.5	78.2	72.8
16								98.4	92.5	87.1	82.0	77.0
17									95.6	90.3	85.4	80.6
18									98.6	93.3	88.4	83.9
19										96.1	91.3	86.8
20										98.7	94.0	89.5
21											96.5	92.1
22											98.9	94.5
23												96.8
24												98.9

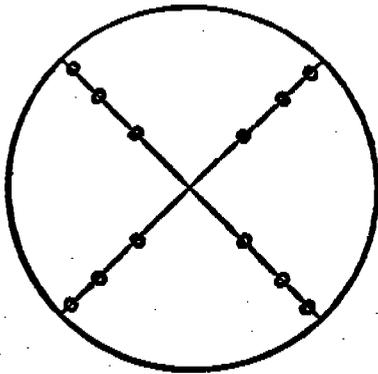


Figure 1-2. Cross section of circular stack divided into 12 equal areas, showing location of traverse points at centroid of each area.

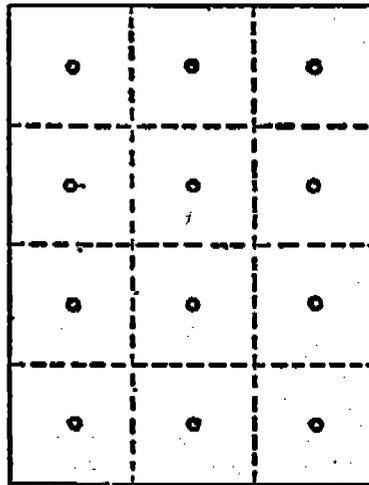


Figure 1-3. Cross section of rectangular stack divided into 12 equal areas, with traverse points at centroid of each area.

2.2.2 For rectangular stacks divide the cross section into as many equal rectangular areas as traverse points, such that the ratio of the length to the width of the elemental areas is between one and two. Locate the traverse points at the centroid of each equal area according to Figure 1-3.

### 3. References.

Determining Dust Concentration in a Gas Stream, ASME Performance Test Code #27, New York, N.Y., 1957.

Devorkin, Howard, et al., Air Pollution Source Testing Manual, Air Pollution Control District, Los Angeles, Calif. November 1963.

Methods for Determination of Velocity, Volume, Dust and Mist Content of Gases, Western Precipitation Division of Joy Manufacturing Co., Los Angeles, Calif. Bulletin WP-50, 1968.

Standard Method for Sampling Stacks for Particulate Matter, in: 1971 Book of ASTM Standards, Part 23, Philadelphia, Pa. 1971, ASTM Designation D-2928-71.

### METHOD 2—DETERMINATION OF STACK GAS VELOCITY AND VOLUMETRIC FLOW RATE (TYPE S PITOT TUBE)

#### 1. Principle and applicability.

1.1 Principle. Stack gas velocity is determined from the gas density and from measurement of the velocity head using a Type S (Stauscheibe or reverse type) pitot tube.

1.2 Applicability. This method should be applied only when specified by the test pro-

cedures for determining compliance with the New Source Performance Standards.

#### 2. Apparatus.

2.1 Pitot tube—Type S (Figure 2-1), or equivalent, with a coefficient within  $\pm 5\%$  over the working range.

2.2 Differential pressure gauge—Inclined manometer, or equivalent, to measure velocity head to within 10% of the minimum value.

2.3 Temperature gauge—Thermocouple or equivalent attached to the pitot tube to measure stack temperature to within 1.5% of the minimum absolute stack temperature.

2.4 Pressure gauge—Mercury-filled U-tube manometer, or equivalent, to measure stack pressure to within 0.1 in. Hg.

2.5 Barometer—To measure atmospheric pressure to within 0.1 in. Hg.

2.6 Gas analyzer—To analyze gas composition for determining molecular weight.

2.7 Pitot tube—Standard type, to calibrate Type S pitot tube.

#### 3. Procedure.

3.1 Set up the apparatus as shown in Figure 2-1. Make sure all connections are tight and leak free. Measure the velocity head and temperature at the traverse points specified by Method 1.

3.2 Measure the static pressure in the stack.

3.3 Determine the stack gas molecular weight by gas analysis and appropriate calculations as indicated in Method 3.

#### 4. Calibration.

4.1 To calibrate the pitot tube, measure the velocity head at some point in a flowing gas stream with both a Type S pitot tube and a standard type pitot tube with known coefficient. Calibration should be done in the laboratory and the velocity of the flowing gas stream should be varied over the normal working range. It is recommended that the calibration be repeated after use at each field site.

4.2 Calculate the pitot tube coefficient using equation 2-1.

$$C_{p_{test}} = C_{p_{std}} \sqrt{\frac{\Delta P_{std}}{\Delta P_{test}}} \quad \text{equation 2-1}$$

where:

$C_{p_{test}}$  = Pitot tube coefficient of Type S pitot tube.

$C_{p_{std}}$  = Pitot tube coefficient of standard type pitot tube (if unknown, use 0.99).

$\Delta P_{std}$  = Velocity head measured by standard type pitot tube.

$\Delta P_{test}$  = Velocity head measured by Type S pitot tube.

4.3 Compare the coefficients of the Type S pitot tube determined first with one leg and then the other pointed downstream. Use the pitot tube only if the two coefficients differ by no more than 0.01.

#### 5. Calculations.

Use equation 2-2 to calculate the stack gas velocity.

$$(V_s)_{avg} = K_p C_p (\sqrt{\Delta p})_{avg} \sqrt{\frac{(T_s)_{avg}}{P_s M_s}}$$

Equation 2-2

where:

$(V_s)_{avg}$  = Stack gas velocity, feet per second (f.p.s.).

$K_p = 85.48 \frac{\text{ft.}}{\text{sec.}} \left( \frac{\text{lb.}}{\text{lb. mole} \cdot \text{ft}^3} \right)^{1/4}$  when these units are used.

$C_p$  = Pitot tube coefficient, dimensionless.

$(T_s)_{avg}$  = Average absolute stack gas temperature, R.

$(\sqrt{\Delta p})_{avg}$  = Average velocity head of stack gas, inches H<sub>2</sub>O (see Fig. 2-2).

$P_s$  = Absolute stack gas pressure, inches Hg.

$M_s$  = Molecular weight of stack gas (wet basis), lb./lb.-mole.

$M_d(1 - B_{wv}) + 18B_{wv}$

$M_d$  = Dry molecular weight of stack gas (from Method 3).

$B_{wv}$  = Proportion by volume of water vapor in the gas stream (from Method 4).

Figure 2-2 shows a sample recording sheet for velocity traverse data. Use the averages in the last two columns of Figure 2-2 to determine the average stack gas velocity from Equation 2-2.

Use Equation 2-3 to calculate the stack gas volumetric flow rate.

$$Q_s = 3600 (1 - B_{wv}) V_s A \left( \frac{T_{std}}{(T_s)_{avg}} \right) \left( \frac{P_s}{P_{std}} \right) \quad \text{Equation 2-3}$$

where:

$Q_s$  = Volumetric flow rate, dry basis, standard conditions, ft.<sup>3</sup>/hr.

$A$  = Cross-sectional area of stack, ft.<sup>2</sup>

$T_{std}$  = Absolute temperature at standard conditions, 530° R.

$P_{std}$  = Absolute pressure at standard conditions, 29.92 inches Hg.

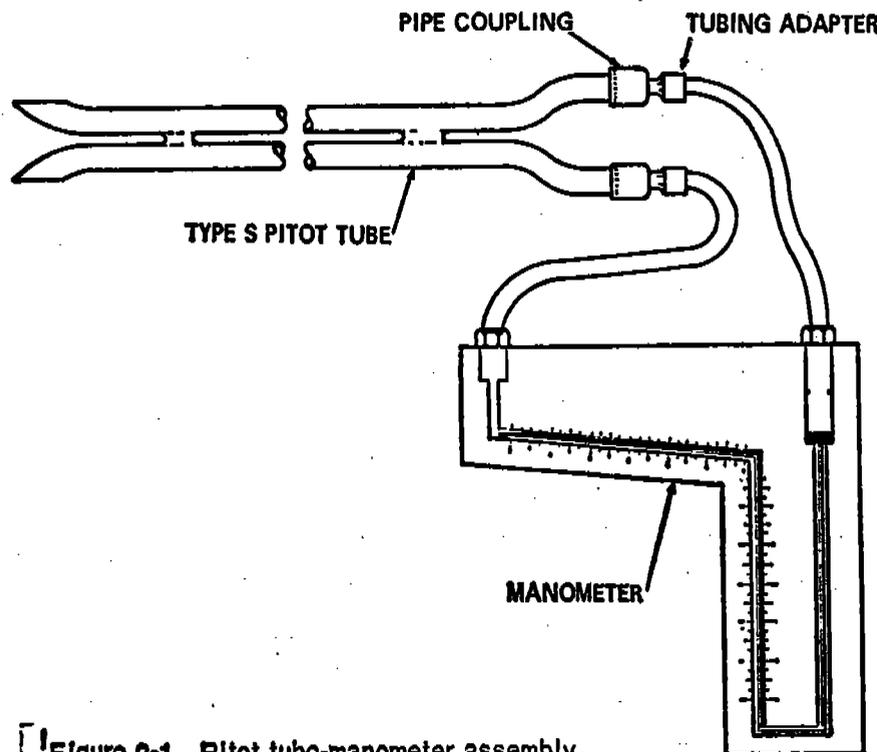


Figure 2-1. Pitot tube-manometer assembly.



## 4.2 Gas volume.

$$V_{ms} = V_m \left( \frac{P_m}{P_{std}} \right) \left( \frac{T_{std}}{T_m} \right) = 17.71 \frac{^\circ R}{\text{in. Hg}} \left( \frac{V_m P_m}{T_m} \right) \text{ equation 4-2}$$

where:

- $V_{ms}$  = Dry gas volume through meter at standard conditions, cu. ft.  
 $V_m$  = Dry gas volume measured by meter, cu. ft.  
 $P_m$  = Barometric pressure at the dry gas meter, inches Hg.  
 $P_{std}$  = Pressure at standard conditions, 29.92 inches Hg.  
 $T_{std}$  = Absolute temperature at standard conditions, 580° R.  
 $T_m$  = Absolute temperature at meter (°F + 460), °R.

## 4.3 Moisture content.

$$B_{ws} = \frac{V_{ws}}{V_{ws} + V_{ms}} + B_{wm} = \frac{V_{ws}}{V_{ws} + V_{ms}} + (0.025) \text{ equation 4-3}$$

where:

- $B_{ws}$  = Proportion by volume of water vapor in the gas stream, dimensionless.  
 $V_{ws}$  = Volume of water vapor collected (standard conditions), cu. ft.  
 $V_{ms}$  = Dry gas volume through meter (standard conditions), cu. ft.  
 $B_{wm}$  = Approximate volumetric proportion of water vapor in the gas stream leaving the impingers, 0.025.

## 5. References.

Air Pollution Engineering Manual, Danielson, J. A. (ed.), U.S. DEW, PHS, National Center for Air Pollution Control, Cincinnati, Ohio, PHS Publication No. 999-AP-40, 1967.  
 Devorkin, Howard, et al., Air Pollution Source Testing Manual, Air Pollution Control District, Los Angeles, Calif., November 1963.

Methods for Determination of Velocity, Volume, Dust and Mist Content of Gases, Western Precipitation Division of Joy Manufacturing Co., Los Angeles, Calif., Bulletin WP-50, 1938.

## METHOD 5—DETERMINATION OF PARTICULATE EMISSIONS FROM STATIONARY SOURCES

## 1. Principle and applicability.

1.1 Principle. Particulate matter is withdrawn isokinetically from the source and its weight is determined gravimetrically after removal of uncombined water.

1.2 Applicability. This method is applicable for the determination of particulate emissions from stationary sources only when specified by the test procedures for determining compliance with New Source Performance Standards.

## 2. Apparatus.

2.1 Sampling train. The design specifications of the particulate sampling train used by EPA (Figure 5-1) are described in APTD-0581. Commercial models of this train are available.

2.1.1 Nozzle—Stainless steel (316) with sharp, tapered leading edge.

2.1.2 Probe—Pyrex<sup>1</sup> glass with a heating system capable of maintaining a minimum gas temperature of 250° F. at the exit end during sampling to prevent condensation from occurring. When length limitations (greater than about 8 ft.) are encountered at temperatures less than 600° F., Incoloy 825<sup>1</sup>, or equivalent, may be used. Probes for sampling gas streams at temperatures in excess of 600° F. must have been approved by the Administrator.

2.1.3 Pitot tube—Type S, or equivalent, attached to probe to monitor stack gas velocity.

2.1.4 Filter Holder—Pyrex<sup>1</sup> glass with heating system capable of maintaining minimum temperature of 225° F.

2.1.5 Impingers/Condensate—Four impingers connected in series with glass ball joint fittings. The first, third, and fourth impingers are of the Greenburg-Smith design, modified by replacing the tip with a 1/4-inch ID glass tube extending to one-half inch from the bottom of the flask. The second impinger is of the Greenburg-Smith design with the standard tip. A condenser may be used in place of the impingers provided that the moisture content of the stack gas can still be determined.

2.1.6 Metering system—Vacuum gauge, leak-free pump, thermometers capable of measuring temperature to within 5° F., dry gas meter with 2% accuracy, and related equipment, or equivalent, as required to maintain an isokinetic sampling rate and to determine sample volume.

2.1.7 Barometer—To measure atmospheric pressure to ±0.1 inches Hg.

## 2.2 Sample recovery.

2.2.1 Probe brush—At least as long as probe.

2.2.2 Glass wash bottles—Two.

2.2.3 Glass sample storage containers.

2.2.4 Graduated cylinder—250 ml.

## 2.3 Analysis.

2.3.1 Glass weighing dishes.

2.3.2 Desiccator.

2.3.3 Analytical balance—To measure to ±0.1 mg.

2.3.4 Trip balance—300 g. capacity, to measure to ±0.05 g.

## 3. Reagents.

3.1 Sampling.

3.1.1 Filters—Glass fiber, MSA 1106 BH<sup>1</sup>, or equivalent, numbered for identification and preweighed.

3.1.2 Silica gel—Indicating type, 6-16 mesh, dried at 175° C. (350° F.) for 2 hours.

3.1.3 Water.

3.1.4 Crushed ice.

3.2 Sample recovery.

3.2.1 Acetone—Reagent grade.

3.3 Analysis.

3.3.1 Water.

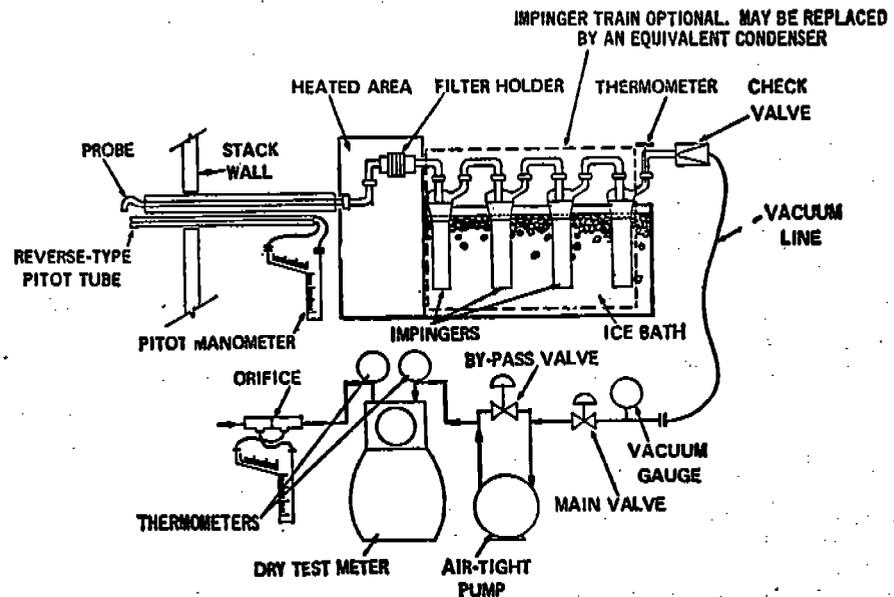


Figure 5-1. Particulate-sampling train.

3.3.2 Desiccant—Drierite<sup>1</sup>, indicating.

## 4. Procedure.

## 4.1 Sampling

4.1.1 After selecting the sampling site and the minimum number of sampling points, determine the stack pressure, temperature, moisture, and range of velocity head.

4.1.2 Preparation of collection train. Weigh to the nearest gram approximately 200 g. of silica gel. Label a filter of proper diameter, desiccate<sup>2</sup> for at least 24 hours and weigh to the nearest 0.5 mg. in a room where the relative humidity is less than 50%. Place 100 ml. of water in each of the first two impingers, leave the third impinger empty, and place approximately 200 g. of preweighed silica gel in the fourth impinger. Set up the train without the probe as in Figure 5-1. Leak check the sampling train at the sampling site by plugging up the inlet to the filter holder and pulling a 15 in. Hg vacuum. A leakage rate not in excess of 0.02 c.f.m. at a vacuum of 15 in. Hg is acceptable. Attach the probe and adjust the heater to provide a gas temperature of about 250° F. at the probe outlet. Turn on the filter heating system. Place crushed ice around the impingers. Add

<sup>1</sup> Trade name.

<sup>2</sup> Dry using Drierite<sup>1</sup> at 70° F. ± 10° F.

more ice during the run to keep the temperature of the gases leaving the last impinger as low as possible and preferably at 70° F., or less. Temperatures above 70° F. may result in damage to the dry gas meter from either moisture condensation or excessive heat.

4.1.3 Particulate train operation. For each run, record the data required on the example sheet shown in Figure 5-2. Take readings at each sampling point, at least every 5 minutes, and when significant changes in stack conditions necessitate additional adjustments in flow rate. To begin sampling, position the nozzle at the first traverse point with the tip pointing directly into the gas stream. Immediately start the pump and adjust the flow to isokinetic conditions. Sample for at least 5 minutes at each traverse point; sampling time must be the same for each point. Maintain isokinetic sampling throughout the sampling period. Nomographs are available which aid in the rapid adjustment of the sampling rate without other computations. APTD-0576 details the procedure for using these nomographs. Turn off the pump at the conclusion of each run and record the final readings. Remove the probe and nozzle from the stack and handle in accordance with the sample recovery process described in section 4.2.



PLANT \_\_\_\_\_  
 DATE \_\_\_\_\_  
 RUN NO. \_\_\_\_\_

CONTAINER NUMBER	WEIGHT OF PARTICULATE COLLECTED, mg		
	FINAL WEIGHT	TARE WEIGHT	WEIGHT GAIN
1			
2			
TOTAL			

	VOLUME OF LIQUID WATER COLLECTED	
	IMPINGER VOLUME, ml	SILICA GEL WEIGHT, g
FINAL		
INITIAL		
LIQUID COLLECTED		
TOTAL VOLUME COLLECTED		g <sup>a</sup> ml

CONVERT WEIGHT OF WATER TO VOLUME BY DIVIDING TOTAL WEIGHT INCREASE BY DENSITY OF WATER. (1 g/ml):

$$\frac{\text{INCREASE, g}}{(1 \text{ g/ml})} = \text{VOLUME WATER, ml}$$

Figure 5-3. Analytical data.

6.6.2 Concentration in lb./cu. ft.

$$c_s = \frac{\left(\frac{1 \text{ lb.}}{453,600 \text{ mg.}}\right) M_n}{V_{m, std}} = 2.205 \times 10^{-6} \frac{M_n}{V_{m, std}}$$

equation 5-5

where:

$c_s$  = Concentration of particulate matter in stack gas, lb./s.c.f., dry basis.  
 453,600 = Mg/lb.

$M_n$  = Total amount of particulate matter collected, mg.

$V_{m, std}$  = Volume of gas sample through dry gas meter (standard conditions), cu. ft.

6.7 Isokinetic variation.

$$I = \frac{T_s \left[ \frac{V_{i_0} (\rho_{H_2O}) R}{M_{H_2O}} + \frac{V_m}{T_m} \left( P_{bar} + \frac{\Delta H}{13.6} \right) \right]}{\theta V_s P_s A_n} \times 100$$

$$= \frac{(1.667 \frac{\text{min.}}{\text{sec.}}) \left[ \left( 0.00267 \frac{\text{in. Hg-cu. ft.}}{\text{ml.}^\circ \text{R}} \right) V_{i_0} + \frac{V_m}{T_m} \left( P_{bar} + \frac{\Delta H}{13.6} \right) \right]}{\theta V_s P_s A_n}$$

Equation 5-6

where:

$I$  = Percent of isokinetic sampling.

$V_{i_0}$  = Total volume of liquid collected in impingers and silica gel (See Fig. 5-3), ml.

$\rho_{H_2O}$  = Density of water, 1 g./ml.

$R$  = Ideal gas constant, 21.83 inches Hg-cu. ft./lb. mole-°R.

$M_{H_2O}$  = Molecular weight of water, 18 lb./lb.-mole.

$V_m$  = Volume of gas sample through the dry gas meter (meter conditions), cu. ft.

$T_m$  = Absolute average dry gas meter temperature (see Figure 5-2), °R.

$P_{bar}$  = Barometric pressure at sampling site, inches Hg.

$\Delta H$  = Average pressure drop across the orifice (see Fig. 5-2), inches H<sub>2</sub>O.

$T_s$  = Absolute average stack gas temperature (see Fig. 5-2), °R.

$\theta$  = Total sampling time, min.

$V_s$  = Stack gas velocity calculated by Method 2, Equation 2-2, ft./sec.

$P_s$  = Absolute stack gas pressure, inches Hg.

$A_n$  = Cross-sectional area of nozzle, sq. ft.

6.8 Acceptable results. The following range sets the limit on acceptable isokinetic sampling results:

If  $90\% \leq I \leq 110\%$ , the results are acceptable, otherwise, reject the results and repeat the test.

7. Reference.

Addendum to Specifications for Incinerator Testing at Federal Facilities, PHS, NCAPC, Dec. 6, 1967.

Martin, Robert M., Construction Details of Isokinetic Source Sampling Equipment, Environmental Protection Agency, APTD-0581.

Rom, Jerome J., Maintenance, Calibration, and Operation of Isokinetic Source Sampling Equipment, Environmental Protection Agency, APTD-0576.

Smith, W. S., R. T. Shigehara, and W. F. Todd, A Method of Interpreting Stack Sampling Data, Paper presented at the 63d Annual Meeting of the Air Pollution Control Association, St. Louis, Mo., June 14-19, 1970.

Smith, W. S., et al., Stack Gas Sampling Improved and Simplified with New Equipment, APCA paper No. 67-119, 1967.

Specifications for Incinerator Testing at Federal Facilities, PHS, NCAPC, 1967.

METHOD 6—DETERMINATION OF SULFUR DIOXIDE EMISSIONS FROM STATIONARY SOURCES

1. Principle and applicability.

1.1 Principle. A gas sample is extracted from the sampling point in the stack. The acid mist, including sulfur trioxide, is separated from the sulfur dioxide. The sulfur dioxide fraction is measured by the barium-thorin titration method.

1.2 Applicability. This method is applicable for the determination of sulfur dioxide emissions from stationary sources only when specified by the test procedures for determining compliance with New Source Performance Standards.

2. Apparatus.

2.1 Sampling. See Figure 6-1.

2.1.1 Probe—Pyrex<sup>1</sup> glass, approximately 5 to 6 mm. ID, with a heating system to prevent condensation and a filtering medium to remove particulate matter including sulfuric acid mist.

2.1.2 Midget bubbler—One, with glass wool packed in top to prevent sulfuric acid mist carryover.

2.1.3 Glass wool.

2.1.4 Midget impingers—Three.

2.1.5 Drying tube—Packed with 6 to 16 mesh indicating-type silica gel, or equivalent, to dry the sample.

2.1.6 Valve—Needle valve, or equivalent, to adjust flow rate.

2.1.7 Pump—Leak-free, vacuum type.

2.1.8 Rate meter—Rotameter or equivalent, to measure a 0-10 s.c.f.h. flow range.

2.1.9 Dry gas meter—Sufficiently accurate to measure the sample volume within 1%.

2.1.10 Pitot tube—Type S, or equivalent.

<sup>1</sup> Trade names.

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## APPENDIX C

## STANDARD SAMPLING PROCEDURES

The sampling procedures used during the test are the same as those published in the Federal Register, Volume 36, Number 24, Thursday, December 23, 1971. These methods are as follows (Methods 1, 2, 5). Additionally, the impinger catch was analyzed for particulate content.



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## APPENDIX D

## LABORATORY REPORT

1. On Site Handling and Transfer

After the completion of a test run, the probe and nozzle were disconnected from the impinger train and all open ends sealed immediately to avoid any possible contamination. At the laboratory facility, the nozzle was disconnected from the probe and very carefully washed with acetone, using a fine bristled brush. All acetone washings were collected in a clean glass jar, the jar itself being placed on a large piece of clean aluminum foil. The probe was then washed with acetone, using a long-handled brush. The brush was rotated slowly and pushed through the probe while a continuous stream of acetone was run through it. The brush was also carefully cleaned and all washings collected in the glass jar. The probe was finally eye-ball checked for transfer efficiency.

The impinger train was initially wiped clean on the outside and all glassware connectors, including the filter, removed carefully and all exposed surfaces wiped clean. All the connectors were placed on a piece of aluminum foil, ready for washing. The first three impingers were then analyzed for water collection by transferring the water through the outlet port into a graduated cylinder and noting the volume. The impingers were not dismantled and all transfers and washings were performed through the inlet and outlet ports. All of the glassware in the back half of the filter, up to the fourth impinger was then carefully washed with distilled water and the washings collected. This was followed by an acetone wash which was again collected in a separate jar.



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Acetone washings from the glassware in the front half of the filter were collected in the same jar as the probe and nozzle wash. The filter was carefully removed from the holder and placed in a plastic dish which was then sealed with tape. Silica gel in the fourth impinger was weighed in a previously tared glass jar using a triple-beam balance.

All acetone jars had aluminum lined lids, or aluminum foil was used before screwing on the lids. The following designations were used for labeling the containers:

- Container #1: Filter
- Container #2: Acetone wash front half from filter
- Container #3: Water wash back half from filter
- Container #4: Silica gel
- Container #5: Acetone wash back half from filter

## 2. Laboratory Handling and Analysis

### a. Filter Transfer

Clean plastic dishes were desiccated for 24 hours, labeled and tared on an electronic balance. The filter containers were unsealed and desiccated for 24 hours before carefully transferring the filters to the tared dishes using a fine pair of tweezers. Care was taken to place a piece of aluminum foil under the transfer operation. A "static-master" brush was used to brush any fine particles adhering to the container or foil. All transfers were performed near the balance and the weight reported to the nearest 0.1 mg. The plastic dishes were then sealed for shipment.



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b. Acetone Washes

250 ml. beakers were used for acetone wash transfers. These beakers were leached for 24 hours in 50% nitric acid, washed thoroughly and oven dried overnight. These were then desiccated for 24 hours and tared. Once tared, the beakers were sealed with "parafilm". Handling of beakers was done as far as possible with tongs and "Kimwipes".

All acetone glass jars were left loosely covered in a hood until the acetone was evaporated. This was found to be safer than transferring the acetone into the tared beaker and evaporating. Once the acetone was evaporated, the glass jar was rinsed with acetone, using a rubber policeman, and the washings collected in the tared beaker.

Once the acetone evaporated in the beakers, the beakers were desiccated for 24 hours and weighed to a constant weight.

In some cases where water was present in the acetone wash, the water was evaporated in an oven at 90°C after the acetone had all evaporated.

c. Water Wash Extraction

Beakers tared as described before were used for collecting the organic extract and the water wash after extraction. The amount of water collected was marked and the volume later measured and reported. The water wash was transferred into a 2000 ml. extraction flask and three 25 cc portions of chloroform used for the initial extraction. Often when a large volume of water was collected (above 500 cc), a fourth portion was used. The extraction flask was shaken thoroughly, and once the chloroform extract settled at the bottom, it was collected directly in the tared beaker.



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Due to the large volume of water usually collected, three 50 ml. portions of ether were used. The ether extract separated at the top and the water portion was collected in the original jars. The ether extract was then collected along with the chloroform extract. Once all the ether extract was collected, the extract portion was transferred back into the extraction flask and the funnel and sides of the flask rinsed with distilled water. The chloroform and ether extract separating at the bottom was then drained into the tared beaker and allowed to evaporate in the hood before desiccating and weighing.

The water portion was transferred to tared beakers, oven dried at 90°C, desiccated and weighed. All beakers were "parafilm" sealed for shipment.

The Project Officer requested that particle size analysis not be performed. Table D-1 presents a summary of the measurements and weight analysis for particulates.



TABLE D-1  
SUMMARY OF WEIGHT MEASUREMENTS

	Run 1			Run 2			Run 3		
	Final (g)	Tare (g)	Gross Blank Net (mg)	Final (g)	Tare (g)	Gross Blank Net (mg)	Final (g)	Tare (g)	Gross Blank Net (mg)
Container #1 (Filter)	88.1375	8.1370	0.5	8.1508	8.1508	0.0	7.5899	7.5899	0.0
Container #2 (Acetone wash front half)	83.3790	83.3395	39.5	87.0653	87.0584	6.9	82.9152	82.9050	10.2
Container #3a (Organic extract)	83.8845	83.8795	5.0	82.2180	32.3180	0.0	85.8033	85.8015	1.8
Container #3b (Water after extraction)	92.8184	92.8005	17.9	82.1840	82.1812	2.8	82.9045	82.8992	5.3
Container #5 (Acetone wash back half)	-	-	*	85.7350	85.6976	37.4	88.7124	88.6965	15.9
Probe, cyclone, filter, mg.:			39.29	Probe, cyclone, filter, mg.:		6.19	Probe, cyclone, filter, mg.:		9.45
Total, mg.:			54.52	Total, mg.:		43.17	Total, mg.:		25.97



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## APPENDIX E

## TEST LOG

The Eastern Associates Coal Company plant was located on the north side of the railroad tracks in Keystone, West Virginia. Figure 1 gives a rough schematic of the stack locations, the approximate dimensions and the sampling setup used. The main building was approximately 70 feet to the top of the flat roof where the ports were located. The sample setup and transfer facilities were done in a relatively clean room located in a single storied building about 100 feet east of the main building.

Wednesday, February 23, 1972

All the necessary equipment was hauled up and set up for the initial flow traverse by about 1300 hours. There was some shower activity at this time, which increased in intensity by late afternoon.

Some electrical grounding problems were encountered, possibly due to the rain. Grounding the meter box overcame this difficulty. A leak test was performed after the initial traverse and the first run started at 1435. Six points were sampled at each of three ports with a time period of 7 minutes at each point. The first run ended at 1648. No problems were encountered in port transfer.

The sample box configuration was modified for this site due to the low height of the sample port from the flat roof (approximately 6"). The sample box had a special inlet on the backside and the impinger train was placed facing away from the ports.



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The complete impinger train and the probe were carried to the laboratory facilities where the sample transfer was accomplished. Very low particulate collection was noticed in this and the other two runs performed at this site. The halocarbon grease used for glassware sealing was found to be attacked by acetone and hence it was advised by the Project Officer not to collect a container #5 (acetone wash back half) for this run. All glass ware cleanup and setup for the following day were done at the Keystone laboratory facilities.

The Project Officer also advised that it would be satisfactory to collect a minimum 60 cubic foot sample rather than a minimum 90 cubic foot sample.

Thursday, February 24, 1972

Very heavy rain was encountered throughout most of the day. Stopcock grease was obtained from the Bluefield State College and no problems were encountered during sample transfer and glassware work. Two runs were accomplished, the first one starting at 1155 and ending at 1410, the second one from 1520 to 1735. All sample transfer and glassware wash were done at the laboratory facility.

Friday, February 25, 1972

All equipment was unloaded, cleaned and packed for transfer to next site by 1300 hours.



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## APPENDIX F

## PROJECT PARTICIPANTS AND TITLES

Thomas Ward	Project Officer - EPA
Joseph Wilson	Field Team Leader - SRL
Jyotin Sachdev	Engineer - SRL
Norman Troxel	Senior Engineer - SRL
Zenophon Tomaras	Chemist - SRL
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