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/

The file name refers to the reference number, the AP42 chapter and section. The file name "ref02_c01s02.pdf" would mean the reference is from AP42 chapter 1 section 2. The reference may be from a previous version of the section and no longer cited. The primary source should always be checked.

101

AP-42 Section 11.10
Reference 20
Report Sect.
Reference

73-CCL-2

SCOTT RESEARCH LABORATORIES, INCORPORATED

SRL 1281 65 1072

Environmental Protection Agency
Test No. 73-CCL-2
Thomas E. Ward, Project Test Officer
Island Creek Coal Company
Van Sant, Virginia, Norman R. Troxel, P.E.

October 1972

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

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SRL 1281 65 1072

1.0 INTRODUCTION

Scott Research Laboratories, Inc. performed source sampling tests at the Van Sant, Virginia plant of Island Creek Coal Company during the weeks of September 11 and 18, 1972. The plant uses a Research Cottrell high energy flooded elbow scrubber to control the exhaust gas emissions from a coal cleaning and preparation operation.

This plant had been tested previously, however, it was desired to determine the reproducibility of emission loadings and also what effect the placement of straightening vanes in the stack would have on the particulate loading emissions.

The outlet exhaust gases, as they were being emitted to the atmosphere, were sampled and analyzed for the determination of total particulate loading concentration. Tests were conducted both with and without straightening vanes installed in the stack.

Two tests were run on September 12, one test on September 13, and one test on September 20, 1972 all without the straightening vanes in the stack. The vanes were then put in place and two tests were run on September 20 and one test on September 21, 1972.

Figure 1 shows the location of the sampling points at the plant.

SRL 1281 65 1072

ISLAND CREEK COAL CO.
VAN SANT, VIRGINIA

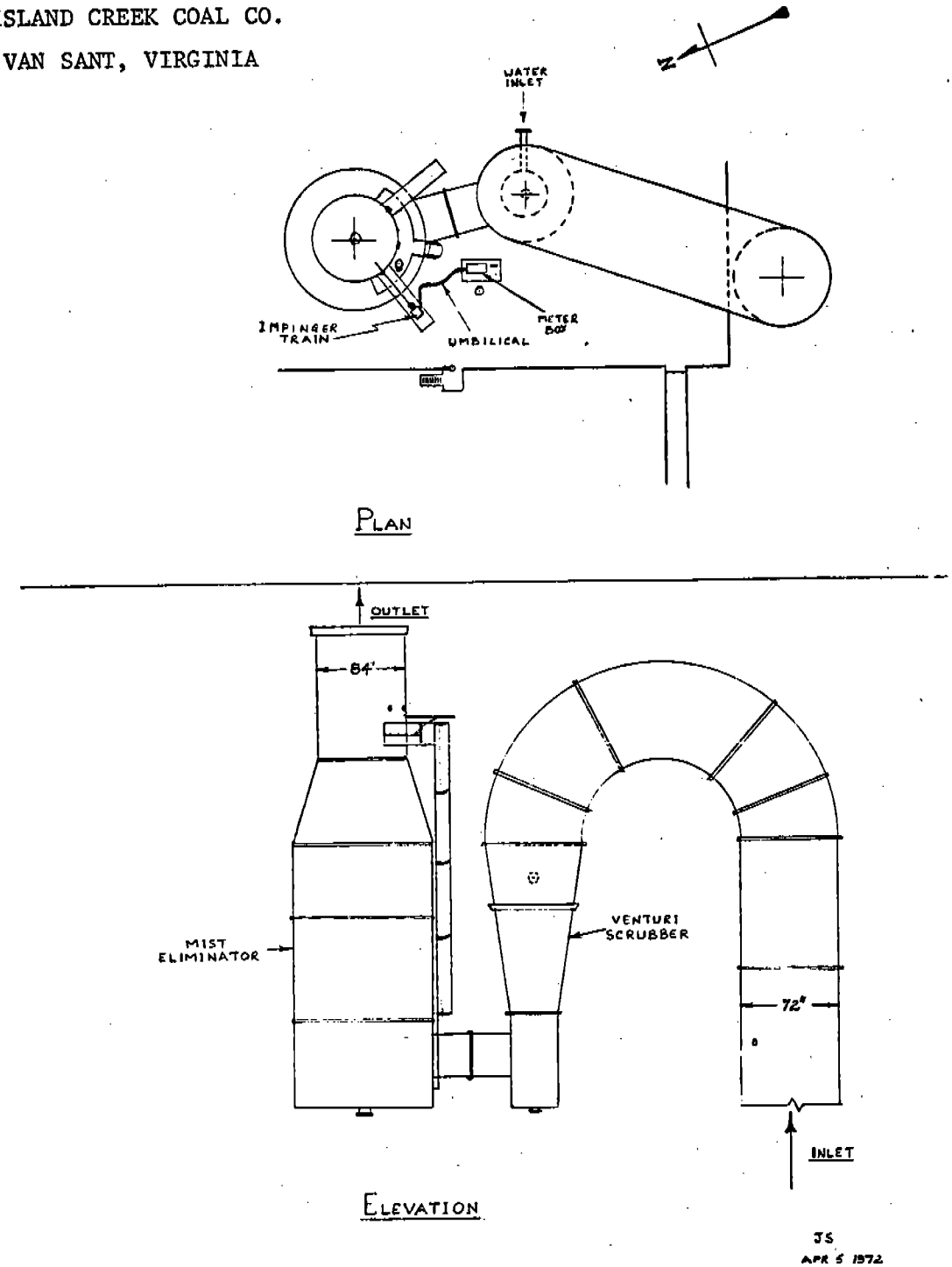

FIGURE 1 - SAMPLE POINT LOCATIONS

2.0 SUMMARY OF RESULTS

A summary of test results is presented in Table 1. The particulate weights are summarized and shown in Table 2 with all of the particulate results included as Appendix A. The raw data sheets are included as Appendix B.

As can be seen from Table 1, the particulate loading concentrations found during the tests made without the straightening vanes installed in the stack, were considerably lower than those found during the tests made with them installed. The straightening vanes also had an effect on the measured gas flow rate. A lower gas flow was observed when the vanes were installed.

The results show very clearly that the addition of the straightening vanes in the stack had a very marked effect upon the sampling results. The average particulate concentration found without the vanes was 0.0303 gr/scf, while with the vanes it was 0.0513 gr/scf.

The particulate concentration found during the first test, which was run with only 50% of the fine coal being fed with the coarser coal to the dryer, was the lowest. However, another test (3) in which 100% of the filter cake was utilized, the particulate concentration was only 20% higher. The results of the other two tests where 100% filter cake was run, were considerably higher.

TABLE 1 SUMMARY OF TEST RESULTS

	Without Straightening Vanes				With Straightening Vanes		
Run Number	1	2	3	5	6	7	8
Sample Date	9/12/72	9/12/72	9/13/72	9/20/72	9/20/72	9/20/72	9/21/72
Sample Gas Vol., SCF	100.59	102.27	88.47	109.19	81.99	83.55	84.97
Moisture, %	11.97	13.41	13.16	14.59	14.59	13.98	13.36
Stack Gas Temp., °F	115	119	125	125	126	124	123
Stack Gas Vol., SCFM	169,026	165,033	164,013	169,055	127,433	127,723	129,760
Particulate Collected							
Probe, cyclone, filter, mg.	85.5	130.3	121.2	218.5	245.7	270.5	192.9
Total, mg.	139.9	250.4	145.3	261.3	282.9	317.8	230.1
Particulate Concentration							
Probe, cyclone, filter, gr/scf.	0.0131	0.0196	0.0211	0.0308	0.0461	0.0498	0.0350
Total, gr/scf.	0.0214	0.0377	0.0253	0.0369	0.0531	0.0590	0.0417
Particulate Emissions							
Probe, cyclone, filter, lb/hr.	18.98	27.75	29.66	44.58	50.35	54.51	38.92
Total, lb/hr.	31.00	53.32	35.56	53.46	58.00	64.58	46.37
Percent Isokinetic	90.81	94.56	96.82	98.55	97.71	99.81	99.92

SCOTT RESEARCH LABORATORIES, INC.

TABLE 2 PARTICULATE SUMMARY

Run Number	1	2	3	5	6	7	8
Container 1, mg.	45.5	68.7	28.5	34.0	25.0	24.2	26.2
Container 2, mg.	40.0	61.6	92.7	184.5	220.7	246.3	166.7
Container 3a, mg.	14.5	64.0	2.5	5.5	1.0	2.7	7.5
Container 3b, mg.	29.5	43.8	18.0	31.7	25.5	32.5	28.0
Container 5, mg.	10.4	12.3	3.6	5.6	10.7	12.1	1.7
Probe, cyclone, filter, mg.	85.5	130.3	121.2	218.5	245.7	270.5	192.9
Total, mg.	139.9	250.4	145.3	261.3	282.9	317.8	230.1

3.0 PROCESS OPERATION

Thermal dryer tests were conducted at Island Creek Coal Company's Virginia Pocanontas #3 plant, Van Sant, Virginia during the weeks of September 11 and 18, 1972.

The first test was run with 50% of the fine coal (filter cake from froth floation cells) being fed with the coarser coal to the dryer. The second run and all of the remaining runs were performed utilizing 100% filter cake in the dryer feed.

Four runs were performed in swirling flow, after which straightening vanes were installed in the stack and three more tests were performed.

Process data monitored during the tests were cleaned coal production, combustion zone and dryer exhaust temperatures power consumption of inlet and outlet dryer fans, gas pressure drop across scrubber system, and visible emissions. Temperature recording charts were maintained during all tests and collected at the conclusion of testing.

The following summarizes process data during testing:

Run No.	Dryer Feed Rate	% Filter Cake	Scrubber ΔP	Visible Emissions
1	281 TPH	50	34-35"w.g.	5%
2	344	100	34-35"	5%
3	306	100	35"	not taken
5	306	100	35"	0
6*	306	100	35"	0
7*	335	100	35"	0
8*	306	100	35%	0

* Straightening vanes installed.

4.0 LOCATION OF SAMPLING POINTS

The exhaust gases from the coal cleaning operation pass through a 72 inch diameter duct into a Research Cottrell venturi scrubber. From the venturi scrubber, the gases flow through a mist eliminator and are then emitted to the atmosphere through an 84 inch diameter stack.

The location for sampling the gases prior to the discharge to the atmosphere was in a straight section of the 84 inch diameter stack atop the mist eliminator. The sampling ports were located approximately 1 foot upstream from the top of the stack and approximately 9 feet downstream from the outlet of the mist eliminator.

Two sampling ports were used and they were spaced 90° apart. The two ports were designated as A and B. A was the port on the left and B was the port 90° to the right of A.

Special sampling platforms were required to support the sampling train at both ports. An angle iron support extending out from the stack supported a plywood platform which held the sample box.

Figure 2 shows the traverse points used during the tests. A total of 48 traverse points were sampled 2.5 minutes each for each test. In order to stay at least two inches away from the wall, the first two and last two points on each traverse were combined. Thus, the first and last points (each containing two traverse points) were sampled for 5 minutes each. The traverse points were chosen in accordance with Method 1 published in the Federal Register, Volume 36, No. 24.

SRL 1281 65 0472

ISLAND CREEK COAL CO.
VAN SANT, VIRGINIA

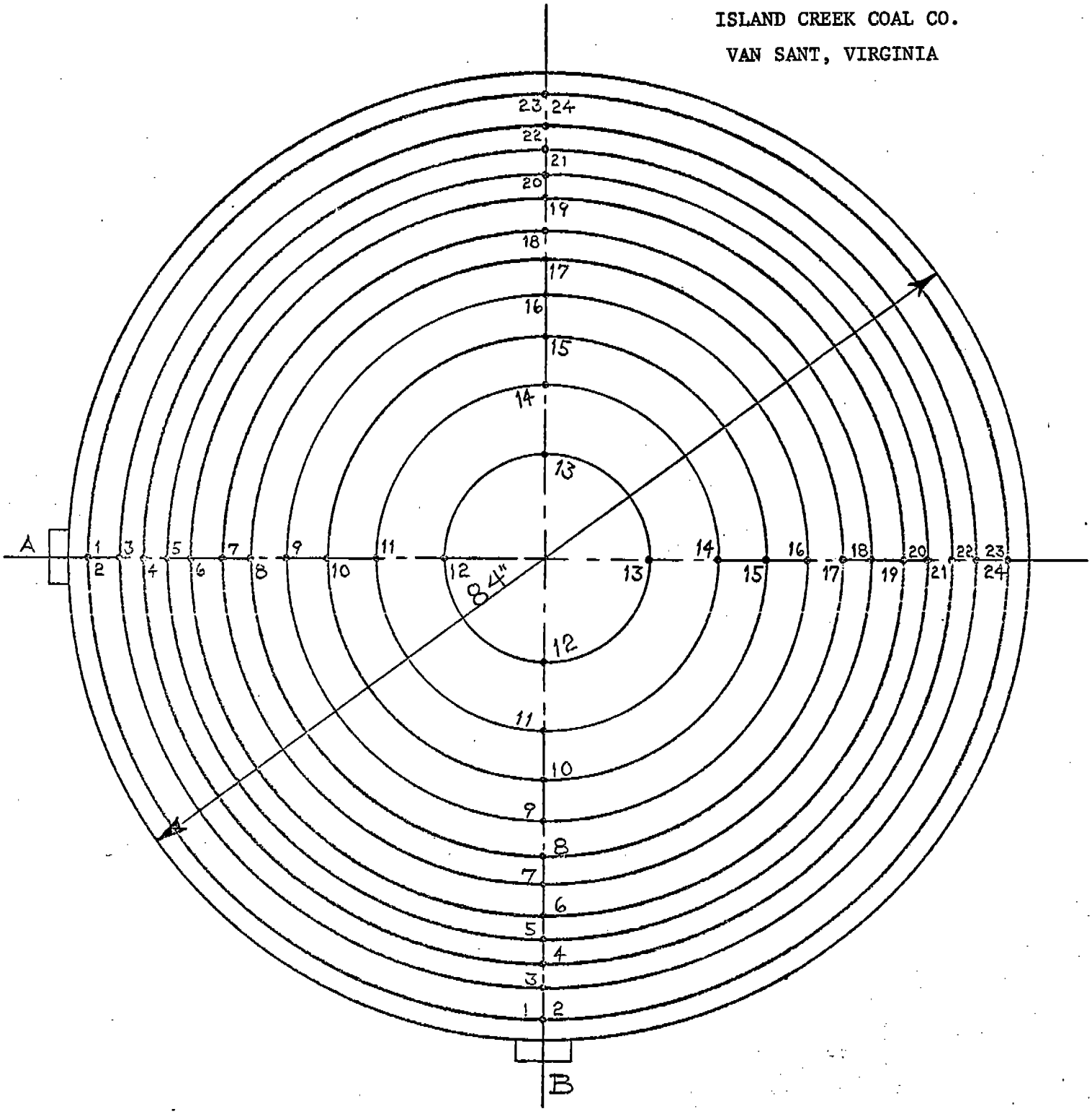

FIGURE 2 TRAVERSE POINT LOCATIONS

5.0 SAMPLING AND ANALYTICAL PROCEDURES

Samples were collected for the determination of particulate matter from the outlet of the venturi scrubber. The sample and analytical procedures used were the same as those specified by Method 5, "Determination of Particulate Emissions from Stationary Sources", and published in the Federal Register, Volume 36, No. 247, Thursday, December 23, 1971. This method is attached as Appendix D. 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 cyclone, filter, and impinger train. The cyclone and filter are contained in a heated box. The sample volume is measured with a dry gas meter, and isokinetic conditions are maintained by monitoring the stack gas velocity with an "S" type pitot tube. After testing is completed, the train is thoroughly washed including the probe. The washings are evaporated, dried, and weighed along with the filter in order to obtain a total weight of particulate matter collected.

The stack gas velocity and flow rate were 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.

APPENDIX A

COMPLETE PARTICULATE RESULTS WITH EXAMPLE CALCULATIONS

REPORT NO. 1281-60 PAGE OF PAGES

SOURCE TESTING CALCULATION FORMS

Test. No. 6 No. Runs 1 to 8 omit 4

Name of Firm Island Creek #3

Location of Plant Vansant, Virgina

Type of Plant Coal Cleaning

Control Equipment Venturi Scrubber

Sampling Point Locations Outlet Stacks; 84" dia; 2 ports; 24 points each port

Pollutants Sampled Particulate

Time of Particulate Test:

Run No.	1	5	Date 9/12/72	9/20/72	Begin 9:25	09:40	End 11:42	11:43
Run No.	2	6	Date 9/12/72	9/20/72	Begin 13:31	13:54	End 15:45	15:56
Run No.	3	7	Date 9/13/72	9/20/72	Begin 21:04	19:54	End 22:52	21:58

PARTICULATE EMISSION DATA

Run No. wo = without vanes; w = with vanes	1	2	3	5	6	7
	wo vanes	wo	wo	wo	w	w
P_b barometric pressure, "Hg Absolute	29.14	29.14	28.95	29.12	29.02	29.06
P_m orifice pressure drop, "H_2O	2.629	2.827	2.814	3.075	1.801	1.837
V_m volume of dry gas sampled @ meter conditions, ft.^{3}	109.66	113.82	96.01	118.99	90.58	90.39
T_m Average Gas Meter Temperature, ^oF	106	118	100	106	110	99
$V_{m_{std.}}$ Volume of Dry Gas Sampled @ Standard conditions, ft.^{3}	100.59	102.27	88.47	109.19	81.99	83.55
V_w Total H_2O collected, ml., Impingers & Silical Gel.	289.	334.4	283.02	393.8	295.7	286.5
$V_{w_{gas}}$ Volume of Water Vapor Collected ft.^{3} @ Standard Conditions*	13.69	15.85	13.41	18.66	14.01	13.58

* 70°F, 29.92" Hg.

* 2.5 minutes each port

PARTICULATE EMISSION DATA (cont'd)

Run No. (wo = without vanes; w = with vanes)	1	2	3	5	6	7
	wo	wo	wo	wo	w	w
%M - % Moisture in the stack gas by volume	11.97	13.41	13.16	14.59	14.59	13.98
M_d - Mole fraction of dry gas	.880	.865	.868	.854	.854	.860
% CO_2 (Assumed air)	0.03	0.03	0.03	0.03	0.03	0.03
% O_2 (Assumed air)	20.95	20.95	20.95	20.95	20.95	20.95
% N_2 (Assumed air)	79.02	79.02	79.02	79.02	79.02	79.02
MW_d - Molecular weight of dry stack gas (based on dry air)	28.966	28.966	28.966	28.966	28.966	28.966
MW - Molecular weight of stack gas	27.650	27.485	27.518	27.364	27.364	27.430
ΔPs - Velocity Head of stack gas, In.H_2O	2.3937	2.3351	2.3487	2.5416	1.5233	1.5039
T_s - Stack Temperature, °F	115	119	125	125	126	124
$(\Delta P_s X (T_s + 460))$	36.37	36.27	36.42	37.94	28.83	28.48
P_s - Stack Pressure, "Hg. Absolute	29	29	28.83	29	28.90	28.94
V_s - Stack Velocity @ stack conditions, fpm	5587.4	5588.4	5625.0	5858.1	4459.8	4396.8
A_s - Stack Area, in.^{2}	5541.7	5541.7	5541.7	5541.7	5541.7	5541.7
Q_s - Stack Gas Volume @ Standard Conditions, *SCFM	169026	165039	164013	169055	127433	127722
T_t - Net Time of Test, min.	120	120	102	120	120	120
D_n - Sampling Nozzle Diameter, in.	.196	.196	.196	.196	.196	.196
%I - Percent isokinetic	90.81	94.56	96.82	98.55	97.71	99.81
m_f - Particulate - probe, cyclone and filter, mg.	85.5	130.3	121.2	218.5	245.7	270.5
m_t - Particulate - total, mg.	139.9	250.4	145.3	261.3	282.9	317.8
C_{an} - Particulate - probe, cyclone, and filter, gr/SCF	.0131	.01962	.0211	.03077	.0461	.0498
C_{ao} - Particulate - total, gr/SCF	.0214	.0377	.0253	.0369	.0531	.0590
C_{at} - Particulate - probe, cyclone, & filter gr/cf @ stack conditions	.0103	.0150	.01597	.02824	.03440	.07430

PARTICULATE EMISSION DATA (cont'd)

Run No. (wo = without vanes; w = with vanes)	1	2	3	5	6	7
	wo	wo	wo	wo	w	w
C_{au} - Particulate, total, gr/cf @ stack cond.	.0168	.0289	.01916	.0277	.03958	.0445
C_{aw} - Particulate, probe, cyclone, and filter, lb/hr.	18.98	27.75	29.66	44.58	50.35	54.51
C_{ax} - Particulate - total, lb/hr.	31.00	53.72	35.56	53.46	58.00	64.58
% EA - % Excess air @ sampling point	302.22	302.22	302.22	302.22	302.22	302.22

*70°F. 29.92" Hg.

Based on assumed air

REPORT NO. 1281-60 PAGE OF PAGES

SOURCE TESTING CALCULATION FORMS

Test. No. 6 (continued) No. Runs 1 to 8 omit 4

Name of Firm Island Creek #3

Location of Plant Vansant, Virgina

Type of Plant Coal Cleaning

Control Equipment Venturi Scrubber

Sampling Point Locations Outlet Stacks; 84" dia; 2 ports; 24 points each port

Pollutants Sampled Particulate

Time of Particulate Test:

Run No. 8 Date 9/21/72 Begin 8:49 End 11:01

Run No. Date Begin End

Run No. Date Begin End

PARTICULATE EMISSION DATA

Run No. wo = without vanes w = with vanes	8 w					
P_b barometric pressure, "Hg Absolute	29.00					
P_m orifice pressure drop, "H_2O	1.813					
V_m volume of dry gas sampled @ meter conditions, ft.^{3}	90.63					
T_m Average Gas Meter Temperature, ^oF	90					
$V_{m_{std.}}$ Volume of Dry Gas Sampled @ Standard conditions, ft.^{3}	84.97					
V_w Total H_2O collected, ml., Impingers & Silical Gel.	276.7					
$V_{w_{gas}}$ Volume of Water Vapor Collected ft.^{3} @ Standard Conditions*	13.11					

* 70°F, 29.92" Hg.

* 2.5 minutes each point

PARTICULATE EMISSION DATA (cont'd)

Run No. WO = without vanes W = with vanes	8					
	W					
%M - % Moisture in the stack gas by volume	13.36					
M_d - Mole fraction of dry gas	.866					
% CO_2	0.03					
% O_2 } Assumed air	20.95					
% N_2	79.02					
MW_d - Molecular weight of dry stack gas (based on dry air)	28.966					
MW - Molecular weight of stack gas	27.496					
ΔPs - Velocity Head of stack gas, In.H_2O	1.4916					
T_s - Stack Temperature, ^oF	123					
$\sqrt{\Delta P_s X (T_s+460)}$	28.75					
P_s - Stack Pressure, "Hg. Absolute	28.88					
V_s - Stack Velocity @ stack conditions, fpm	4437.6					
A_s - Stack Area, in.^{2}	5541.7					
Q_s - Stack Gas Volume @ Standard Conditions, *SCFM	12976.0					
T_t - Net Time of Test, min.	120					
D_n - Sampling Nozzle Diameter, in.	.196					
%I - Percent isokinetic	99.92					
m_f - Particulate - probe, cyclone and filter, mg.	192.9					
m_t - Particulate - total, mg.	230.1					
C_{an} - Particulate - probe, cyclone, and filter, gr/SCF	.0350					
C_{ao} - Particulate - total, gr/SCF	.0417					
C_{at} - Particulate - probe, cyclone, & filter gr/cf @ stack conditions	.0266					

PARTICULATE EMISSION DATA (cont'd)

Run No.	wo = with vanes w = with vanes	8 W					
C_{au} - Particulate, total, gr/cf @ stack cond.		.0317					
C_{aw} - Particulate, probe, cyclone, and filter, lb/hr.		38.92					
C_{ax} - Particulate - total, lb/hr.		46.37					
% EA - % Excess air @ sampling point		302.22					

*70°F. 29.92" Hg.

Based on assumed Air

PARTICULATE CALCULATIONS

Example: Run #1

1. Volume of dry gas sampled at standard conditions - 70°F, 29.92" Hg, ft.^{3}

$$V_{m_{std}} = \frac{17.7 \times V_m \left(P_B + \frac{P_m}{13.6} \right)}{(T_m + 460)} = \text{Ft.}^3 = \frac{17.7 \times 109.66 \left(29.14 + \frac{2.629}{13.6} \right)}{106 + 460}$$

$= 100.5926$ Ft^3

2. Volume of water vapor at 70°F & 29.92" Hg, Ft.^{3}

$$V_{w_{gas}} = 0.0474 \times V_w = \text{Ft.}^3$$

$.0474 \times 289$

$V_w = 13.6986$ Ft^3

3. % moisture in stack gas

$$\%M = \frac{100 \times V_{w_{gas}}}{V_{m_{std}} + V_{w_{gas}}} = \%$$

$$\frac{100 \times 13.69}{100.59 + 13.69}$$

$M = 11.97\%$

4. Mole fraction of dry gas

$$M_d = \frac{100 - \%M}{100} = \frac{100 - 11.97}{100}$$

$M_d = .8803$

5. Average molecular weight of dry stack gas

$$MW_d = (\%CO_2 \times \frac{44}{100}) + (\%O_2 \times \frac{32}{100}) + (\%N_2 \times \frac{28}{100}) + (\%CO \times \frac{28}{100})$$

$= 28.966$ (assumed to be air)

6. Molecular weight of stack gas

$$MW = MW_d \times M_d + 18\,(1 - M_d)$$

$28.966 \times .88 + 18(1 - .88)$

$MW = 27.650$

7. Stack velocity @ stack conditions, fpm

$$V_s = 4350 \times \sqrt{\Delta P_s \times (T_s + 460)} \left[\frac{1}{P_s \times MW} \right]^{1/2} = \text{fpm}$$

5587.2 fpm (Averaged over 48 velocities)

8. Stack gas volume @ standard conditions, SCFM

$$Q_s = \frac{0.123 \times V_s \times A_s \times M_d \times P_s}{(T_s + 460)} = \text{SCFM}$$

$$\frac{.123(5587.2)(5541.7)(.880)(29)}{115 + 460}$$

$= 169026.$ SCF

9. Per cent isokinetic

$$\%I = \frac{1032 \times (T_s + 460) \times V_{m\,std}}{V_s \times T_t \times P_s \times M_d \times (D_n)^2} = \%$$

$$\frac{1032 \times (115 + 460) \times 100.59}{5587.2 \times (120)\,29\,(.880)\,(.196)^2}$$

$\%I = 90.81\ \%$

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

$$C_{an} = 0.0154 \times \frac{M_f}{V_{m\,std}} = \text{gr/SCF}$$

$$.0154 \times \frac{85.5}{100.59}$$

$C_{an} = .0130897$ gr/SCF

11. Particulate total, gr/SCF

$$C_{ao} = 0.0154 \times \frac{M_t}{V_{m_{std}}} = gr/SCF$$

$$.0154 \times \frac{139.9}{100.59}$$

$C_{ao} = .02141$ gm/SCF

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

$$C_{at} = \frac{17.7 \times C_{an} \times P_s \times M_d}{(T_s + 460)} = gr/CF$$

$$\frac{17.7 \times .0131 \times 29 \times .880}{115 + 460}$$

$C_{at} = .010290$ gr/CF

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

$$C_{au} = \frac{17.7 \times C_{ao} \times P_s \times M_d}{(T_s + 460)} = gr/CF$$

$$\frac{17.7 \times .0214 \times 29 \times .880}{115 + 460}$$

$C_{au} = .016811$ gr/CF

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

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

$.00857 \times .0131 \times 169026.$

$C_{aw} = 18.976$ lb/hr.

15. Particulate - total, lb/hr.

$$C_{ax} = 0.00857 \times C_{ao} \times Q_s = lb/hr.$$

$.00857 \times .0214 \times 169.026$

$C_{ax} = 30.999$ lb/hr.

10. % excess air at sampling point

$$\% EA = \frac{100 \times \% O_2}{0.266 \times \% N_2 - \% O_2} = \% \quad \frac{100 \times 20.95}{.266 \times 79.02 - 20.95}$$

Based on asumed air

302.22 %

APPENDIX B

FIELD DATA

#1

FIELD DATA

PLANT Island Coal #3
DATE 9/12/72
SAMPLING LOCATION Outlet w/o Straight.
SAMPLE TYPE Point
RUN NUMBER 1 (1/2 FILTER CAKE)
OPERATOR FYW
AMBIENT TEMPERATURE 68
BAROMETRIC PRESSURE 29.15
STATIC PRESSURE, (P_s) 2.0
FILTER NUMBER (s) #1 .3625

PROBE LENGTH AND TYPE 8 gl
NOZZLE I.D. .196
ASSUMED MOISTURE, % 13
SAMPLE BOX NUMBER
METER BOX NUMBER
METER $\Delta H_@$ 1.84
C FACTOR ~~.99~~ .90
PROBE HEATER SETTING
HEATER BOX SETTING 25
REFERENCE Δp 1.5

Stabs 2.0"

SCHEMATIC OF TRAVERSE POINT LAYOUT

READ AND RECORD ALL DATA EVERY _____ MINUTES

TRAVERSE POINT NUMBER	SAMPLING TIME, min / CLOCK TIME (24-hr CLOCK)	GAS METER READING (V_m), ft^3	VELOCITY HEAD (Δp_s), in. H_2O	ORIFICE PRESSURE DIFFERENTIAL (ΔH), in. H_2O DESIRED	ACTUAL	STACK TEMPERATURE (T_s), °F	DRY GAS METER TEMPERATURE INLET ($T_{m\ in}$), °F	OUTLET ($T_{m\ out}$), °F	PUMP VACUUM, in. Hg	SAMPLE BOX TEMPERATURE, °F	IMPINGER TEMPERATURE, °F
	0925	442.69									
1	2.5		4.5	5.5	4.0	115			20	250	50
2	5		4.5	5.5	4.0	115					
3	7.5 0930	450.435	4.0	4.9	3.6		82	69	21		
4	10	452.955	3.4	4.1	3.4		89	70	21		
5	12.5	455.57	3.0	3.6	3.4		97	72	21		
6	15	458.19	3.0	3.6	3.4		105	74	21		
7	17.5	460.75	2.6	3.1	3.2		106	76	19		
8	20	463.270	2.4	2.9	3.0		112	79	14		
9	22.5	465.530	2.0	2.4	2.5		115	55	11		
10	25	467.74	1.8	2.2	2.2		115	83	10		
11	27.5	469.80	1.6	2.0	2.0						
12	30	471.83	1.6	2.0	2.0		115	55	9		
13	32.5	474.00	1.4	1.7	1.8		115	56	8		
14	35	475.50	1.4	1.7	1.8						
15	37.5	477.53	1.4	1.7	1.8		115	90	8		
16	40	479.39	1.3	1.6	1.7		115	92	7.5		
17	42.5	481.42	1.4	1.7	1.8		116	93	8.0		
18	45	483.18	1.3	1.6	1.7		116	93	8.0		
19	47.5	485.03	1.4	1.7	1.8		117	95	8.0		
20	50	486.90	1.4	1.7	1.8		118	96	8.0		
21	52.5	489.02	1.8	2.2	2.3		120	97	10.0		
22	55	491.345	2.1	2.6	2.7		122	98	12.5		
23	55.5	496.126	2.2	2.7	2.8		124	99	13.0		
24	60.										

EPA (Dur) 235
4/72

TRAVERSE POINT NUMBER	SAMPLING TIME, min / CLOCK TIME (24-hr CLOCK)	GAS METER READING (V_m), ft^3	VELOCITY HEAD (Δp_s), in. H_2O	ORIFICE PRESSURE DIFFERENTIAL (ΔH), in. H_2O DESIRED	ORIFICE PRESSURE DIFFERENTIAL (ΔH), in. H_2O ACTUAL	STACK TEMPERATURE (T_s), °F	DRY GAS METER TEMPERATURE INLET ($T_{m\,in}$), °F	DRY GAS METER TEMPERATURE OUTLET ($T_{m\,out}$), °F	PUMP VACUUM, in Hg	SAMPLE BOX TEMPERATURE, °F	IMPINGER TEMPERATURE, °F
	1012	496.175									
1	2.5	501.53	3.4	4.0	3.6	115	116	100	20	50	
2	5		3.7		3.8						
3	7.5	504.30	3.3	4.0	3.6		124	102	20		
4	10	506.885	3.3	4.0	3.4		126	102	20		
5	12.5	509.55	3.4	4.0	3.4		128	103	21		
6	15	512.21	3.5	4.2	3.4		130	104	21		
7	17.5	514.53	2.9	3.4	3.3		132	105	21		
8	20	517.1485	3.0	3.6	3.2		133	105	21		Stuck 3"
9	22.5	520.05	3.0	3.6	3.2		134	107	21		
10	25	522.64	2.7	3.2	3.2		134	104			
11	27.5	525.022	2.1	2.7	2.8						
12	30	527.375	1.9	2.4	2.5		135	109	15		2.5
13	32.5	529.11	1.9	1.9	1.2		134	109	8		
14	35	530.87	1.1	1.4	1.5		131	110	9		
15	37.5	532.52	1.0	1.2	1.3		131	110	8.5		
16	40	534.35	1.1	1.4	1.5		130	110	9		
17	42.5	536.11	1.3	1.6	1.7		130	110	10		1.5
18	45	538.015	1.5	1.8	1.8		130	110	11		
19	47.5	540.32	2.0	2.4	2.5		132	111	16.5		
20	50	542.725	2.2	2.8	2.9		132	112	21		2.0
21	52.5	545.175	2.9	3.5	2.7		134	117	21.5		
22	55	547.58	3.1	4.1	2.7		135	113	21.5		
23	57.5	552.350	3.9	4.8	2.7		136	116	21.5		
24	60		3.9	4.8	2.7		136	116	21.5		

EPA (Dur) 236
4/72

Island Creek Coal B-4 W/o Straightner

WATER VOLUME

Run No. #1 Date 9/12/72

Bubbler #1 ~~247~~ 296 Silica Gel No. 7 Wgt. g. 508.9

#2 135

#3 12 Bubbler #4 551.9 ~~552.9~~

in acetone wash 3

Gross 446

Water Added(-) 200 Gross Wgt.(-) 508.9

Net (A) 246 cc Net (B) 42.4 g

Net (A) 246

Net (B) (+) 42.4

Total Water 288.4 cc

check for water in front half wash

Form R&D 109

FIELD DATA

PLANT ISLAND CREEK V.P. #3
DATE 9/12/72
SAMPLING LOCATION OUTLET WITHOUT STRAIGHTENERS
SAMPLE TYPE PARTICULATE
RUN NUMBER 2
OPERATOR J. WILSON
AMBIENT TEMPERATURE 76
BAROMETRIC PRESSURE 29.15
STATIC PRESSURE, (P_s) -2.0
FILTER NUMBER (s) #2 .4345
#4 .3605

PROBE LENGTH AND TYPE 8' GLASS LINED
NOZZLE I.D. 0.196
ASSUMED MOISTURE, % 13
SAMPLE BOX NUMBER
METER BOX NUMBER SN 5 1396 RAC
METER $\Delta H_@$ 1.89
C FACTOR 0.90
PROBE HEATER SETTING XXX
HEATER BOX SETTING 300
REFERENCE Δp 1.5

SCHEMATIC OF TRAVERSE POINT LAYOUT

READ AND RECORD ALL DATA EVERY _____ MINUTES

TRAVERSE POINT NUMBER	SAMPLING TIME, min / CLOCK TIME (24-hr CLOCK)	GAS METER READING (V_m), ft^3	VELOCITY HEAD (Δp_s), in. H_2O	ORIFICE PRESSURE DIFFERENTIAL (ΔH), in. H_2O DESIRED	ACTUAL	STACK TEMPERATURE (T_s), °F	DRY GAS METER TEMPERATURE INLET ($T_{m\ in}$), °F	OUTLET ($T_{m\ out}$), °F	PUMP VACUUM, in. Hg	SAMPLE BOX TEMPERATURE, °F	IMPINGER TEMPERATURE, °F
	13.31	553.257									
A-1	2.5		3.4	4.1	4.2	115	98	95	14	300	50
2	5	558.85					115				
3	7.5	561.90	3.6	4.3	4.3	115	98	96	15		
4	10	564.048	3.0	3.6	3.6		118	97	13		
5	12.5	567.275	3.2	3.8	3.8		124	97	13.5		
6	15	569.975	2.7	3.2	3.2		126	98	11.0		
7	17.5	572.475	2.5	3.0	3.0		127	100	10.0		
8	20	574.968	2.3	2.5	2.5		126	101	9.5		
9	22.5	577.285	2.0	2.4	2.4		127	102	8.5		set 2.0
10	25	579.545	1.9	2.3	2.3	126	102	102	8.0		
11	27.5	581.655	1.6	2.0	2.0		126	102	7.0		
12	30	583.77	1.7	2.1	2.1		124	104	7.5		
13	32.5	585.815	1.7	1.6	1.6		124	104	6.0		
14	35	587.365	1.2	1.5	1.5		124	105	5.5		
15	37.5	589.185	1.4	1.7	1.7		124	105	6.0		
16	40	591.100	1.5	1.8	1.8		126	106	6.5		
17	42.5	592.95	1.3	1.6	1.6		126	105	6.0		
18	45	594.85	1.3	1.6	1.6		126	108	6.0		
19	47.5	596.65	1.5	1.8	1.8		127	108	6.5		4.5
20	50	598.580	1.6	1.9	1.9		128	109	7.0		
21	52.5	600.735	1.3	2.9	2.9		130	109	5.5		
22	55	603.085	2.1	2.6	2.6		131	110	9.5		
23	57.5	605.095	2.5	3.0	3.0		132	110	10.0		
A-24	60.		2.5	3.0	3.0		132	110	10.0		

1431

EPA (Dur) 235
4/72

TRAVERSE POINT NUMBER	SAMPLING TIME, min / CLOCK TIME (24-hr CLOCK)	GAS METER READING (V_m), ft^3	VELOCITY HEAD (Δp_s), in. H_2O	ORIFICE PRESSURE DIFFERENTIAL (ΔH), in. H_2O DESIRED	ORIFICE PRESSURE DIFFERENTIAL (ΔH), in. H_2O ACTUAL	STACK TEMPERATURE (T_s), °F	DRY GAS METER TEMPERATURE INLET ($T_{m\,in}$), °F	DRY GAS METER TEMPERATURE OUTLET ($T_{m\,out}$), °F	PUMP VACUUM, in Hg	SAMPLE BOX TEMPERATURE, °F	IMPINGER TEMPERATURE, °F
	1435	605.095									
B-1	2.5	613.35	3.0	3.6	3.6	125	126	110	13		
2	5					125					
3	7.5	616.105	3.1	3.5	3.8	↓	132	110	14		
4	10	618.857	2.9	3.5	3.5		134	110	13.5		
5	12.5	621.575	3.0	3.6	3.6		136	111	13.5		
6	15	624.425	3.3	3.9	3.9		138	112	13.5		
7	17.5	627.11	2.7	3.2	3.2		138	112	11.5		
8	20	628.825	3.0	3.6	3.6		137	112	12.0		
9	22.5	632.25	2.85	3.3	3.3		138	112	12.0		
10	25	635.19	2.7	3.2	3.2		138	113	12.0		
11	27.5	637.64	2.2	2.7	2.7		138	113	10.0		
12	30	640.000	2.2	2.7	2.7		138	113	10.0		
13	32.5	642.050	1.5	1.85	1.85		134	113	8.0		
14	35	643.755	1.3	1.3	1.3		132	113	7.0		
15	37.5	645.340	1.1	1.3	1.3		130	114	7.0		
16	40	647.045	1.2	1.5	1.5		129	114	8.0		
17	42.5	648.65	1.1	1.3	1.3		129	114	9.0		
18	45	650.20	1.7	2.1	2.1		130	114	22		
19	47.5	652.92	2.1	2.6	2.6		124	116	7		
20	50	655.37	2.6	3.2	3.3						
21	52.5	657.50	3.2	3.85	3.85		126	117	8		
22	55	660.055	3.5	4.2	4.2		131	118	9		
23	57.5	662.063	3.9	4.6	4.6		136	118	10		
B-24	60		3.7	4.6	4.6		136	118	10		

Static pressure prior the venturi was 34" to 35" positive water pressure on P.E. wand

@ 1450

520
532
(above filter 360F)
545

EPA (Dur) 236
4/72

WATER VOLUME

Run No. #2 Date 9/12/72

Bubbler #1 249 − 30 = 279 Silica Gel No. 8 Wgt. g. 505.4

#2 211

#3 6 Bubbler #4 543.8

Gross 496

Water Added(-) 200 Gross Wgt.(-) 505.4

Net (A) 296 cc Net (B) 38.4 g

Net (A) 296.

Net (B) (+) 38.4

Total Water 334.4 cc

check for water in front half wash

Form R&D 109

FIELD DATA

PLANT Island Creek #3
DATE 9/13/72
SAMPLING LOCATION Outlet w/o Scrubbers
SAMPLE TYPE Particu.
RUN NUMBER #3
OPERATOR JGW
AMBIENT TEMPERATURE 69°F
BAROMETRIC PRESSURE 28.96
STATIC PRESSURE, (P_s) 1.5 - 2.0 1.75
FILTER NUMBER (s) #7 13675

PROBE LENGTH AND TYPE 8" glass
NOZZLE I.D. .196
ASSUMED MOISTURE, % 13
SAMPLE BOX NUMBER
METER BOX NUMBER
METER $\Delta H_@$ 1.87
C FACTOR .90
PROBE HEATER SETTING 30
HEATER BOX SETTING 300
REFERENCE Δp 1.5

SCHEMATIC OF TRAVERSE POINT LAYOUT

READ AND RECORD ALL DATA EVERY _____ MINUTES

TRAVERSE POINT NUMBER	SAMPLING TIME, min / CLOCK TIME (24-hr CLOCK)	GAS METER READING (V_m), ft^3	VELOCITY HEAD (Δp_s), in. H_2O	ORIFICE PRESSURE DIFFERENTIAL (ΔH), in. H_2O DESIRED	ACTUAL	STACK TEMPERATURE (T_s), °F	DRY GAS METER TEMPERATURE INLET ($T_{m\ in}$), °F	OUTLET ($T_{m\ out}$), °F	PUMP VACUUM, in. Hg	SAMPLE BOX TEMPERATURE, °F	IMPINGER TEMPERATURE, °F
	2104	667.245									
A 1	2.5	673.70	3.5	4.2	4.2	125	75	75	10	300	50
2	5										
3	7.5	676.6	4.0	4.7	4.7		94	78	11		
4	10	679.35	3.1	3.8	3.8		100	78	9.5		
5	12.5	682.20	3.5	4.1	4.1		103	80	10		
6	15	684.90	3.0	3.6	3.6		106	80	9.0		
7	17.5	687.615	3.0	3.6	3.6		108	81	9.0		
8	20	690.14	2.5	3.0	3.0		110	83	8.1		
9	22.5	692.48	2.1	2.5	2.5		110	84	7.0		
10	25	694.645	1.8	2.1	2.1		110	84	6.1		
11	27.5	696.695	1.6	2.0	2.0		110	84	6.0		
12	30	698.58	1.5	1.7	1.7		104	85	5.4		
13	32.5	700.355	1.2	1.5	1.5		108	88	5.0		
14	35	702.375	1.4	1.7	1.7		108	88	5.1		
15	37.5	704.005	1.4	1.7	1.7		108	88	5.1		
16	40	705.815	1.3	1.7	1.7		108	89	5.1		
17	42.5	707.575	1.2	1.5	1.5		108	89	5.0		
18	45	709.410	1.5	1.8	1.8		108	90	5.7		
19	47.5	711.485	1.7	2.1	2.1		108	90	6.8		
20	50	713.615	1.8	2.2	2.2		111	91	7.0		
21	52.5	715.83	2.0	2.4	2.4		112	92	7.5		
22	55	718.15	2.3	2.6	2.6		114	92	8.0		
23	57.5		2.7	3.2	3.2		115	93	9.5		
24	60	723.151	2.7	3.2	3.2		115	93	9.5		

2204

EPA (Dur) 235
4/72

Sheet 2 B

TRAVERSE POINT NUMBER	SAMPLING TIME, min / CLOCK TIME (24-hr CLOCK)	GAS METER READING (V_m), ft^3	VELOCITY HEAD (Δp_s), in. H_2O	ORIFICE PRESSURE DIFFERENTIAL (ΔH), in. H_2O DESIRED	ACTUAL	STACK TEMPERATURE (T_s), °F	DRY GAS METER TEMPERATURE INLET ($T_{m\ in}$), °F	OUTLET ($T_{m\ out}$), °F	PUMP VACUUM, in Hg	SAMPLE BOX TEMPERATURE, °F	IMPINGER TEMPERATURE, °F
	2211	723.151									
1	2.5	728.770	3.3	3.9	3.9	125	104	91	11.5	300	50
2	5										
3	7.5	731.600	3.5	4.2	4.2		113	92	12.1		
4	10	734.33	3.4	4.0	4.0		116	92	12.0		
5	12.5	737.175	3.4	4.0	4.0		118	92	12.0		
6	15	740.115	3.3	3.9	3.9		119	93	12.0		
7	17.5	743.35	3.3	3.9	3.9		120	94	12.0		
8	20	746.0	3.0	3.6	3.6		120	94	11.5		
9	22.5	748.41	2.9	3.5	3.5		120	94	11.0		
10	25	751.25	2.7	3.2	3.2		120	94	11.0		
11	27.5	753.575	2.3	2.8	2.8		120	95	10.0		
12	30	755.885	2.0	2.4	2.4		119	95	9.0		
13	32.5	757.95	1.2	1.5	1.5		116	95	6.2		
14	35	759.395	1.0	1.2	1.2		114	94	5.5		
15	37.5	760.980	1.0	1.2	1.2		112	94	5.5		
16	40 (40.49)	762.650	1.1	1.4	1.4		110	94	6.0		
17	42.5	763.246	1.4	1.7	1.7						
18	45										
19	47.5										
20	50										
21	52.5										
22	55										
23	57.5										
24	60										

2252

EPA (Dur) 236
4/72

WATER VOLUME

Run No. 3 Date 9/13/72

Bubbler #1 236 Silica Gel No. 11 Wgt. g. 506.9

#2 138 537.0

#3 6 Bubbler #4 ~~536.5~~

acetone wash 74

Gross ~~379~~ 453

Water Added(-) 200 Gross Wgt.(-) 508.9

Net ~~179~~ cc Net 30.02 ~~26.6~~ g

(A) 253 (B)

253

~~74~~ (cycl. hopper)

Net (A) ~~179~~

Net (B) (+) ~~26.6~~ 30.02

Total Water ~~279.6~~ cc 283.02

Form R&D 109

RUN # 4
SHEET 1 OF 2

Broken Vanes
No Water Data

FIELD DATA

PLANT ISLAND CREEK COAL CO. V.P. #3
DATE 9/14/72
SAMPLING LOCATION OUTLET WITH VANES
SAMPLE TYPE PARTICULATE
RUN NUMBER #4
OPERATOR JOE WILSON
AMBIENT TEMPERATURE 67 °F
BAROMETRIC PRESSURE 28.94
STATIC PRESSURE, (P_s) 1.5 - 2.0
FILTER NUMBER (s) 324

PROBE LENGTH AND TYPE 8" GLASS LINED
NOZZLE I.D. 0.196
ASSUMED MOISTURE, % 13
SAMPLE BOX NUMBER
METER BOX NUMBER SN 51396 RAC
METER $\Delta H_@$ 1.84
C FACTOR 0.90
PROBE HEATER SETTING ~~300~~ 70%
HEATER BOX SETTING 300
REFERENCE Δp 1.5

SCHEMATIC OF TRAVERSE POINT LAYOUT

READ AND RECORD ALL DATA EVERY _____ MINUTES

TRAVERSE POINT NUMBER	SAMPLING TIME, min / CLOCK TIME (24-hr CLOCK)	GAS METER READING (V_m), ft^3	VELOCITY HEAD (Δp_s), in. H_2O	ORIFICE PRESSURE DIFFERENTIAL (ΔH), in. H_2O DESIRED	ORIFICE PRESSURE DIFFERENTIAL (ΔH), in. H_2O ACTUAL	STACK TEMPERATURE (T_s), °F	DRY GAS METER TEMPERATURE INLET ($T_{m\ in}$), °F	DRY GAS METER TEMPERATURE OUTLET ($T_{m\ out}$), °F	PUMP VACUUM, in. Hg	SAMPLE BOX TEMPERATURE, °F	IMPINGER TEMPERATURE, °F
	0945	763.709									
A-1	2.5	766.025	.07	.63	.63	~~115~~ 120	70	70	3.2	350	<50
2	5										
3	7.5	767.150	.45	.56	.66		76	71	3.0		
4	10	768.275	.45	.56	.56		80	72	3.0		
5	12.5	769.387	.47	.57	.56		83	73	3.0		
6	15	770.530	.55	.65	.68		83	76	3.1		
7	17.5	771.635	.52	.65	.65		85	78	3.0		
8	20	773.985	.66	.83	.83		91	78	4.0		
9	22.5	774.266	.60	.75	.75	125	94	79	4.0		
10	25	775.585	.63	.78	.78		97	81	4.0		
11	27.5	776.885	.60	.75	.75		99	82	3.9		
12	30	778.155	.55	.69	.69		101	83	3.9		
13	32.5	779.550	1.5	1.8	1.8		104	85	6.0		
14	35	782.225	2.4	2.6	2.6		109	86	9.0		
15	37.5	784.385	1.8	2.2	2.2		114	89	8.2		
16	40	786.524	1.7	2.1	2.2		116	90	8.1		
17	42.5	788.600	1.6	2.0	2.0		118	92	8.0		
18	45	790.750	1.9	2.3	2.3		120	94	9.0		
19	47.5	793.100	2.1	2.6	2.6		121	95	9.9		
20	50	795.345	2.1	2.6	2.6		123	96	9.9		
21	52.5	797.761	2.4	2.9	2.9		125	97	10.5		
22	55	800.335	2.0	2.4	2.4		127	98	9.5		
23	57.5		1.1	1.8	1.8						
A-24	60		1.1	1.8	1.5		127	98	9.5		

Start Scale 0953 1004

Finish 1045 1048

EPA (Dur) 235
4/72

RUN 4
SHEET 2 OF 2

TRAVERSE POINT NUMBER	SAMPLING TIME, min / CLOCK TIME (24-hr CLOCK)	GAS METER READING (V_m), ft^3	VELOCITY HEAD (Δp_s), in. H_2O	ORIFICE PRESSURE DIFFERENTIAL (ΔH), in. H_2O		STACK TEMPERATURE (T_s), °F	DRY GAS METER TEMPERATURE		PUMP VACUUM, in Hg	SAMPLE BOX TEMPERATURE, °F	IMPINGER TEMPERATURE, °F
				DESIRED	ACTUAL		INLET ($T_{m\ in}$), °F	OUTLET ($T_{m\ out}$), °F			
B-1	2.5					12.5					<50
2	5.0										
3	7.5										
4	10										
5	12.5										
6	15										
7	17.5										
8	20										
9	22.5										
10	25										
11	27.5										
12	30										
13	32.5										
14	35										
15	37.5										
16	40										
17	42.5										
18	45										
19	47.5										
20	50										
21	52.5										
22	55										
23	57.5										
B-24	60										

EPA (Dur) 236
4/72

Sheet #1
Run 5

FIELD DATA

PLANT Island Coal #3
DATE 9/20/72
SAMPLING LOCATION outlet w/o vane
SAMPLE TYPE Part.
RUN NUMBER #5
OPERATOR JJW
AMBIENT TEMPERATURE 68°F
BAROMETRIC PRESSURE ~~24.3~~ 29.13
STATIC PRESSURE, (P) 1.5 - 2 1.75
FILTER NUMBER (s) #5 , 3642

PROBE LENGTH AND TYPE 8 ft S
NOZZLE I.D. .196
ASSUMED MOISTURE, % 13
SAMPLE BOX NUMBER
METER BOX NUMBER
METER $\Delta H_@$ 1.84
C FACTOR .90
PROBE HEATER SETTING
HEATER BOX SETTING 350
REFERENCE Δp 1.5

SCHEMATIC OF TRAVERSE POINT LAYOUT

READ AND RECORD ALL DATA EVERY _____ MINUTES

TRAVERSE POINT NUMBER	SAMPLING TIME, min / CLOCK TIME (24-hr CLOCK)	GAS METER READING (V_m), ft^3	VELOCITY HEAD (Δp_s), in. H_2O	ORIFICE PRESSURE DIFFERENTIAL (ΔH), in. H_2O DESIRED	ORIFICE PRESSURE DIFFERENTIAL (ΔH), in. H_2O ACTUAL	STACK TEMPERATURE (T_s), °F	DRY GAS METER TEMPERATURE INLET ($T_{m\ in}$), °F	DRY GAS METER TEMPERATURE OUTLET ($T_{m\ out}$), °F	PUMP VACUUM, in. Hg	SAMPLE BOX TEMPERATURE, °F	IMPINGER TEMPERATURE, °F
	0940	504.644									
1	2.5		~~4.2~~	~~4.2~~							
2	5	812.92	4.2	5.0	5.0	128	75	73	10.1		
3	7.5	815.9	4.2	5.0	5.0		97	75	11.0		
4	10	818.865	3.6	4.2	4.2		102	76	10.0		
5	12.5	821.570	3.3	4.0	4.0		106	75	12.0	~~70~~	70
6	15	824.355	3.3	4.0	4.0		109	80			
7	17.5	826.890	2.6	3.1	3.1	125	110	80	8.0		
8	20	829.135	2.0	2.4	2.4		110	80			
9	22.5	831.225	1.7	2.1	2.1	123	109	83	6.0		
10	25	833.250	1.6	2.0	2.0		109	85	5.8		65
11	27.5	835.172	1.5	1.8	1.8	125	109	85	5.2		52
12	30	837.065	1.5	1.8	1.8		109	87	5.2		
13	32.5	838.92	1.5	1.8	1.8	126	110	87	5.2		50
14	35	840.77	1.4	1.7	1.7	127	110	90	5.0		
15	37.5	842.70	1.4	1.7	1.7	130	110	90	5.0		50
16	40	844.475	1.5	1.8	1.8		112	91	5.6		
17	42.5	846.50	1.7	2.1	2.1		114	92	6.0		
18	45	848.555	1.7	2.1	2.1		115	93	6.0		50
19	47.5	850.7	1.6	2.0	2.0	129	116	94	6.0		
20	50	852.75	2.0	2.4	2.4	127	118	96	7.0		
21	52.5	855.085	2.2	2.7	2.7		120	97	8.0		50
22	55	857.475	2.3	2.8	2.8		122	98	8.0		
23	57.5	862.574	2.7	3.2	3.2	127	124	100	9.0		50
24	60		2.7	3.2	3.2	127	124	100	9.0		50

1040

EPA (Dur) 235
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Sheet 2

TRAVERSE POINT NUMBER	SAMPLING TIME, min / CLOCK TIME (24-hr CLOCK)	GAS METER READING (V_m), ft^3	VELOCITY HEAD (Δp_s), in. H_2O	ORIFICE PRESSURE DIFFERENTIAL (ΔH), in. H_2O DESIRED	ACTUAL	STACK TEMPERATURE (T_s), °F	DRY GAS METER TEMPERATURE INLET ($T_{m\,in}$), °F	OUTLET ($T_{m\,out}$), °F	PUMP VACUUM, in Hg	SAMPLE BOX TEMPERATURE, °F	IMPINGER TEMPERATURE, °F
	1043	862.574									
B 1	2.5	865.275	3.3	4.0	4.0		122	101	11.0		
2	5										
3	7.5	871.21	3.6	4.4	4.4	129	127	103	11.7		
4	10	874.134	3.7	4.5	4.5	129	129	104	12.0		
5	12.5	877.045	3.5	4.1	4.1		130	104	12.0		
6	15	879.900	3.3	4.0	4.0		129	104	12.0		
7	17.5	882.8	3.3	4.0	4.0	129	130	105	12.0		
8	20	885.641	3.3	4.0	4.0		130	105	12.0		
9	22.5	888.546	3.4	4.1	4.1		131	106	12.0		
10	25	891.185	2.6	3.2	3.2		132	106	10.0		50
11	27.5	893.585	2.2	2.5	2.5	119	130	106	7.5		
12	30	895.880	2.2	2.5	2.5	116	130	107	7.5		
13	32.5	897.88	1.2	1.5	1.5	114	128	108	6.0		
14	35	899.438	1.2	1.5	1.5	117	126	108	6.0		
15	37.5	901.136	1.1	1.4	1.4	119	124	108	6.0		50
16	40	902.901	1.3	1.6	1.6	121	123	108	6.3		
17	42.5	904.734	1.3	1.6	1.6	122	122	108	6.3		
18	45	906.751	1.7	2.1	2.1		122	107	7.5		
19	47.5	909.125	2.3	2.8	2.8		125	108	10.0		50
20	50	911.68	2.8	3.3	3.3	129	128	108	11.5		
21	52.5	914.43	3.2	3.8	3.8		130	108	13.0		
22	55	917.335	3.6	4.3	4.3	123	132	108	15.0		
23	57.5	923.639	4.4	5.4	5.1	126	134	109	19.0		50
1143 24	60		4.4	5.4	5.1	126	134	109	19.0		

EPA (Dur) 236
4/72

WATER VOLUME

Run No. #5 Date 10/20/72

Bubbler #1 ~~[illegible]~~ 284 Silica Gel No. 13 Wgt. g. 510.9

#2 168

#3 8 Bubbler #4 544.7

acetone Front 100 ~~cyclone 165~~

Gross 560

Water Added(-) 200 Gross Wgt.(-) 510.9

Net (A) ~~240~~ 360 cc Net (B) 33.8 g

Net (A) 360

Net (B) (+) 33.8

Total Water 393.8 cc

Form R&D 109

SHEET #1
RUN #6

FIELD DATA

PLANT ISLAND CREEK COAL VP #3
DATE 9/20/72
SAMPLING LOCATION OUTLET WITH VANES
SAMPLE TYPE PARTICULATE
RUN NUMBER #6
OPERATOR JOE WILSON
AMBIENT TEMPERATURE 74°F
BAROMETRIC PRESSURE 29.03
STATIC PRESSURE, (P_s) 1.5 - 2.0 - 1.75
FILTER NUMBER (s) #6 .4220

PROBE LENGTH AND TYPE 8' SS.
NOZZLE I.D. 0.196
ASSUMED MOISTURE, % 13
SAMPLE BOX NUMBER
METER BOX NUMBER
METER $\Delta H_@$ 1.84
C FACTOR 0.90
PROBE HEATER SETTING =
HEATER BOX SETTING 300
REFERENCE Δp 1.5

O_2 75 } 2 mm
O_3 00 } Leak rate test

SCHEMATIC OF TRAVERSE POINT LAYOUT

READ AND RECORD ALL DATA EVERY _____ MINUTES

TRAVERSE POINT NUMBER	SAMPLING TIME, min / CLOCK TIME (24 hr CLOCK)	GAS METER READING (V_m), ft^3	VELOCITY HEAD (Δp_s), in. H_2O	ORIFICE PRESSURE DIFFERENTIAL (ΔH), in. H_2O DESIRED	ACTUAL	STACK TEMPERATURE (T_s), °F	DRY GAS METER TEMPERATURE INLET ($T_{m\ in}$), °F	OUTLET ($T_{m\ out}$), °F	PUMP VACUUM, in. Hg	SAMPLE BOX TEMPERATURE, °F	IMPINGER TEMPERATURE, °F
	1554	924.255									
A-1	2.5	927.500	1.5	1.8	1.8		88	88	7.0	300	
2	5										
3	7.5	929.590	1.3	1.6	1.6		95	90	7.0		
4	10	931.201	.98	1.2	1.2	129	100	90	5.6		60
5	12.5	932.679	.78	.96	.96		103	91			
6	15	934.070	.66	.83	.83		105	91	4.5		
7	17.5	935.415	.64	.80	.80		106	92	4.5		
8	20	936.854	.80	.97	.97	128	105	94	5.0		
9	22.5	938.32	.77	.95	.95		110	95	5.0		
10	25	939.734	.75	.93	.93	127	111	96	5.0		50
11	27.5	941.105	.65	.80	.80		112	97	4.6		
12	30	942.438	.63	.78	.78		112	98	4.5		
13	32.5	943.945	.85	1.05	1.05	128	112	98	5.2		50
14	35	945.616	1.4	1.8	1.8		115	99	7.2		
15	37.5	947.628	1.7	2.1	2.1		117	100	9.0		
16	40.0	949.805	2.0	2.4	2.4	128	119	101	10.5		50
17	42.5	951.138	2.3	2.8	2.8		121	101	13.0		
18	45.0	954.546	2.4	2.9	2.9		124	102	13.3		
19	47.5	957.000	2.4	2.9	2.9	125	127	104	14.		
20	50.0	959.415	2.2	2.7	2.7		125	104	13.5		
21	52.5	961.85	2.3	2.8	2.8	125	125	104	13.6		50
22	55	964.282	2.4	2.9	2.9		129	105	14.		
23	57.5	966.301	2.6	3.1	3.1	125	129	105	15		50
A-24	60.0		2.6	3.1	3.1	125	129	105	15		

1454

EPA (Dur) 235
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#4 Sheet 2

TRAVERSE POINT NUMBER	SAMPLING TIME, min / CLOCK TIME (24 hr CLOCK)	GAS METER READING (V_m), ft^3	VELOCITY HEAD (Δp_s), in. H_2O	ORIFICE PRESSURE DIFFERENTIAL (ΔH), in. H_2O DESIRED	ORIFICE PRESSURE DIFFERENTIAL (ΔH), in. H_2O ACTUAL	STACK TEMPERATURE (T_s), °F	DRY GAS METER TEMPERATURE INLET ($T_{m\ in}$), °F	DRY GAS METER TEMPERATURE OUTLET ($T_{m\ out}$), °F	PUMP VACUUM, in Hg	SAMPLE BOX TEMPERATURE, °F	IMPINGER TEMPERATURE, °F
	1456	969.301									
B-1	2.5	974.815	3.6	4.3	3.6	126	123	105	20	350	
2	5.		3.6	4.3	3.6		128	106	20.5		
3	7.5	977.536									
4	10	980.21	3.4	4.0	3.6	126	128	106	20.5		60
5	12.5	982.821	2.6	3.1	3.1						
6	15	985.175	2.0	2.4	2.4		130	107	12.0		
7	17.5	987.435	1.7	2.1	2.1		130	107	10.5		
8	20	989.035	1.6	2.0	2.0	125	130	108	10.0		
9	22.5	991.350	1.4	1.7	1.7	125	128	108	8.2		50
10	25	993.154	1.2	1.5	1.5	126	127	108	7.0		
11	27.5	994.795	.96	1.2	1.2		124	108	6.0		
12	30	996.347	.83	1.05	1.05		122	108	5.5		
13	32.5 997.727	997.727	.60	.75	.75	126	120	108	4.5		50
14	35	999.114	.70	.88	.85		117	108	5.0		
15	37.5	000.615	.90	1.10	1.10		118	107	6.0		
16	40	002.282	1.10	1.35	1.40	126	119	107	6.5		50
17	42.5	004.064	1.10	1.35	1.40		120	107	6.5		
18	45	005.780	1.10	1.35	1.40	127	120	107	6.5		50
19	47.5	007.384	1.00	1.2	1.20		120	108	6.4		
20	50	008.900	.90	1.1	1.1	127	120	107	6.0		50
21	52.5	010.415	.82	1.0	1.0		120	108	5.8		
22	55	012.125	.80	.98	.98	127	120	108	5.5		
23	57.5	014.838	.75	.93	.93		119	108	5.1		
B-24	60		.75	.93	.93	127	119	105	5.1		
~~25~~											
~~26~~											
~~27~~											

1556

EPA (Dur) 236
4-72

WATER VOLUME

Run No. ~~#3~~ #6 Date 9/20/72

Bubbler #1 273 Silica Gel No. 10 Wgt. g. 506.1

#2 124

#3 .5 Bubbler #4 529.3

acetone front 75

472.5 Cyclone ~~95~~

Gross ~~39.75~~

Water Added(-) 200 Gross Wgt.(-) 506.1

Net (A) ~~197.5~~ 272.5 cc Net (B) ~~22.9~~ 23.2 g

Net (A) 272.5

Net (B) (+) 23.2

Total Water 295.7 cc

~~123~~ Front half

Form R&D 109

Run #7
Sheet 1

FIELD DATA

PLANT Island Creek Coal V.P. #3
DATE 9/20/72
SAMPLING LOCATION Outlet w/ vane
SAMPLE TYPE Part
RUN NUMBER #7
OPERATOR gjw
AMBIENT TEMPERATURE 29.02 70°F
BAROMETRIC PRESSURE 29.07
STATIC PRESSURE, (P_s) 1.5-2.0 1.75
FILTER NUMBER (s) #3 .4290

PROBE LENGTH AND TYPE 8' SS
NOZZLE I.D. .196
ASSUMED MOISTURE, % 13
SAMPLE BOX NUMBER
METER BOX NUMBER
METER $\Delta H_@$ 1.84
C FACTOR .90
PROBE HEATER SETTING
HEATER BOX SETTING 350
REFERENCE Δp 1.5

SCHEMATIC OF TRAVERSE POINT LAYOUT

READ AND RECORD ALL DATA EVERY _____ MINUTES

TRAVERSE POINT NUMBER	SAMPLING TIME, min / CLOCK TIME (24-hr CLOCK)	GAS METER READING (V_m), ft^3	VELOCITY HEAD (Δp_s), in. H_2O	ORIFICE PRESSURE DIFFERENTIAL (ΔH), in. H_2O DESIRED	ACTUAL	STACK TEMPERATURE (T_s), °F	DRY GAS METER TEMPERATURE INLET ($T_{m\ in}$), °F	OUTLET ($T_{m\ out}$), °F	PUMP VACUUM, in. Hg	SAMPLE BOX TEMPERATURE, °F	IMPINGER TEMPERATURE, °F
	1454	015.033									
1	2.5 7	020.495	3.2	3.8	3.8	123	83	82	16		50
2	5	023.5210	3.9	4.7	4.7		100	82	14		
3	7.5										
4	10	026.301	3.6	4.2	4.2	124	104	82	12.2		50
5	12.5	029.010	2.9	3.5	3.5		108	83	10		
6	15	031.195	2.1	2.6	2.6	126	110	84	8.0		50
7	17.5	033.601	1.9	2.3	2.3		110	84	7.1		
8	20	035.725	1.7	2.1	2.1	124	110	85	6.5		50
9	22.5	037.649	1.4	1.7	1.7		110	85	5.2		
10	25	039.470	1.3	1.6	1.6		109	86	5.0		
11	27.5	041.114	1.0	1.2	1.2	122	108	88	4.2		
12	30	042.682	.86	1.1	1.1	124	108	89	4.0		
13	32.5	044.012	.86	.70	.70		106	90	3.0		50
14	35	045.339	.66	.83	.83	125	105	90	3.2		
15	37.5	046.849	.88	1.1	1.1		106	90	4.1		
16	40.	048.201	.95	1.2	1.2	127	109	91	4.2		50
17	42.5	050.066	1.1	1.4	1.4		108	92	4.9		
18	45	051.700	.96	1.2	1.2	124	108	92	4.5		
19	47.5	052.298	1.1	1.4	1.4		108	93	4.4		
20	50.	054.799	.80	.98	.98	123	108	93	4.4		50
21	52.5	056.256	.75	.94	.94		108	93	4.0		
22	55	057.724	.77	.95	.95	123	107	94	4.0		
23	57.5 7	060.596	.72	.91	.91	123	107	94	4.0		50
24	60		.72	.91	.91	123	107	94	4.0		50

2054

EPA (Dur) 235
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Sheet 2

TRAVERSE POINT NUMBER	SAMPLING TIME, min / CLOCK TIME (24-hr CLOCK)	GAS METER READING (V_m), ft^3	VELOCITY HEAD (Δp_s), in. H_2O	ORIFICE PRESSURE DIFFERENTIAL (ΔH), in H_2O DESIRED	ACTUAL	STACK TEMPERATURE (T_s), °F	DRY GAS METER TEMPERATURE INLET ($T_{m\ in}$), °F	OUTLET ($T_{m\ out}$), °F	PUMP VACUUM, in Hg	SAMPLE BOX TEMPERATURE, °F	IMPINGER TEMPERATURE, °F
	2058	060.596									
A 1	2.5	064.091	.61	1.4	1.4	120	103	93	5.1		
2	5					120					
3	7.5	065.722	.12	1.5	1.5	128	106	93	5.2		50
4	10	067.400	.9	1.1	1.1	126	106	93	5.0		
5	12.5	068.58	.68	.86	.86		106	93	4.0		
6	15	070.252	.68	.86	.86	125	106	93	4.0		50
7	17.5	071.653	.68	.86	.86	119	105	93	4.0		
8	20	073.076	.75	.93	.93		105	93	4.1		
9	22.5	074.536	.75	.93	.93	123	105	93	4.1		50
10	25	075.981	.75	.93	.93		106	94	4.1		
11	27.5	077.384	.70	.87	.87	124	106	94	4.0		
12	30	078.788	.70	.87	.87		105	93	4.0		
13	32.5	080.170	.85	1.05	1.05	124	105	93	4.5		50
14	35	082.024	1.3	1.6	1.6		107	94	6.6		
15	37.5	083.920	1.5	1.8	1.8	120	105	94	6.8		50
16	40	086.070	1.9	2.3	2.3		110	94	8.5		
17	42.5	088.277	2.0	2.4	2.4	126	112	94	8.9		57
18	45	090.620	2.2	2.7	2.7		112	94	10.0		
19	47.5	090.970	2.2	2.7	2.7	126	114	94	10.0		60
20	50	095.316	2.4	2.9	2.9		116	94	11.0		
21	52.5	097.845	2.4	2.9	2.9	126	116	94	11.0		65
22	55	100.274	2.4	2.9	2.9		116	94	11.0		
23	57.5	103.142.6	2.7	3.2	3.2	126	118	94	13.0		68
24	60		2.7	3.2	3.2	126	118	94	13.0		75
2158		105.842.6									

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4-72

WATER VOLUME

Run No. 7 Date 9/20/72

Bubbler #1 223 Silica Gel No. 9 Wgt. g. ~~539.8~~ 512.7

#2 124

#3 2. Bubbler #4 ~~539.8~~ 540.2

acetone trap 110

Gross ~~349~~ 459

Water Added(-) 200 Gross Wgt.(-) 512.7

Net (A) ~~149~~ 259 cc Net (B) ~~271~~ 27.5 g

~~cyclone 110~~

Net (A) ~~149~~ 259

Net (B) (+) 27.5

Total Water ~~293.1~~ 286.50 cc

Form R&D 109

FIELD DATA

PLANT Island Creek UP #3
DATE 9/21/72
SAMPLING LOCATION Outlet w/ cones
SAMPLE TYPE Port
RUN NUMBER 8
OPERATOR GW
AMBIENT TEMPERATURE 60°
BAROMETRIC PRESSURE 29.01
STATIC PRESSURE, (P_s) 1.5 - 2 = 1.75
FILTER NUMBER (s) #10 .4605

PROBE LENGTH AND TYPE 8' SS
NOZZLE I.D. .194
ASSUMED MOISTURE, % 13
SAMPLE BOX NUMBER
METER BOX NUMBER
METER $\Delta H_@$ 1.84
C FACTOR .9
PROBE HEATER SETTING —
HEATER BOX SETTING 350
REFERENCE Δp 1.3

SCHEMATIC OF TRAVERSE POINT LAYOUT

READ AND RECORD ALL DATA EVERY 2.5 MINUTES

TRAVERSE POINT NUMBER	SAMPLING TIME, min / CLOCK TIME (24-hr CLOCK)	GAS METER READING (V_m), ft^3	VELOCITY HEAD (Δp_s), in. H_2O	ORIFICE PRESSURE DIFFERENTIAL (ΔH), in. H_2O DESIRED	ACTUAL	STACK TEMPERATURE (T_s), °F	DRY GAS METER TEMPERATURE INLET ($T_{m\,in}$), °F	OUTLET ($T_{m\,out}$), °F	PUMP VACUUM, in. Hg	SAMPLE BOX TEMPERATURE, °F	IMPINGER TEMPERATURE, °F
	0849	105.818									
1	2.5	110.50	2.8	3.3	3.3	122	57	57	9.0		50
2	5										
3	7.5	113.10	3.1	3.8	3.8		75	58	10.0		
4	10	115.8	3.2	3.9	3.9		80	58	10.2		
5	12.5	118.4	2.9	3.6	3.6		86	60	9.8		
6	15	120.9	2.3	2.9	2.9		90	61	8.0		
7	17.5	123.4	2.0	2.5	2.5	123	91	63	7.0		60
8	20	125.4	1.9	2.4	2.4		92	64	6.5		
9	22.5	127.4	1.5	1.9	1.9	127	92	66	5.0		55
10	25	129.2	1.3	1.6	1.6		92	67	4.0		
11	27.5	130.8	0.97	1.2	1.2	127	91	68	3.5		50
12	30	132.3	0.80	1.0	1.0		90	69	3.2		
13	32.5	133.75	0.92	1.15	1.15	120	90	70	3.5		
14	35	135.45	1.3	1.6	1.6		91	71	4.5		
15	37.5	137.4	1.7	2.1	2.1		94	72	6.0		
16	40	139.4	1.7	2.1	2.1		95	72	6.0		
17	42.5	141.3	1.6	2.0	2.0	127	97	75	6.0		50
18	45	143.05	1.2	1.5	1.5		98	76	5.0		
19	47.5	144.75	1.1	1.4	1.4	125	98	77	4.5		50
20	50	146.6	0.98	1.2	1.2		98	78	4.0		
21	52.5	147.85	0.85	1.1	1.1	126	98	79	3.8		50
22	55	149.4	0.80	1.0	1.0		98	80	3.5		
23	57.5	152.997	0.80	1.0	1.0	125	98	80	3.5		50
24	60 / 0949		0.80	1.0	1.0	125	98	80	3.5		

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TRAVERSE POINT NUMBER	SAMPLING TIME, min / CLOCK TIME (24-hr CLOCK)	GAS METER READING (V_m), ft^3	VELOCITY HEAD (Δp_s), in. H_2O	ORIFICE PRESSURE DIFFERENTIAL (ΔH), in. H_2O DESIRED	ORIFICE PRESSURE DIFFERENTIAL (ΔH), in. H_2O ACTUAL	STACK TEMPERATURE (T_s), °F	DRY GAS METER TEMPERATURE INLET ($T_{m\ in}$), °F	DRY GAS METER TEMPERATURE OUTLET ($T_{m\ out}$), °F	PUMP VACUUM, in Hg	SAMPLE BOX TEMPERATURE, °F	IMPINGER TEMPERATURE, °F
	0957	152.997									
1	2.5	156.30	1.3	1.6	1.6	125	96	83	5.0		50
2	5										
3	7.5	158.0	1.2	1.5	1.5	127	103	86	4.5		
4	10	160.1	0.85	1.1	1.1		105	87	4.0		
5	12.5	160.85	0.7	0.9	0.9		105	88	3.5		
6	15	162.15	0.65	0.82	0.82	127	105	89	3.0		
7	17.5	163.7	0.65	0.82	0.82		105	89	3.0		
8	20	165.05	0.75	0.94	0.94		107	91	3.5		
9	22.5	166.55	0.75	0.94	0.94	123	107	91	3.5		
10	25	168.9	0.85	1.1	1.1		108	92	4.0		
11	27.5	169.45	0.70	0.9	0.9		108	87	3.5		
12	30	170.90	0.70	0.9	0.9		101	94	3.5		
13	32.5	172.50	0.68	0.87	0.87		104	94	3.5		
14	35	173.85	1.20	1.5	1.5		106	94	5.0		
15	37.5	175.80	1.6	2.0	2.0	125	109	95	6.0		50
16	40	177.90	1.7	2.1	2.1		112	96	6.5		
17	42.5	180.10	2.1	2.6	2.6	122	115	96	7.4		
18	45	182.40	2.1	2.6	2.6		117	97	7.5		
19	47.5	184.70	2.1	2.6	2.6		119	98	7.5		
20	50	187.20	2.2	2.7	2.7	121	120	98	7.5		50
21	52.5	189.40	2.0	2.5	2.5		120	99	8.5		
22	55	191.75	2.0	2.5	2.5	123	121	99	8.5		
23	57.5	196.457	2.2	2.7	2.7		122	100	9.5		
24	60 1031		2.2	2.7	2.7	123	120	100	9.5		

STOPPED FOR 8 MINUTES TO CHECK PITOT

EPA (Dur) 236
4-72

WATER VOLUME

Run No. # 9 with straighner Date 10/20/72

Bubbler #1 224 Silica Gel No. 15 Wgt. g. 511.5

#2 118

#3 2 Bubbler #4 529.2

acetone trout 115

Gross 459

Water Added(-) 200 Gross Wgt.(-) 511.5

Net (A) 259 cc Net (B) 17.7 g

Net (A) 259

Net (B) (+) 17.7

Total Water 276.7 cc

Form R&D 109

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 247, Thursday, December 23, 1971. These methods are as follows (Methods 1, 2, 3, 4 and 5). In addition, the impinger catch was analyzed.

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_2 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.^{3} 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.$=Q_s \times c$, where Q_s=volumetric flow rate of the effluent in ft.^{3}/hr. at standard conditions, dry basis as determined in accordance with paragraph (c)(2) of this section, and c=acid mist and SO_2 concentrations in lb./ft.^{3} 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:

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

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 2.2.2.

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.

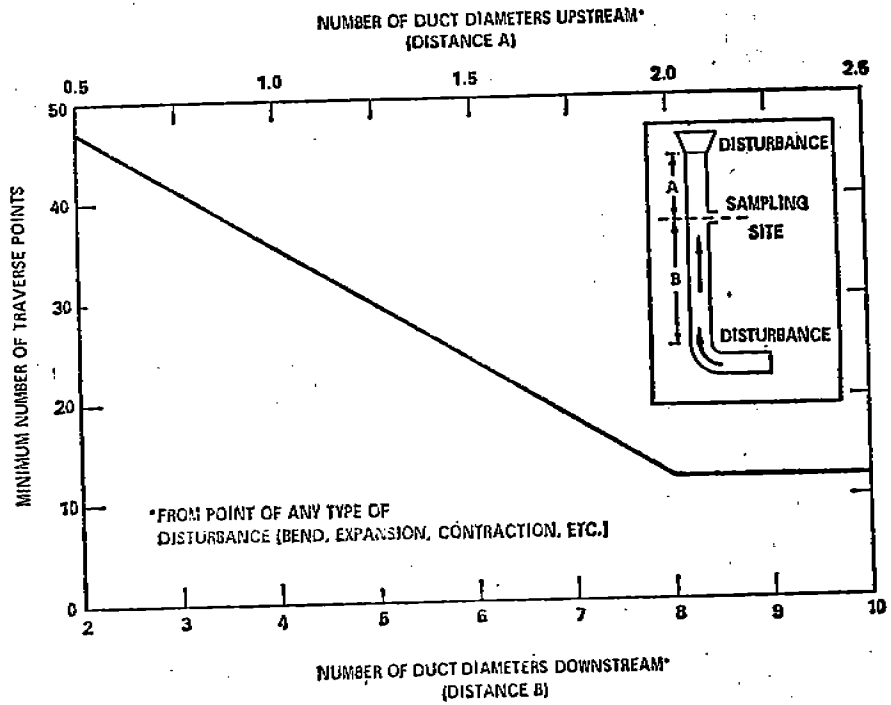


Figure 1-1. Minimum number of traverse points.

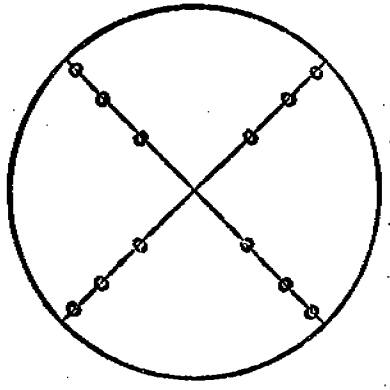


Figure 1-2. Cross section of circular stack divided into 12 equal areas, showing location of traverse points at centroid of each area.

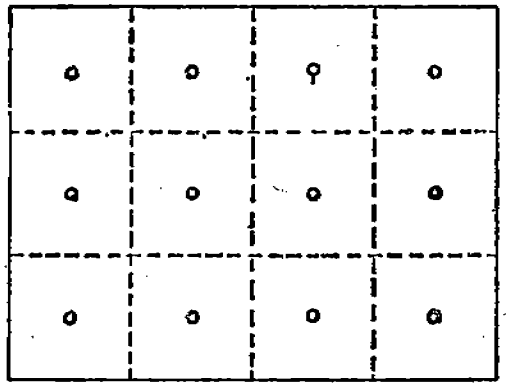


Figure 1-3. Cross section of rectangular stack divided into 12 equal areas, with traverse points at centroid of each area.

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	63.4	37.5	29.6	25.0	21.8	19.4
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	31.6	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

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 procedures 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 ±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.

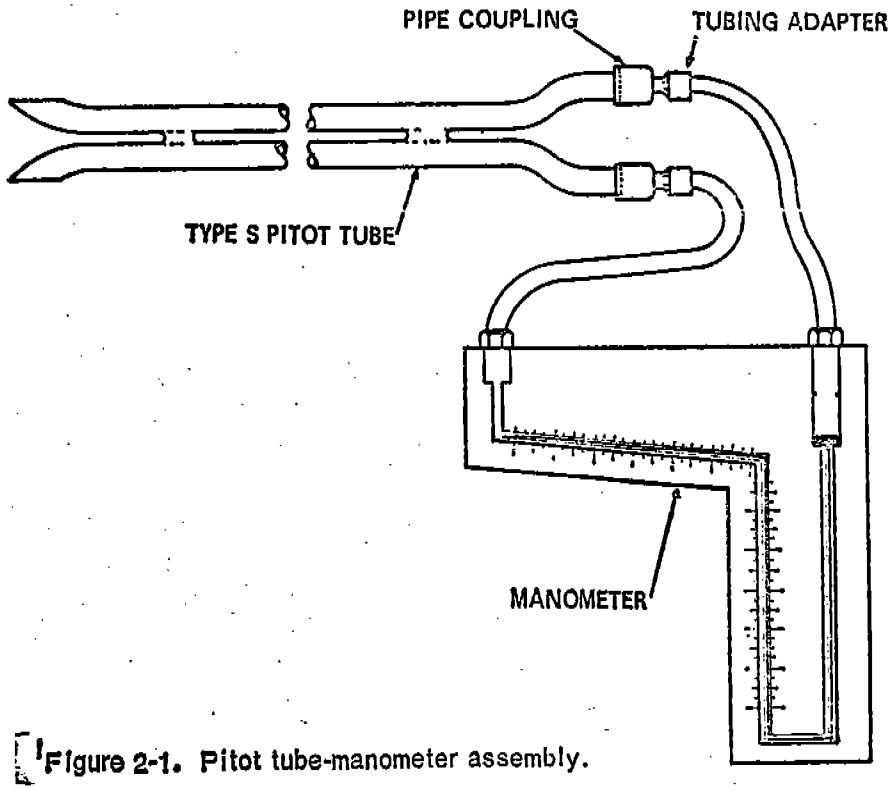


Figure 2-1. Pitot tube-manometer assembly.

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).

Δp_{std} = Velocity head measured by standard type pitot tube.

Δp_{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.).

$K_p = 85.48 \frac{\text{ft.}}{\text{sec.}} \left(\frac{\text{lb.}}{\text{lb. mole-°R}}\right)^{1/2}$ 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_2O (see Fig. 2-2).

P_s = Absolute stack gas pressure, inches Hg.

M_s = Molecular weight of stack gas (wet basis), lb./lb.-mole. $M_d(1-B_{wo})+18B_{wo}$

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

B_{wo} = 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.

$$Q_s = 3600\ (1-B_{wo})\ V_s A \left(\frac{T_{std}}{(T_s)_{avg.}}\right)\left(\frac{P_s}{P_{std}}\right)$$

Equation 2-3

where:

Q_s = Volumetric flow rate, dry basis, standard conditions, ft.³/hr.

A = Cross-sectional area of stack, ft.²

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

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

6. *References.*

Mark, L. S., Mechanical Engineers' Handbook, McGraw-Hill Book Co., Inc., New York, N.Y., 1951.

Perry, J. H., Chemical Engineers' Handbook, McGraw-Hill Book Co., Inc., New York, N.Y., 1960.

Shigehara, R. T., W. F. Todd, and W. S. Smith, Significance of Errors in Stack Sampling Measurements. Paper presented at the Annual Meeting of the Air Pollution Control Association, St. Louis, Mo., June 14–19, 1970.

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

Vennard, J. K., Elementary Fluid Mechanics, John Wiley & Sons, Inc., New York, N.Y., 1947.

PLANT_____

DATE_____

RUN NO._____

STACK DIAMETER, in._____

BAROMETRIC PRESSURE, in. Hg._____

STATIC PRESSURE IN STACK (P_g), in. Hg._____

OPERATORS_____

SCHEMATIC OF STACK CROSS SECTION

Traverse point number	Velocity head, in. H_2O	$\sqrt{\Delta_p}$	Stack Temperature (T_S), °F
	AVERAGE:		

Figure 2-2. Velocity traverse data.

METHOD 3—GAS ANALYSIS FOR CARBON DIOXIDE, EXCESS AIR, AND DRY MOLECULAR WEIGHT

1. *Principle and applicability.*

1.1 Principle. An integrated or grab gas sample is extracted from a sampling point and analyzed for its components using an Orsat analyzer.

1.2 Applicability. This method should be applied only when specified by the test procedures for determining compliance with the New Source Performance Standards. The test procedure will indicate whether a grab sample or an integrated sample is to be used.

2. *Apparatus.*

2.1 Grab sample (Figure 3-1).

2.1.1 Probe—Stainless steel or Pyrex[1] glass, equipped with a filter to remove particulate matter.

2.1.2 Pump—One-way squeeze bulb, or equivalent, to transport gas sample to analyzer.

[1] Trade name.

2.2 *Integrated sample (Figure 3-2).*

2.2.1 Probe—Stainless steel or Pyrex[1] glass, equipped with a filter to remove particulate matter.

2.2.2 Air-cooled condenser or equivalent—To remove any excess moisture.

2.2.3 Needle valve—To adjust flow rate.

2.2.4 Pump—Leak-free, diaphragm type, or equivalent, to pull gas.

2.2.5 Rate meter—To measure a flow range from 0 to 0.035 cfm.

2.2.6 Flexible bag—Tedlar,[1] or equivalent, with a capacity of 2 to 3 cu. ft. Leak test the bag in the laboratory before using.

2.2.7 Pitot tube—Type S, or equivalent, attached to the probe so that the sampling flow rate can be regulated proportional to the stack gas velocity when velocity is varying with time or a sample traverse is conducted.

2.3 *Analysis.*

2.3.1 Orsat analyzer, or equivalent.

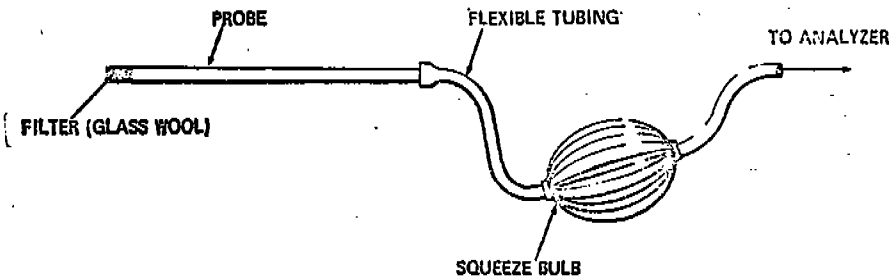


Figure 3-1. Grab-sampling train.

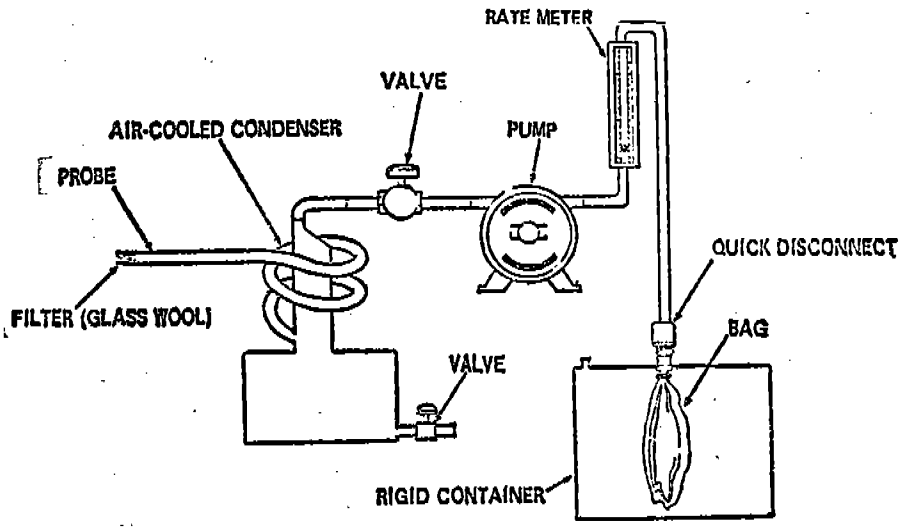


Figure 3-2. Integrated gas - sampling train.

3. *Procedure.*

3.1 Grab sampling.

3.1.1 Set up the equipment as shown in Figure 3-1, making sure all connections are leak-free. Place the probe in the stack at a sampling point and purge the sampling line.

3.1.2 Draw sample into the analyzer.

3.2 Integrated sampling.

3.2.1 Evacuate the flexible bag. Set up the equipment as shown in Figure 3-2 with the bag disconnected. Place the probe in the stack and purge the sampling line. Connect the bag, making sure that all connections are tight and that there are no leaks.

3.2.2 Sample at a rate proportional to the stack velocity.

3.3 Analysis.

3.3.1 Determine the CO_2, O_2, and CO concentrations as soon as possible. Make as many passes as are necessary to give constant readings. If more than ten passes are necessary, replace the absorbing solution.

3.3.2 For grab sampling, repeat the sampling and analysis until three consecutive samples vary no more than 0.5 percent by volume for each component being analyzed.

3.3.3 For integrated sampling, repeat the analysis of the sample until three consecutive analyses vary no more than 0.2 percent by volume for each component being analyzed.

4. *Calculations.*

4.1 Carbon dioxide. Average the three consecutive runs and report the result to the nearest 0.1% CO_2.

4.2 Excess air. Use Equation 3-1 to calculate excess air, and average the runs. Report the result to the nearest 0.1% excess air.

$$\%\,EA = \frac{(\%\,O_2) - 0.5(\%\,CO)}{0.264(\%\,N_2) - (\%\,O_2) + 0.5(\%\,CO)} \times 100 \qquad \text{equation 3-1}$$

where:

$\%EA$ = Percent excess air.

$\%O_2$ = Percent oxygen by volume, dry basis.

$\%N_2$ = Percent nitrogen by volume, dry basis.

$\%CO$ = Percent carbon monoxide by volume, dry basis.

0.264 = Ratio of oxygen to nitrogen in air by volume.

4.3 Dry molecular weight. Use Equation 3-2 to calculate dry molecular weight and average the runs. Report the result to the nearest tenth.

$$M_d = 0.44(\%CO_2) + 0.32(\%O_2) + 0.28(\%N_2 + \%CO) \qquad \text{equation 3-2}$$

where:

M_d = Dry molecular weight, lb./lb-mole.

$\%CO_2$ = Percent carbon dioxide by volume, dry basis.

$\%O_2$ = Percent oxygen by volume, dry basis.

$\%N_2$ = Percent nitrogen by volume, dry basis.

0.44 = Molecular weight of carbon dioxide divided by 100.

0.32 = Molecular weight of oxygen divided by 100.

0.23 = Molecular weight of nitrogen and CO divided by 100.

5. *References.*

Altshuller, A. P., et al., Storage of Gases and Vapors in Plastic Bags, Int. J. Air & Water Pollution, 6:75-81, 1963.

Conner, William D., and J. S. Nader, Air Sampling with Plastic Bags, Journal of the American Industrial Hygiene Association, 25:291-297, May-June 1964.

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

METHOD 4—DETERMINATION OF MOISTURE IN STACK GASES

1. *Principle and applicability.*

1.1 Principle. Moisture is removed from the gas stream, condensed, and determined volumetrically.

1.2 Applicability. This method is applicable for the determination of moisture in stack gas only when specified by test procedures for determining compliance with New Source Performance Standards. This method does not apply when liquid droplets are present in the gas stream[1] and the moisture is subsequently used in the determination of stack gas molecular weight.

Other methods such as drying tubes, wet bulb-dry bulb techniques, and volumetric condensation techniques may be used.

2. *Apparatus.*

2.1 Probe—Stainless steel or Pyrex[2] glass sufficiently heated to prevent condensation and equipped with a filter to remove particulate matter.

2.2 Impingers—Two midget impingers, each with 30 ml. capacity, or equivalent.

2.3 Ice bath container—To condense moisture in impingers.

2.4 Silica gel tube (optional)—To protect pump and dry gas meter.

2.5 Needle valve—To regulate gas flow rate.

2.6 Pump—Leak-free, diaphragm type, or equivalent, to pull gas through train.

2.7 Dry gas meter—To measure to within 1% of the total sample volume.

2.8 Rotameter—To measure a flow range from 0 to 0.1 c.f.m.

2.9 Graduated cylinder—25 ml.

2.10 Barometer—Sufficient to read to within 0.1 inch Hg.

2.11 Pitot tube—Type S, or equivalent, attached to probe so that the sampling flow rate can be regulated proportional to the stack gas velocity when velocity is varying with time or a sample traverse is conducted.

3. *Procedure.*

3.1 Place exactly 5 ml. distilled water in each impinger. Assemble the apparatus without the probe as shown in Figure 4-1. Leak check by plugging the inlet to the first impinger and drawing a vacuum. Insure that flow through the dry gas meter is less than 1% of the sampling rate.

3.2 Connect the probe and sample at a constant rate of 0.075 c.f.m. or at a rate proportional to the stack gas velocity. Continue sampling until the dry gas meter registers 1 cubic foot or until visible liquid droplets are carried over from the first impinger to the second. Record temperature, pressure, and dry gas meter readings as required by Figure 4-2.

3.3 After collecting the sample, measure the volume increase to the nearest 0.5 ml.

4. *Calculations.*

4.1 Volume of water vapor collected.

$$V_{wc}=\frac{(V_f-V_i)\rho_{H_2O}RT_{std}}{P_{std}M_{H_2O}}=0.0474\frac{ft.^3}{ml.}(V_f-V_i) \qquad \text{equation 4-1}$$

where:

V_{wc}=Volume of water vapor collected (standard conditions), cu. ft.

V_f=Final volume of impinger contents, ml.

V_i=Initial volume of impinger contents, ml.

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

ρ_{H_2O}=Density of water, 1 g./ml.

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

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

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

[1] If liquid droplets are present in the gas stream, assume the stream to be saturated, determine the average stack gas temperature by traversing according to Method 1, and use a psychrometric chart to obtain an approximation of the moisture percentage.

[2] Trade name.

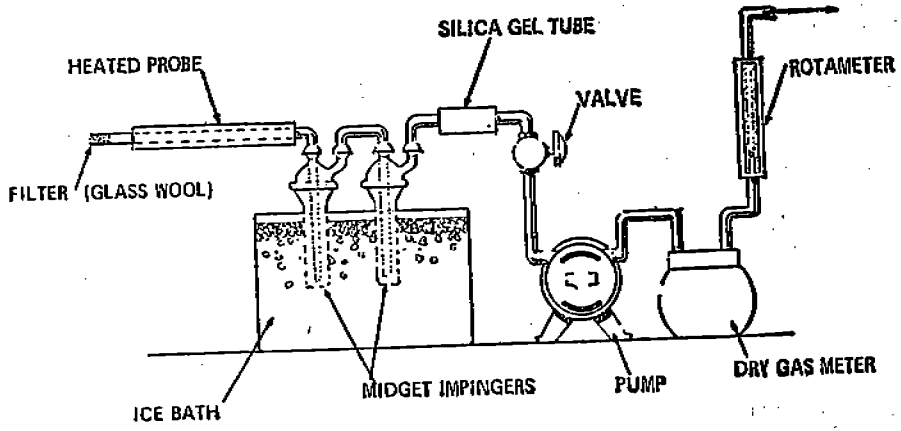


Figure 4-1. Moisture-sampling train.

LOCATION _____ COMMENTS

TEST _____

DATE _____

OPERATOR _____

BAROMETRIC PRESSURE _____

CLOCK TIME	GAS VOLUME THROUGH METER, (Vm), ft^3	ROTAMETER SETTING ft^3/min	METER TEMPERATURE, °F

Figure 4-2. Field moisture determination.

4.2 Gas volume.

$$V_{mc}=V_m\left(\frac{P_m}{P_{std}}\right)\left(\frac{T_{std}}{T_m}\right)=17.71\,\frac{°R}{in.\ Hg}\left(\frac{V_mP_m}{T_m}\right)\quad \text{equation 4-2}$$

where:

V_{mc} = 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, 530° R.

T_m = Absolute temperature at meter (°F+460), °R.

4.3 Moisture content.

$$B_{wc}=\frac{V_{wc}}{V_{wc}+V_{mc}}+B_{wm}=\frac{V_{wc}}{V_{wc}+V_{mc}}+(0.025)\quad \text{equation 4-3}$$

where:

B_{wc} = Proportion by volume of water vapor in the gas stream, dimensionless.

V_{wc} = Volume of water vapor collected (standard conditions), cu. ft.

V_{mc} = 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. DHEW, 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, 1968.

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[1] 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[1], 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.

[1] Trade name.

2.1.4 Filter Holder—Pyrex[1] glass with heating system capable of maintaining minimum temperature of 225° F.

2.1.5 Impingers / Condenser—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 ½-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[1], 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.

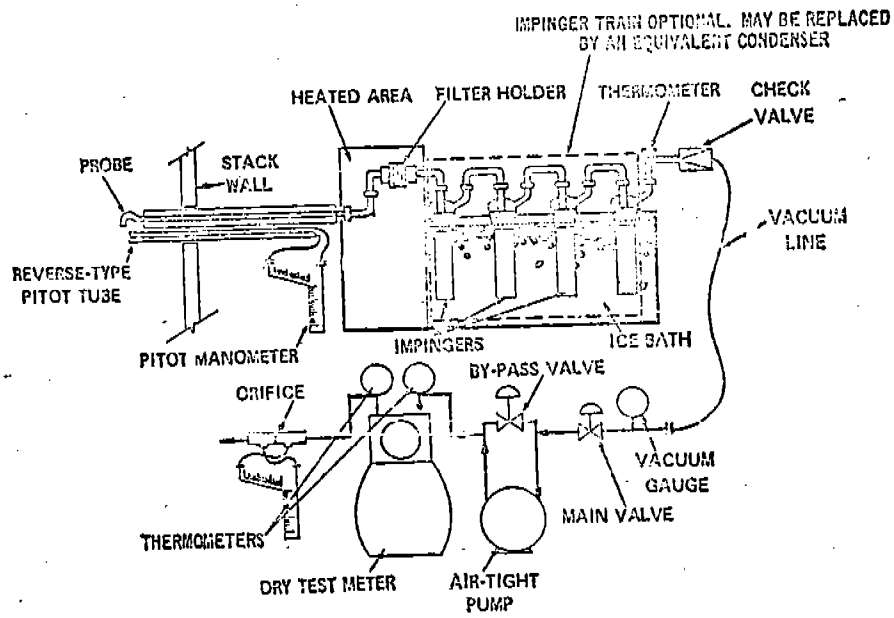


Figure 5-1. Particulate-sampling train.

3.3.2 Desiccant—Drierite,[1] 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[2] 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 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.

[1] Trade name.

[2] Dry using Drierite[1] at 70° F.±10° F.

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 _____
LOCATION _____
OPERATOR _____
DATE _____
RUN NO. _____
SAMPLE BOX NO. _____
METER BOX NO. _____
METER $\Delta H_@$ _____
C FACTOR _____

SCHEMATIC OF STACK CROSS SECTION

AMBIENT TEMPERATURE _____
BAROMETRIC PRESSURE _____
ASSUMED MOISTURE, % _____
HEATER BOX SETTING _____
PROBE LENGTH, m. _____
NOZZLE DIAMETER, in. _____
PROBE HEATER SETTING _____

TRAVERSE POINT NUMBER	SAMPLING TIME (θ), min.	STATIC PRESSURE (P_s), in. Hg	STACK TEMPERATURE (T_s), °F	VELOCITY HEAD (ΔP_s),	PRESSURE DIFFERENTIAL ACROSS ORIFICE METER (ΔH), in. H_2O	GAS SAMPLE VOLUME (V_m), ft^3	GAS SAMPLE TEMPERATURE AT DRY GAS METER		SAMPLE BOX TEMPERATURE, °F	TEMPERATURE OF GAS LEAVING CONDENSER OR LAST IMPINGER, °F
							INLET ($T_{m_{in}}$), °F	OUTLET ($T_{m_{out}}$), °F		
TOTAL							Avg.	Avg.		
AVERAGE							Avg.			

Figure 5-2. Particulate field data.

4.2 Sample recovery. Exercise care in moving the collection train from the test site to the sample recovery area to minimize the loss of collected sample or the gain of extraneous particulate matter. Set aside a portion of the acetone used in the sample recovery as a blank for analysis. Measure the volume of water from the first three impingers, then discard. Place the samples in containers as follows:

Container No. 1. Remove the filter from its holder, place in this container, and seal.

Container No. 2. Place loose particulate matter and acetone washings from all sample-exposed surfaces prior to the filter in this container and seal. Use a razor blade, brush, or rubber policeman to lose adhering particles.

Container No. 3. Transfer the silica gel from the fourth impinger to the original container and seal. Use a rubber policeman as an aid in removing silica gel from the impinger.

4.3 Analysis. Record the data required on the example sheet shown in Figure 5-3. Handle each sample container as follows:

Container No. 1. Transfer the filter and any loose particulate matter from the sample container to a tared glass weighing dish, desiccate, and dry to a constant weight. Report results to the nearest 0.5 mg.

Container No. 2. Transfer the acetone washings to a tared beaker and evaporate to dryness at ambient temperature and pressure. Desiccate and dry to a constant weight. Report results to the nearest 0.5 mg.

Container No. 3. Weigh the spent silica gel and report to the nearest gram.

5. *Calibration.*

Use methods and equipment which have been approved by the Administrator to calibrate the orifice meter, pitot tube, dry gas meter, and probe heater. Recalibrate after each test series.

6. *Calculations.*

6.1 Average dry gas meter temperature and average orifice pressure drop. See data sheet (Figure 5-2).

6.2 Dry gas volume. Correct the sample volume measured by the dry gas meter to standard conditions (70° F., 29.92 inches Hg) by using Equation 5-1.

$$V_{m_{std}} = V_m\left(\frac{T_{std}}{T_m}\right)\left(\frac{P_{bar}+\frac{\Delta H}{13.6}}{P_{std}}\right) = \left(17.71\ \frac{°R}{in.\ Hg}\right)V_m\left(\frac{P_{bar}+\frac{\Delta H}{13.6}}{T_m}\right)$$

equation 5-1

where:

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

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

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

T_m = Average dry gas meter temperature, °R.

P_{bar} = Barometric pressure at the orifice meter, inches Hg.

ΔH = Average pressure drop across the orifice meter, inches H_2O.

13.6 = Specific gravity of mercury.

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

6.3 Volume of water vapor.

$$V_{w_{std}} = V_{l_c}\left(\frac{\rho_{H_2O}}{M_{H_2O}}\right)\left(\frac{RT_{std}}{P_{std}}\right) = \left(0.0474\ \frac{cu.\ ft.}{ml.}\right)V_{l_c}$$

equation 5-2

where:

$V_{w_{std}}$ = Volume of water vapor in the gas sample (standard conditions), cu. ft.

V_{l_c} = Total volume of liquid collected in impingers and silica gel (see Figure 5-3), ml.

ρ_{H_2O} = Density of water, 1 g./ml.

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

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

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

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

6.4 Moisture content.

$$B_{wo} = \frac{V_{w_{std}}}{V_{m_{std}} + V_{w_{std}}}$$

equation 5-3

where:

B_{wo} = Proportion by volume of water vapor in the gas stream, dimensionless.

$V_{w_{std}}$ = Volume of water in the gas sample (standard conditions), cu. ft.

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

6.5 Total particulate weight. Determine the total particulate catch from the sum of the weights on the analysis data sheet (Figure 5-3).

6.6 Concentration.

6.6.1 Concentration in gr./s.c.f.

$$c'_s = \left(0.0154\frac{gr.}{mg.}\right)\left(\frac{M_n}{V_{m_{std}}}\right)$$

equation 5-4

where:

c'_s = Concentration of particulate matter in stack gas, gr./s.c.f., dry basis.

M_n = Total amount of particulate matter collected, mg.

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

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*	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.

$$c_s = \frac{\left(\frac{1}{453{,}600}\ \frac{\text{lb.}}{\text{mg.}}\right) M_n}{V_{m_{std}}} = 2.205 \times 10^{-6} \frac{M_n}{V_{m_{std}}} \qquad \text{equation 5-5}$$

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.

$$I = \frac{T_s\left[\frac{V_{1_c}(\rho_{H_2O})R}{M_{H_2O}} + \frac{V_m}{T_m}\left(P_{bar} + \frac{\Delta H}{13.6}\right)\right]}{\theta V_s P_s A_n} \times 100$$

$$= \frac{\left(1.667\frac{\text{min.}}{\text{sec.}}\right)\left[\left(0.00267\frac{\text{in. Hg-cu. ft.}}{\text{ml.-°R}}\right)V_{1_c} + \frac{V_m}{T_m}\left(P_{bar} + \frac{\Delta H}{13.6}\right)\right]}{\theta V_s P_s A_n} \qquad \text{Equation 5-6}$$

where:

I = Percent of isokinetic sampling.

V_{1_c} = Total volume of liquid collected in impingers and silica gel (See Fig. 5-3), ml.

ρ_{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.

ΔH = Average pressure drop across the orifice (see Fig. 5-2), inches H_2O.

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

θ = 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.

6.3 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[1] 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,

[1] Trade names.

APPENDIX D

LABORATORY REPORT

D.1 ON-SITE HANDLING AND TRANSFER, PARTICULATE

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 contamination. At the motel, 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 using a long handled brush rotated through it under a continuous stream of acetone. The brush was also carefully cleaned, and all washings collected in the glass jar. The probe was finally checked visually for any residue.

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 the 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.

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

D.2 LABORATORY HANDLING AND ANALYSIS, PARTICULATE

D.2.1 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 a tared dishes using a fine pair of tweezers. Care was taken to place a piece of aluminum foil under the transfer operation. A "staticmaster" brush was used to brush any find 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.

D.2.2 Acetone Washes

The 250 ml. beakers to be used for the acetone wash transfers 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" and handled with tongs or "Kimwipes".

The jars containing the acetone washes were left loosely covered in a hood until the acetone was evaporated. Once the acetone was evaporated, the glass jar was rinsed with acetone, using a rubber policeman, and the washings collected in the tared beaker. When the acetone wash of the front half contained considerable particulate matter, the dried particulate cake was transferred carefully with a spatula into the tared beaker along with the final acetone rinse.

After the acetone had evaporated, the beakers were desiccated for 24 hours and weighed to a constant weight. Where water was present in the acetone wash, it was evaporated in an oven at 90°C after the acetone had all evaporated.

D.2.3 Water Washes

The level of water in the collection bottles was marked for later volume measurement. Each water wash was then transferred into a 2000 ml. separatory funnel and extracted three times with 25 ml. portions of chloroform. Often, where a large volume of water was collected (above 500 ml.) a fourth extraction was used. The chloroform extracts were collected directly in a tared beaker prepared in the same manner as described in the previous section.

Extraction with three 50 ml. portions of ether followed, collecting the water portion in the original jars. The ether extracts were combined with the chloroform extracts. These were then washed with distilled water in the separatory funnel and returned to the tared beaker for evaporation.

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. A summary of weight measurements is shown in Table D-1.

TABLE D-1 SUMMARY OF WEIGHT MEASUREMENTS

	Run 1*					Run 2*					Run 3*				
	Gross (g)	Tare (g)	Net (mg)	Blank (mg)	Final (mg)	Gross (g)	Tare (g)	Net (mg)	Blank (mg)	Final (mg)	Gross (g)	Tare (g)	Net (mg)	Blank (mg)	Final (mg)
Container #1 (Filter)	1.8045	1.7590	45.5	-	45.5	3.666	3.5973	68.7	-	68.7	1.7895	1.7610	28.5	-	28.5
Container #2 (Acetone wash front half)	98.5630	98.5220	41.0	1.0	40.0	97.4990	97.4362	62.8	1.2	61.6	93.4418	93.3475	94.3	1.6	92.7
Container #3a (Organic Extract)	100.1905	100.1760	14.5	0.0	14.5	93.9740	93.9100	64.0	0.0	64.0	93.9655	93.9630	2.5	0.0	2.5
Container #3b (Water after extraction)	39.4520	89.4225	29.5	0.0	29.5	89.2405	89.1967	43.8	0.0	43.8	99.0190	99.0010	18.0	0.0	18.0
Container #5 (Acetone wash back half)	102.359	102.3475	11.5	1.1	10.4	95.1155	95.1025	13.0	0.7	12.3	99.3710	99.3665	4.5	0.9	3.6
	Probe, cyclone, filter (mg)				85.5	Probe, cyclone, filter (mg)				130.3	Probe, cyclone, filter, (mg)				121.2
	Total (mg)				139.9	Total (mg)				250.4	Total (mg)				145.3

* Without straightening vanes

TABLE D-1 SUMMARY OF WEIGHT MEASUREMENTS (continued)

	Run 5*					Run 6**				
	Gross (g)	Tare (g)	Net (mg)	Blank (mg)	Final (mg)	Gross (g)	Tare (g)	Net (mg)	Blank (mg)	Final (mg)
Container #1 (Filter)	1.8015	1.7675	34.0	-	34.0	1.8440	1.8190	25.0	-	25.0
Container #2 (Acetone wash front half)	99.7555	99.5700	185.3	1.0	184.5	101.6535	101.4320	221.5	0.8	220.7
Container #3a (Organic Extract)	101.6245	101.6190	5.5	0.4	5.5	100.3445	100.3435	1.0	0.0	1.0
Container #3b (Water after extraction)	85.4995	85.4678	31.7	0.0	31.7	99.0000	98.9745	25.5	0.0	25.5
Container #5 (Acetone wash back half)	99.4355	99.4295	6.0	0.4	5.6	98.5110	98.4995	11.5	0.8	10.7
	Probe, cyclone, filter (mg)				218.5	Probe, cyclone, filter (mg)				245.7
	Total (mg)				261.3	Total (mg)				282.9

	Run 7**					Run 8**				
	Gross (g)	Tare (g)	Net (mg)	Blank (mg)	Final (mg)	Gross (g)	Tare (g)	Net (mg)	Blank (mg)	Final (mg)
Container #1 (Filter)	1.8510	1.8268	24.2	-	24.2	1.8830	1.8568	26.2	-	26.2
Container #2 (Acetone wash front half)	103.7505	103.5025	248.0	1.7	246.3	99.6070	99.4385	168.5	1.8	166.7
Container #3a (Organic Extract)	94.1477	94.1450	2.7	0.0	2.7	97.2865	97.2790	7.5	0.0	7.5
Container #3b (Water after extraction)	95.6230	95.5905	32.5	0.0	32.5	96.2685	96.2405	28.0	0.0	28.0
Container #5 (Acetone wash back half)	97.8040	97.7195	12.5	0.4	12.1	97.3770	97.3750	2.0	0.3	1.7
	Probe, cyclone, filter (mg)				270.5	Probe, cyclone, filter (mg)				192.9
	Total (mg)				317.8	Total (mg)				230.1

* Without straightening vanes
** With straightening vanes

APPENDIX E

TEST LOG

On Monday, September 11, 1972, the Scott team arrived at the Van Sant, Virginia plant of Island Creek Coal Company and set up the test equipment. The velocity and temperature information from the previous tests was used for selecting the appropriate nozzle size. The test equipment was completely set up at the site for the test the next day. The cleanup and field laboratory facilities were then prepared at the motel site.

On Tuesday, September 12, 1972, the leak test was performed and the first test was started at 0925. The test was stopped at 0927 because the correct ΔH could not be obtained. Consultation with Tom Ward resolved that the highest ΔP's would be found at the first six traverse points which was not anticipated. The balance of the first run was then completed without incident at 1142. The ±10% isokinetic requirement was maintained. This test was run with ½ filter cake feed.

A second test was started at 1331. The long delay between tests was due to stopping and starting of scrubbers. During the test the probe heater malfunctioned for a short period. While sampling at the 18th traverse point on the second traverse, the filter apparently became overloaded causing the vacuum to climb to 22" Hg. At this point the filter frit broke causing a twelve minute shut down while the filter and holder were replaced. The test was completed at 1545. During this test there was full filter cake.

Upon arrival at the plant on Wednesday, it was found that a wild cat strike had started during the second shift on Tuesday. Thus, the equipment was prepared and set up for another test to begin when the strike ended. The third test was started at 2104 on Wednesday. The probe was not heated during the test because of a bad fuse. The test was stopped at 2252 when a malfunction occurred in the plant conveyer system. This forced the plant to discontinue operation. Thus, the test was finished somewhat short of the full amount of time of the normal tests.

On Thursday straightening vanes were installed in the stack and the fourth test was started at 0945. The installation of the vanes caused a considerably lower ΔP reading. The test was stopped at 0953 to insure that the pitot tube was in fact clear and operating properly. The test was continued at 1004. At 1035 one of the straightening vanes apparently broke loose and was blown out of the stack. At 1045 an unexplained two inch rise was observed in the ΔH reading. Shortly thereafter the probe was struck by another part of the straightening vanes which had broken loose. Upon inspection it was found that the probe was broken and roughly a third of vanes had broken loose from the assembly.

Testing was called to a halt until further arrangements could be made. The Scott team traveled home on Friday.

The Scott team returned to the plant on Wednesday, September 20, 1972, and set up for a test without the straightening vanes in the stack. Test number 5 was started at 0940 and continued without incident until 1143. After test 5 was completed, new straightening vanes were placed in the stack.

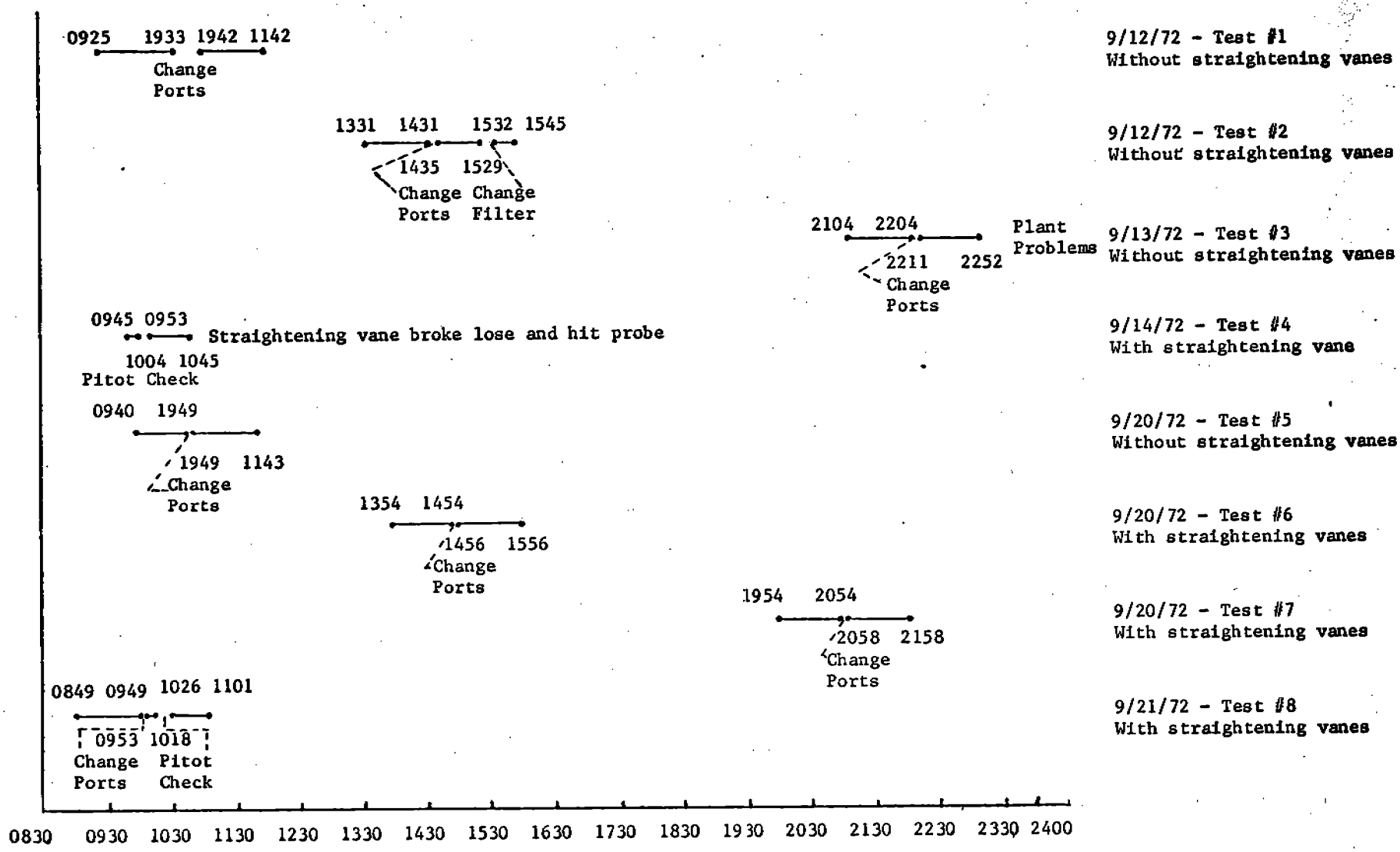
SRL 1281 65 1072

Test 6 was started at 1354 and was completed at 1556 without incident. Test 7 was started at 1954 and completed at 2158.

On Thursday test 8 was started at 0849. The test was stopped at 1018 because of concern about low ΔP readings. Assured that nothing was amiss the test was continued at 1026 and completed at 1101.

The equipment was packed and the Scott team traveled home.

FIGURE E-1 SUMMARY OF TEST PROGRAM



SCOTT RESEARCH LABORATORIES, INC.

APPENDIX F

PROJECT PARTICIPANTS AND TITLES

The personnel taking part in the project include:

Thomas Ward	Project Officer - EPA
Charles Sedman	Project Engineer - EPA
Norman R. Troxel	Senior Engineer - SRL
Joseph Wilson	Field Team Leader - SRL
Jyotin Sachdev	Engineer - SRL
John Trump	Technician - SRL
Margaret Husic	Chemist - SRL
Louis R. Reckner	Manager, Atmospheric Chemistry & Industrial Emissions Dept. - SRL