

COAL PREPARATION PLANT EMISSION TESTS

TEST NO. 1281-25

CONSOLIDATION COAL COMPANY

Bishop, West Virginia

PREPARED FOR

ENVIRONMENTAL PROTECTION AGENCY

Research Triangle Park

North Carolina 27711

Contract No 68-02-0233



SCOTT RESEARCH LABORATORIES, INC.

PLUMSTEADVILLE, PENNSYLVANIA 18949

SRL 1281 25 0472

Test No. 1281-25

Consolidation Coal Company
Bishop, West Virginia, Norman R. Troxel

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

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1.0 INTRODUCTION

Scott Research Laboratories, Inc. performed source sampling tests at the Bishop, West Virginia plant of Consolidation Coal Company during the week of February 28, 1972. The plant uses a Research Cottrell venturi scrubber to control the exhaust gas emissions from a coal cleaning and preparation operation.

The outlet exhaust gases, as they were being emitted to the atmosphere, were sampled and analyzed for the determination of total particulate loading, oxides of nitrogen, sulfur dioxide, carbon dioxide, carbon monoxide, carbon dioxide, and oxygen concentrations. Since there was an easily accessible location for sampling the exhaust gases before they entered the venturi scrubber, samples were also collected in the inlet to the scrubber and the same analyses performed as on the outlet samples. The particulate samples were collected simultaneously at the inlet and outlet of the scrubber; and the gaseous samples were taken at both locations during the particulate traverses.

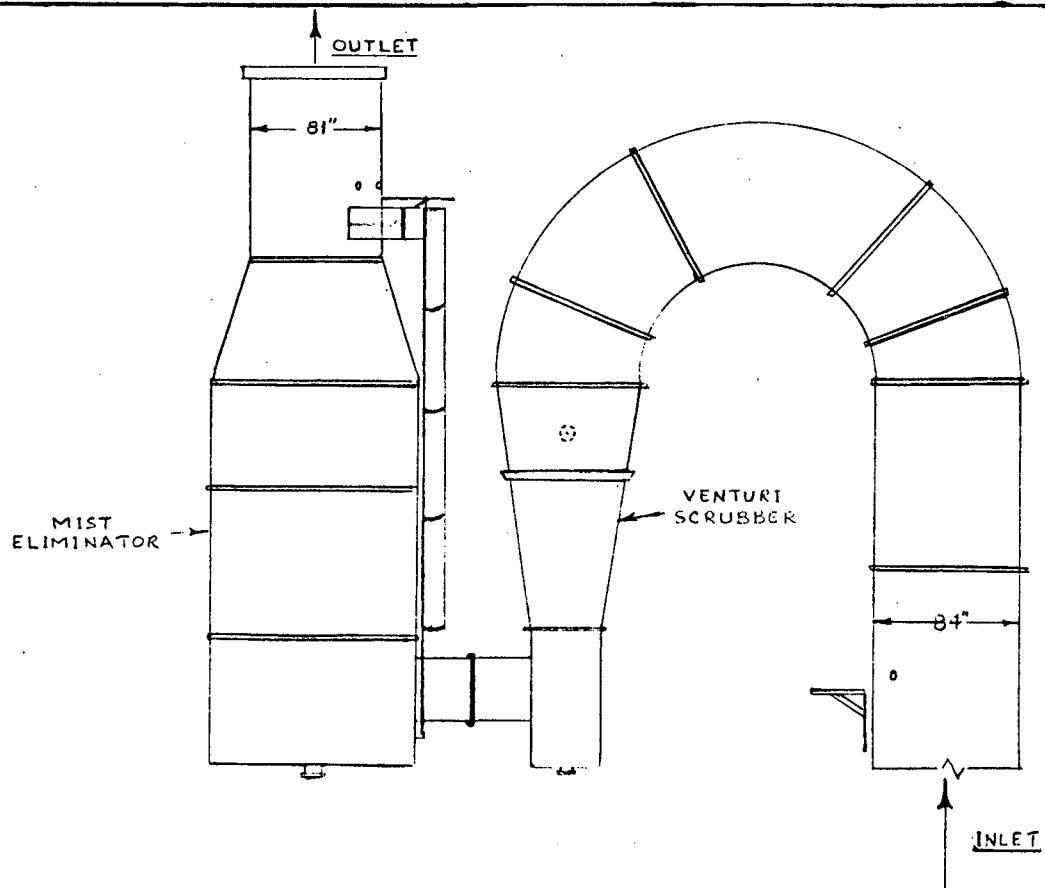
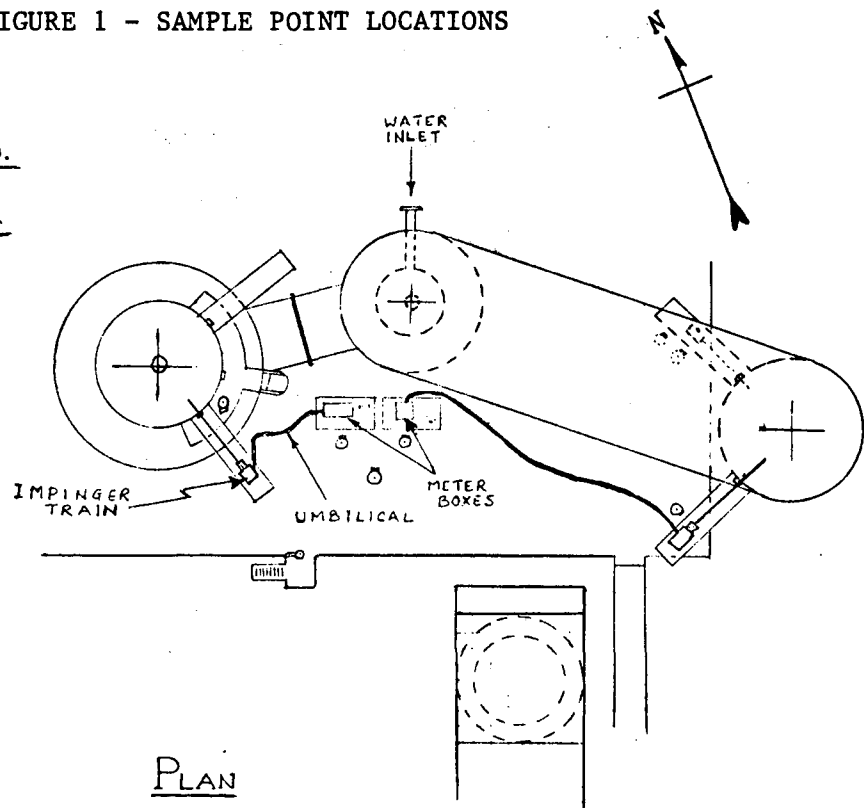
Three complete runs were performed at the plant. One run was conducted each day on February 29, March 1, and 2, 1972. Figure 1 shows the location of the sampling points at the plant.



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FIGURE 1 - SAMPLE POINT LOCATIONS

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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. Appendix B presents all of the gaseous results, and the raw data sheets are included as Appendix C.

From Table 2 it is observed that the particulate matter collected from the outlet during Run 1 is somewhat higher than what was collected during the other two runs. The higher weight was due to an increase both in the front half and back half of the train. The amount of particulate matter collected at the inlet varied considerably from run to run. The first day a total of 55,612.5 mg. were collected, while the next day 83,626.0 mg. were collected, and then only 37,437.0 mg. were collected during the third run.

The average value for the outlet concentration of the second and third run was only 0.013 gr/scf, considering only the front half. This amounts to an emission rate of only 12.5 lbs/hr.

From Table 1 it is observed that the sulfur dioxide concentrations vary all the way from 0.8 ppm up to 3155.6 ppm. The values do not appear to be questionable since the outlet and inlet values both show the same variation from one run to another.

The NO_x values were fairly consistent for both the inlet and outlet. The outlet NO_x concentration averaged 57.1 ppm and the average inlet concentration was 73.1 ppm.

On the basis of the front half of the particulate train values (gr/scf) the collection efficiency of the scrubber varied from 99.79%





TABLE 1 - SUMMARY OF TEST RESULTS

Run Number	1-0	2-0	3-0	1-I	2-I	3-I
Sample Point Location	Outlet	Outlet	Outlet	Inlet	Inlet	Inlet
Sample Date	2/29/72	3/1/72	3/2/72	2/29/72	3/1/72	3/2/72
Sample Gas Vol., scf.	90.78	87.48	88.78	95.44	89.84	94.76
Moisture, %	14.37	12.98	12.74	13.26	15.32	15.32
Stack Gas Temp., °F	125	125	125	149	145	145
Stack Gas Vel., fpm	4054	4060	4232	3906	3935	4055
Stack Gas Vol., SCFM	106,330	107,530	111,560	113,630	112,030	114,860
Particulate Collected						
Probe, cyclone, filter, mg.	98.1	76.3	77.4	55,612.5	83,626.0	37,437.0
Total, mg.	121.3	89.7	89.3	55,743.5	83,702.5	37,474.0
Particulate Concentration						
Probe, cyclone, filter, gr/scf	0.017	0.013	0.013	8.974	14.336	6.084
Total, gr/scf	0.021	0.016	0.015	8.995	14.349	6.090
Particulate Emissions						
Probe, cyclone, filter, lb/hr.	15.16	12.39	12.83	8739.00	13764.00	5988.80
Total, lb/hr.	18.77	14.55	14.81	8759.40	13776.40	5994.70
Percent Isokinetic	96.95	92.39	90.37	102.58	97.93	100.75
Carbon Monoxide, %	0.0	0.0	0.0	0.0	0.0	0.0
Carbon Dioxide, %	1.0	0.7	0.1	0.9	0.9	1.0
Oxygen, %	19.2	19.7	20.6	19.7	18.6	19.0
Sulfur Dioxide, ppm	0.8	3155.6	214.1	17.1	2904.2	300.0
NO _x , ppm	57.7	51.1	62.5	64.8	69.4	85.1



TABLE 2 - PARTICULATE WEIGHTS SUMMARY

Run Number: Sample Location	<u>1-0</u> Outlet	<u>2-0</u> Outlet	<u>3-0</u> Outlet	<u>1-I</u> Inlet	<u>2-I</u> Inlet	<u>3-I</u> Inlet
Container 1, mg.	39.8	51.5	30.0	273.5	253.0	202.0
Container 2, mg.	58.3	24.8	47.4	55,339.0	83,373.0	37,235.0
Container 3a, mg.	3.0	2.9	0*	3.0	32.0	6.0
Container 3b, mg.	8.1	1.7	3.1	21.0	32.5	22.0
Container 5, mg.	12.1	8.7	8.8	107.0	12.0	9.0
Probe, cyclone filter, mg.	98.1	76.3	77.4	55,612.5	83,626.0	37,437.0
Total, mg.	121.3	89.7	89.3	55,743.5	83,702.5	37,474.0

* Blank was higher than sample value.

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to 99.91%. For Run 1 the efficiency was 99.81%, Run 2 it was 99.91%, and for Run 3 it was 99.79%.



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3.0 PROCESS DESCRIPTION AND OPERATION

The Bishop preparation plant was built in the mid 1950's and has been upgraded to process coal through froth flotation cells. An old Link-Belt multilouvre thermal dryer was replaced by a Link-Belt Fluid Bed dryer in March 1970. At that time, a Research Cottrell Flooded Disc scrubber was installed to clean the exhaust gases before being emitted to the atmosphere. The dryer exhaust fans are rated at 183,000 cfm at 170°F and the scrubber design calls for a 26" ΔP according to Research Cottrell.

The Bishop preparation plant has the capability to process all stored coal in 5 hours of continuous operation. Thus, only one test could be made per day. During the tests, 50 percent of the filter cake from flotation cells was being dried in the thermal dryer. This is the maximum amount of cake allowed by design specifications.

Loadout of rail cars during the tests indicated the plant production rate was 400 TPH of cleaned coal. Of this it was calculated 300 tons were being fed to the dryer. Design capacity of the dryer was 368 TPH cleaned, dried coal and 40 TPH exhaust moisture. Plant blueprints gave an operating load of 293 TPH to the dryer.

The control panel in the plant was monitored and the following data taken during the tests:



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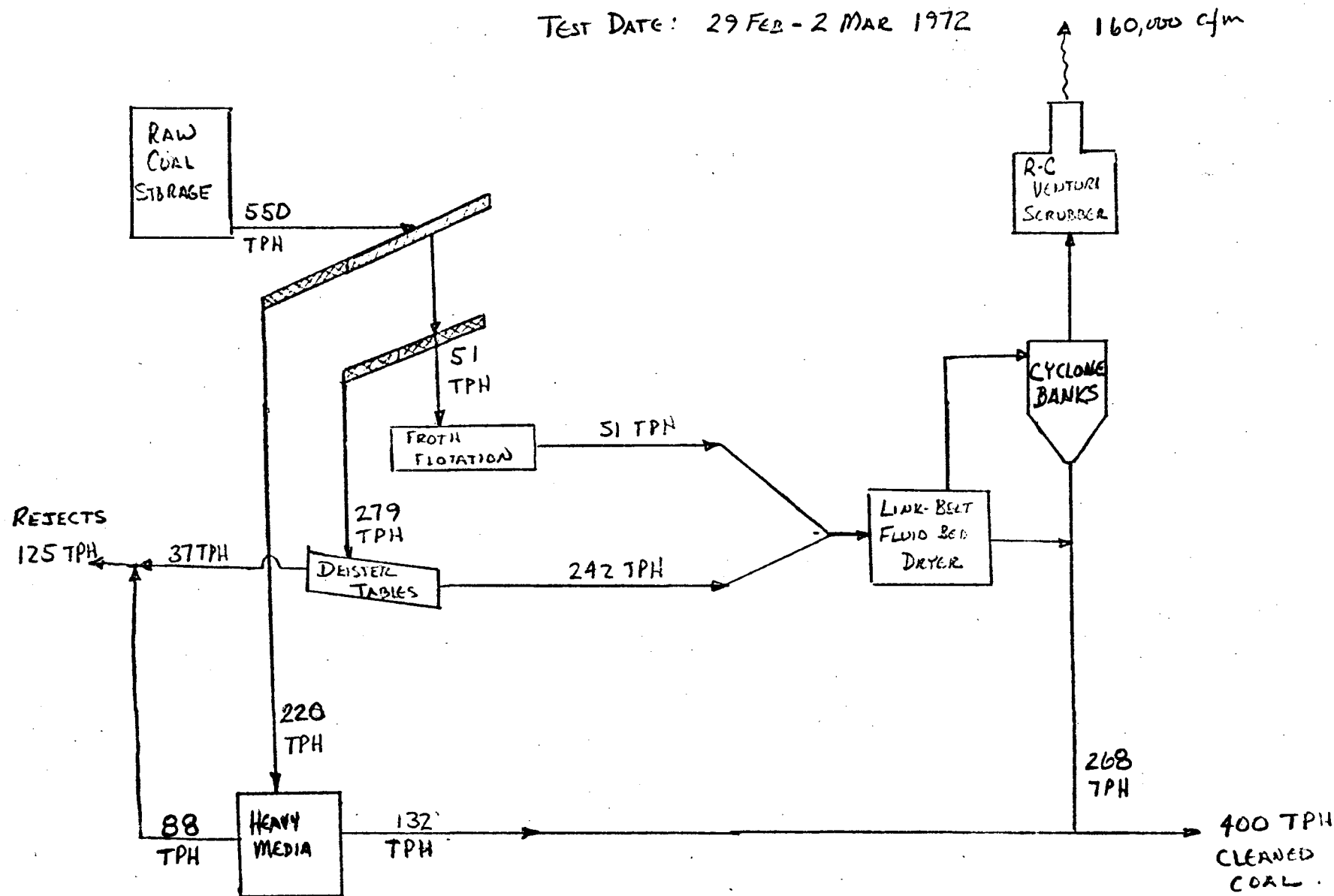
	<u>1st Run</u>	<u>2nd Run</u>	<u>3rd Run</u>
Exhaust fan, amp.	300	300	300
Roll feeder temp., °F	780-800	800	800
Furnace air temp., °F	1020-1240	1000-1210	960-1190
Dryer-inlet temp., °F	910-1030	940-1060	880-1020
Pulverizer temp., °F	180-185	180-185	175-185
Dryer Exhaust, °F	130-140	130-140	130-140
Exhaust fan inlet, °F	170	170	165-170

Taps were installed across the venturi throat so that the pressure drop could be measured during the tests. Readings showed that the scrubber was not operating as designed. The pressure drop measured was in the range of 16-17 in. water gauge.





PLANT: CONSOLIDATION BISHOP
SEAM: POCAHONTAS #3 & #5
TEST DATE: 29 FEB - 2 MAR 1972



PROCESS DIAGRAM

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4.0. LOCATION OF SAMPLING POINTS

The exhaust gases from the coal cleaning operation pass through an 84 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 81 inch diameter stack.

The location (inlet) for sampling the gases before they enter the venturi scrubber was chosen in a straight vertical section of the 84 inch diameter duct. The two ports were installed at 90° apart and were located approximately 40 feet downstream from a bend and approximately 15 feet upstream from a bend. Special sampling platforms were required to support the sampling train at both ports. An angle iron support extending ten feet out from the stack supported a plywood platform.

The location (outlet) for sampling the gases prior to the discharge to the atmosphere was in a straight section of the 81 inch diameter stack atop the mist eliminator. The sampling ports were located approximately 7 feet upstream from the top of the stack and approximately 10 feet downstream from the outlet of the mist eliminator.

There were three sample ports spaced 45° apart at the outlet location. The two ports at 90° apart, were used for the particulate sampling. The center port was used for gaseous sampling. The outlet ports were approximately 30 feet above the platform area where the particulate sample control units were located. Again, special support systems were required to hold the particulate sampling train. Figure 1 shows the physical layout of the system and the location of the sample ports.



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Figure 2 shows the traverse points used at each sample point location. At the inlet, 36 traverse points were sampled four minutes each. At the outlet, 48 traverse points were sampled 3 minutes each. At the outlet location, in order to stay at least two inches away from the wall, the first two and last two points on the traverse were combined. Thus, the first and last points (each containing two traverse points) were sampled for six minutes each. The traverse points were chosen in accordance with Method 1 published in the Federal Register, Volume 36, No. 24.

The two ports at each location were designated as A and B. A was the port on the left and B was the port 90° to the right of A.



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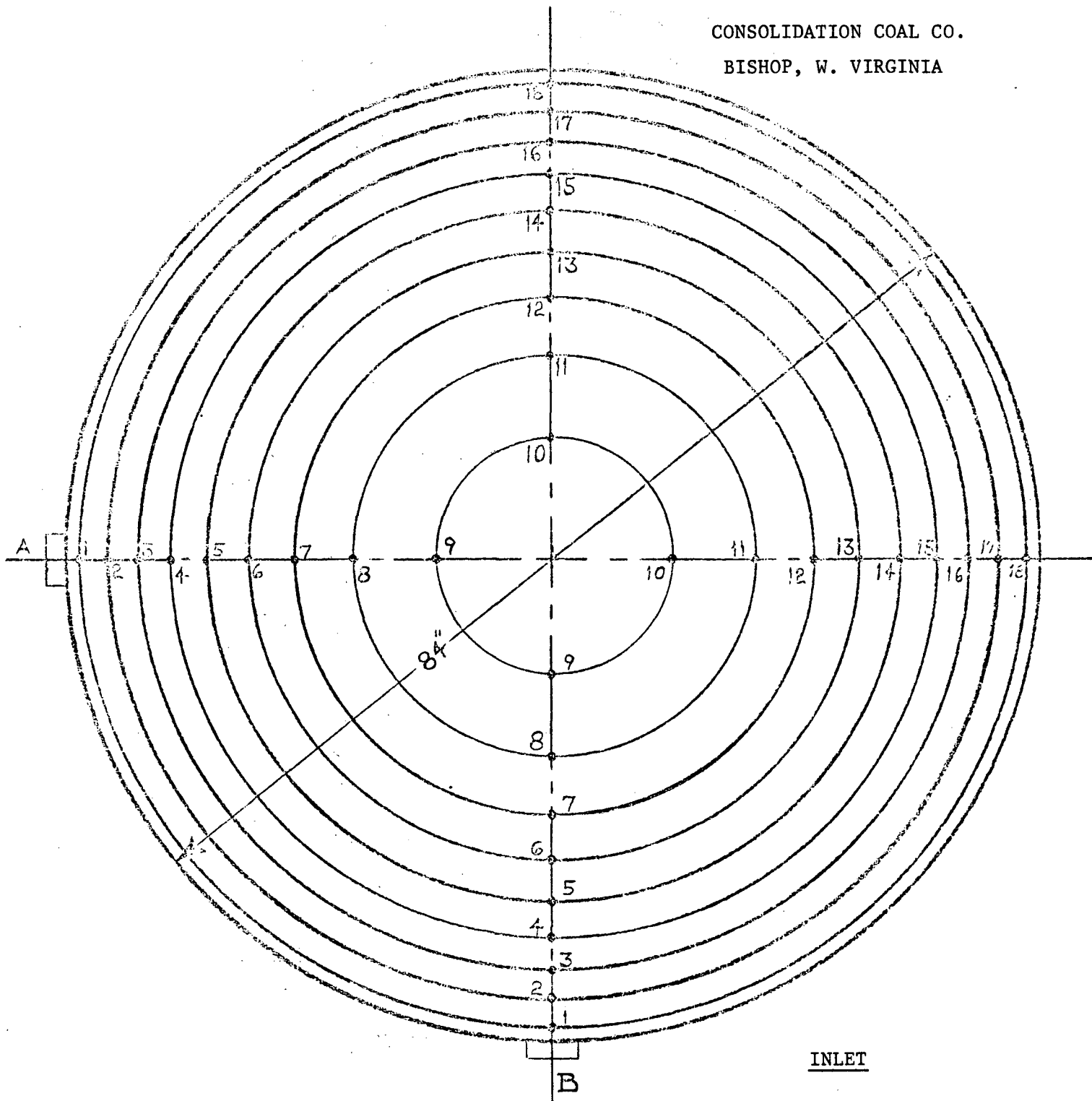
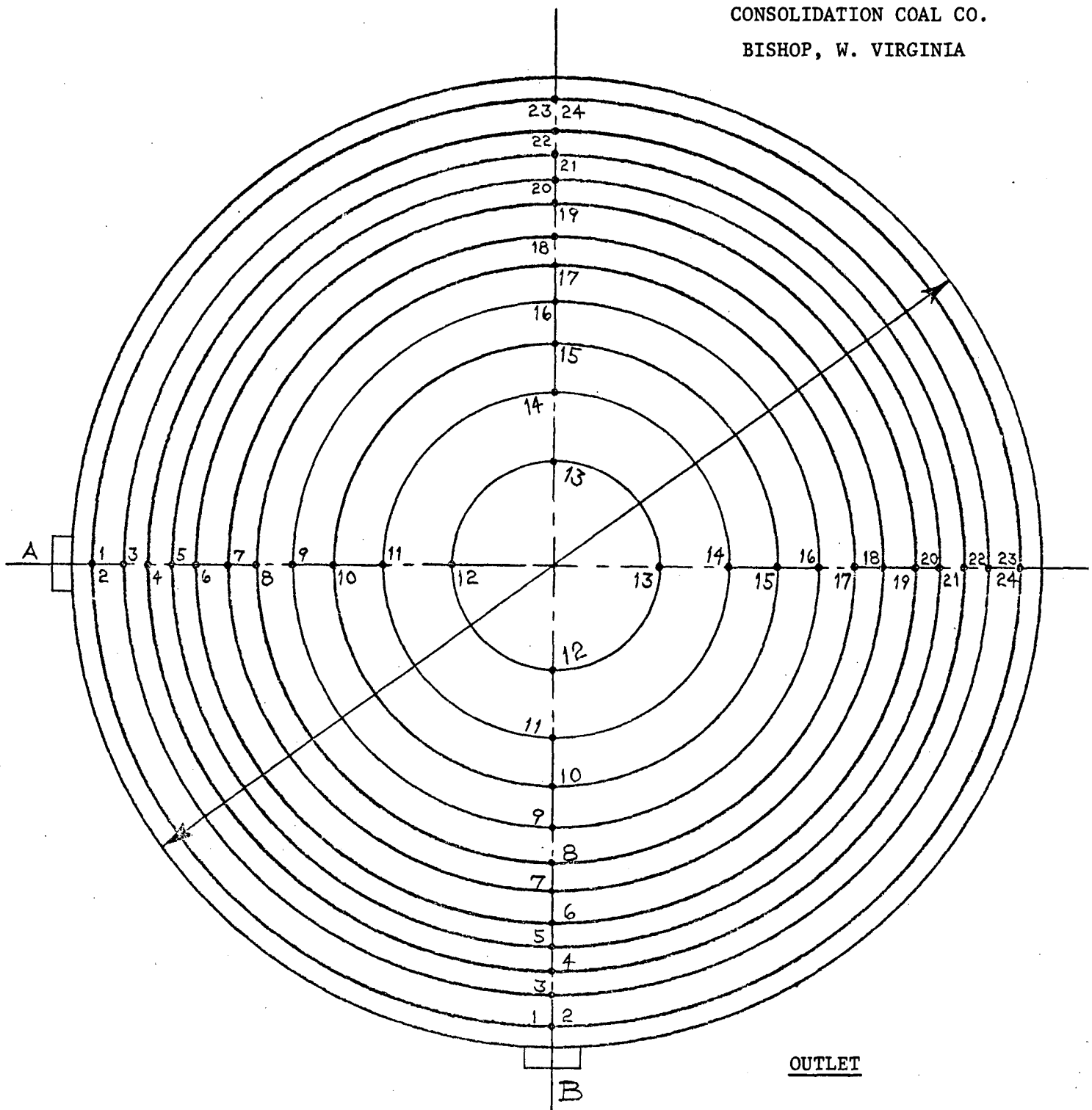


FIGURE 2 TRAVERSE POINT LOCATIONS



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CONSOLIDATION COAL CO.
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(continued)

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5.0 SAMPLING AND ANALYTICAL PROCEDURES

5.1 PARTICULATE SAMPLING AND ANALYTICAL PROCEDURES

Samples were collected for the determination of particulate matter simultaneously from the inlet and outlet of the venturi scrubber. The sampling 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.

5.2 GASEOUS SAMPLING PROCEDURES

Stack gas samples were taken at regular intervals during each particulate sampling traverse to determine the concentration of



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O₂, CO, CO₂, NO_x and SO₂ present in the stack effluent. The sampling locations were the same with respect to the venturi scrubber as those used for the particulate samples. The sampling and analytical procedures used were in accordance with Federal Register, Volume 36, No. 247, December 23, 1972, "Standards of Performance for New Stationary Sources".

5.3 SO₂ SAMPLING AND ANALYTICAL PROCEDURES

All SO₂ samples were taken through a ½ inch O.D. glass probe heated to approximately 250°F. This was connected to a glass sample train consisting of one bubbler and three impingers connected in series. The bubbler contained 15 ml. of 80% isopropanol and was used to remove any SO₃ present in the sample stream. The SO₂ was collected in the next two impingers, each containing 15 ml. of 3% H₂O₂. The third impinger was used to trap any overflow from the two SO₂ impingers.

Each sampling period was 30 minutes in duration, and the sampling rate was maintained at approximately 1 liter per minute with an in-line flowmeter. A temperature compensated dry gas meter was used to measure the total volume of gas sampled.

Following each test, the SO₂ samples were transferred to polyethylene bottles with distilled water washes. All samples were then returned to the laboratory where they were diluted to volume in a 50 or 100 ml. volumetric flask. A suitable aliquot of each sample was then titrated with a 0.01 N barium perchlorate solution in the presence of thorin indicator. The results were reported as parts per million SO₂.



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5.4 NO_x SAMPLING AND ANALYTICAL PROCEDURES

The NO_x samples were taken using the same heated glass probe described in Section 6.3. Each sample was drawn through this probe into a previously evacuated 2 liter flask containing 25 ml. of NO_x absorbing solution. The flasks were shaken for 5 minutes following each sampling period and then allowed to stand for at least 16 hours. Following this, the samples were shaken again for 2 minutes just prior to measuring the final flask pressure. The samples were then transferred to glass shipping bottles with distilled water washes and neutralized with 1.0 N sodium hydroxide. At the end of the test period, all samples were returned to the laboratory for analysis.

The samples were analyzed via the phenoldisulfonic acid procedure described in the aforementioned Federal Register. The absorbances were measured with a Bausch and Lomb Spectronic 20 Colorimeter. The results were reported as parts per million NO₂.

5.5 ORSAT SAMPLING AND ANALYTICAL PROCEDURE

Integrated gas samples were taken for Orsat analysis (CO, CO₂ and O₂) during each particulate sampling period. The sampling apparatus consisted of a 1/4 inch O.D. stainless steel probe, a stainless steel coiled tube condenser, a glass water trap, a carbon vane pump, a flow-meter and needle valve assembly, a 3 inch #21 stainless steel hypodermic needle, and a 5 liter Tedlar sample bag fitted with a syringe cap.

The sampling procedure was initiated by purging the probe and condenser system with stack air, adjusting the sample flow rates to approximately 80 cc per minute, and inserting the hypodermic needle



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into the syringe cap on the sample bag. The integrated sample was taken over a 1 hour period yielding approximately 4.8 liters of sample for analysis.

At the end of each test day, the sample bags were analyzed by Orsat for CO , CO_2 and O_2 . Repetitive analyses were performed on each bag to insure satisfactory duplication. The results were reported in percentages.



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APPENDIX A

COMPLETE PARTICULATE RESULTS WITH EXAMPLE CALCULATIONS



REPORT NO. 1281-25

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OF

PAGES

SOURCE TESTING CALCULATION FORMS

Test. No. 2No. Runs 31 + 30Name of Firm CONSOLIDATION COAL Co.Location of Plant BISHOP, W. Va.Type of Plant Coal cleaningControl Equipment Venturi Scrubber; Mist eliminatorSampling Point Locations Inlet (84" dia) 2 ports; 18 points each; 4 min. each pointPollutants Sampled Particulate; SO₂; NO_x

Time of Particulate Test:

Run No. <u>11 + 10</u>	Date <u>2/29/72</u>	Begin <u>1140</u>	End <u>1610</u>
Run No. <u>21 + 20</u>	Date <u>3/1/72</u>	Begin <u>1152</u>	End <u>1452</u>
Run No. <u>31 + 30</u>	Date <u>3/2/72</u>	Begin <u>1011</u>	End <u>1315</u>

PARTICULATE EMISSION DATA

Run No.	11	10	21	20	31	30
P _b barometric pressure, "Hg Absolute	28.17	28.17	28.11	28.11	27.98	27.98
P _m orifice pressure drop, "H ₂ O	1.603	1.732	1.495	1.624	1.605	1.558
V _m volume of dry gas sampled @ meter conditions, ft. ³	104.07	99.5	97.3	96.12	103.08	97.84
T _m Average Gas Meter Temperature, °F	86	89	81	89	81	88
V _{m std.} Volume of Dry Gas Sampled @ Standard Conditions, ft. ³	95.435	90.776	89.835	87.482	94.760	88.783
V _w Total H ₂ O collected, ml., Impingers & Silical Gel.	307.90	321.45	342.95	275.30	361.80	273.40
V _{w gas} Volume of Water Vapor Collected ft. ³ @ Standard Conditions*	14.594	15.237	16.256	13.049	17.149	12.959

* 70°F, 29.92" Hg.

(*) Outlet (81" dia) 2 ports; 24 points each; 3 min each point.

PARTICULATE EMISSION DATA (cont'd)

Run No.	11	10	21	20	31	30
W - % Moisture in the stack gas by volume	13.264	14.373	15.323	12.980	15.324	12.737
M _d - Mole fraction of dry gas	0.8674	0.8563	0.8468	0.8702	0.8468	0.8726
% CO ₂	0.90	1.00	0.9	0.7	1.0	0.1
% O ₂	19.80	19.20	18.6	19.7	19.0	20.6
% N ₂	79.3	79.8	80.5	79.6	80.0	79.3
M _d - Molecular weight of dry stack gas	28.936	28.928	28.883	28.900	28.920	28.840
M - Molecular weight of stack gas	27.486	27.358	27.220	27.485	27.247	27.459
ΔP _s - Velocity Head of stack gas, in. H ₂ O	1.0905	1.1483	1.0986	1.1497	1.1619	1.2389
T _s - Stack Temperature, °F	149	125	145	125	145	125
(ΔP _s X (T _s + 460))	25.710	25.918	25.781	25.934	26.513	26.921
P _s - Stack Pressure, "Hg. Absolute	29.96	28.27	29.84	28.09	29.69	27.88
V _s - Stack Velocity @ stack conditions, fpm	3906.4	4054.0	3935.0	4060.1	4054.9	4232.4
A _s - Stack Area, in. ²	5541.8	5153.0	5541.8	5153.0	5541.8	5153.0
Q _s - Stack Gas Volume @ Standard Conditions. * SCFM	113,630	106,330	112,030	107,530	114,860	111,560
T _t - Net Time of Test, min.	144	144	144	144	144	144
D _n - Sampling Nozzle Diameter, in.	0.200	0.200	0.200	0.200	0.200	0.200
%I - Percent isokinetic	102.58	96.95	97.93	92.39	100.75	93.37
m _f - Particulate - probe, cyclone and filter, mg.	53,612	98.06	85,626	76.32	37,437	77.36
m _t - Particulate - total, mg.	55,743	121.3	83,703	89.7	37,474	89.3
C _{an} - Particulate - probe, cyclone, and filter, gr/SCF	8.974	.01664	14.336	.01344	6.084	.01342
C _{ao} - Particulate - total, gr/SCF	8.995	.0206	14.349	.01579	6.090	.01549
C _{at} - Particulate - probe, cyclone, & filter, gr/cf @ stack conditions	6.778	.01219	10.60	.00994	4.475	.00988

A-4
PARTICULATE EMISSION DATA (cont'd)

Run No.	11	10	21	20	31	30
C _{au} - Particulate, total, -gr/cf @ stack cond.	6.794	.01509	10.608	.01168	4.479	.01140
C _{aw} - Particulate, probe, cyclone, and filter, lb/hr.	8739.0	15.16	13764.0	12.39	5988.8	12.83
C _{ax} - Particulate - total, lb/hr.	8759.4	18.77	13776.4	14.55	5994.7	14.81
% EA - % Excess air @ sampling point	1530.4	947.3	661.2	1336.9	833.3	4171.7

* 70°F. 29.92" Hg.

PARTICULATE CALCULATIONS

Sample: Run # 1I

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

$$V_{m_{std}} = \frac{17.7 \times V_m \left(\frac{P_B}{13.6} - \frac{P_m}{13.6} \right) = \text{ft.}^3}{(T_m + 460)} = \frac{17.7 \times 104.07 \left(28.17 + \frac{1.603}{13.6} \right)}{(86 + 460)} = \underline{95.435}$$

2. Volume of water vapor at 70°F & 29.92" Hg, ft.³

$$V_{w_{gas}} = 0.0474 \times V_w = \text{ft.}^3 = 0.0474 \times 307.90 = \underline{14.594}$$

3. % moisture in stack gas

$$\%M = \frac{100 \times V_{w_{gas}}}{V_{m_{std}} + V_{w_{gas}}} = \% = \frac{100 \times 14.594}{95.435 + 14.594} = \underline{13.264}$$

4. Mole fraction of dry gas

$$M_d = \frac{100 - \%M}{100} = \frac{100 - 13.264}{100} = \underline{0.8674}$$

5. Average molecular weight of dry stack gas

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

$$= (0.9 \times 0.44) + (19.8 \times 0.32) + (79.3 \times 0.28)$$

$$= \underline{28.936}$$

6. Molecular weight of stack gas

$$M W = M W_d \times H_d + 18 (1 - H_d) = 28.936 \times 0.8674 + 18(1 - 0.8674) \\ = 27.486$$

7. Stack velocity @ stack conditions, fpm

$$V_s = 4350 \times \sqrt{\frac{\Delta P_s \times (T_s + 460)}{P_s \times M W}}^{1/2} = \text{fpm} = 4350 \times 25.770 \left[\frac{1}{29.96 \times 27.486} \right]^{1/2} \\ = 3906.4$$

8. Stack gas volume @ standard conditions, SCFM

$$Q_s = \frac{0.123 \times V_s \times A_s \times M_d \times P_s}{(T_s + 460)} = \text{SCFM} = \frac{0.123 \times 3906.4 \times 55 \times 41.8 \times 0.8674 \times 29.96}{(149 + 460)}$$

9. Per cent isokinetic

$$\%I = \frac{1032 \times (T_s + 460) \times V_{mstd}}{V_s \times T_t \times P_s \times M_d \times (D_n)^2} = \% = \frac{1032 (149 + 460) \times 95.435}{3906.4 \times 144 \times 29.96 \times 0.8674 \times 0.04} \\ = 102.58$$

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

$$C_{an} = 0.0154 \times \frac{M_f}{V_{mstd}} = \text{gr/SCF} = \frac{0.0154 \times 55612}{95.435} = 8.974$$

11. Particulate total, gr/SCF

$$C_{ao} = 0.0154 \times \frac{M_c}{V_{m, std}} = \text{gr/SCF} = \frac{0.0154 \times 55743}{95.43} = \underline{8.995}$$

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

$$C_{at} = \frac{17.7 \times C_{an} \times P_s \times M_d}{(T_s + 460)} = \text{gr/CF} = \frac{17.7 \times 8.974 \times 29.96 \times 3674}{(149 + 460)} = \underline{6.778}$$

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

$$C_{au} = \frac{17.7 \times C_{ao} \times P_s \times M_d}{(T_s + 460)} = \text{gr/CF} = \frac{17.7 \times 8.995 \times 29.96 \times 3674}{(149 + 460)} = \underline{6.794}$$

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

$$C_{aw} = 0.00857 \times C_{an} \times Q_s = \text{lb/hr.} = 0.00857 \times 8.974 \times 113630 = \underline{8738.96}$$

15. Particulate - total, lb/hr.

$$C_{ax} = 0.00857 \times C_{ao} \times Q_s = \text{lb/hr.} = 0.00857 \times 8.995 \times 113630 = \underline{8759.4}$$

16. % excess air at sampling point A-8

$$\begin{aligned} \% EA &= \frac{100 \times \% O_2}{0.266 \times \% H_2 - \% O_2} = \% = \frac{100 \times 19.80}{(0.266 \times 79.3) - 19.80} \\ &= \underline{1530.4} \end{aligned}$$

B-1

SRL 1281 25 0472

APPENDIX B

COMPLETE GASEOUS RESULTS WITH EXAMPLE CALCULATIONS



SCOTT RESEARCH LABORATORIES, INC.

Bishop

SO₂ EMISSION DATA

Run No.	1 inlet	1 outlet	2 inlet	2 outlet	3 inlet	3 outlet
Date	29 Feb	29 Feb	1 Mar	1 Mar	2 Mar	2 Mar
mg SO ₂	1.60	0.09	244.1	310.5	26.24	21.12
T _m - Average Gas Meter Temperature, °F	61	69	60	66	68	70
P _b - Barometric Pressure, "Hg abs.	28.17	28.17	28.11	28.11	27.98	27.98
V _m - Volume of dry gas sampled @ meter conditions, ft. ³	1.27	1.53	1.14	1.35	1.21	1.37
- ppm SO ₂	17.1	0.8	2904.2	3155.6	300.0	214.1

$$\text{ppm SO}_2 = \frac{0.7332 \times \text{mg SO}_2 \times (T_m + 460)}{P_b \times V_m}$$

Sample Calculation:

Run # 1

INLET : $\text{ppm SO}_2 = \frac{0.7332 \times 1.60 \text{ mg SO}_2 \times (61 + 460)}{28.17 \times 1.27}$

$\text{ppm SO}_2 = 17.1$

B-3
Bishop
 NO_x EMISSION DATA
 Run #1

Run No.	1-1 inlet	1-2 inlet	1-3 inlet	1-4 outlet	1-5 outlet	1-6 outlet
Date	29 Feb	29 Feb	29 Feb	29 Feb	29 Feb	29 Feb
mg NO ₂	0.223	0.221	0.215	0.173	0.172	0.178
T _f - Flask Temperature, °F	66	67	73	66	69	73
V _f - Flask Volume, liters	2.059	2.100	2.110	2.113	2.092	2.089
P _i - Initial Flask Vacuum, "Hg.	25.5	25.5	25.5	25.5	25.5	25.5
P _f - Final Flask Vacuum, "Hg.	-0.7	-0.1	1.0	1.3	3.5	3.4
ppm NO ₂	64.4	64.2	65.7	62.7	58.6	60.9

$$\text{ppm NO}_2 = \frac{29.63 \times \text{mg NO}_2 \times (T_f + 460)}{V_f \times (P_i - P_f)}$$

Sample Calculation :

Run #1-1 Inlet :

$$\text{ppm NO}_2 = \frac{29.63 \times 0.223 \text{ mg NO}_2 \times (66 + 460)}{2.059 \text{ l} \times [25.5 - (-0.7)]}$$

$$\text{ppm NO}_2 = 64.4$$

B-4

Bishop

NO_x EMISSION DATA

Run # 2

Run No.	2-1 Inlet	2-2 Inlet	2-3 Inlet	2-4 Outlet	2-5 Outlet	2-6 Outlet
Date	1 Mar	1 Mar	1 Mar	1 Mar	1 Mar	1 Mar
mg NO ₂	0.231	0.238	0.193	0.208	0.108	0.186
T _f - Flask Temperature, °F	73	73	78	70	75	76
V _f - Flask Volume, liters	2.069	2.100	2.110	2.092	2.113	2.089
P _i - Initial Flask Vacuum, "Hg.	25.6	25.6	25.6	25.5	25.6	25.5
P _f - Final Flask Vacuum, "Hg.	-1.4	0.1	5.2	0.6	0.6	1.2
ppm NO ₂	65.9	70.5	71.8	62.7	32.5	58.2

$$\text{ppm NO}_2 = \frac{29.63 \times \text{mg NO}_2 \times (T_f + 460)}{V_f \times (P_i - P_f)}$$

B-5
Bishop
NO_x EMISSION DATA

Run #3

Run No.	3-1 Inlet	3-2 Inlet	3-3 Inlet	3-4 Outlet	3-5 Outlet	3-6 Outlet
Date	2 Mar	2 Mar	2 Mar	2 Mar	2 Mar	2 Mar
mg NO ₂	0.254	0.266	0.286	0.227	0.197	0.134
T _f - Flask Temperature, °F	70	70	70	69	70	68
V _f - Flask Volume, liters	2.069	2.100	2.110	2.092	2.089	2.113
P _i - Initial Flask Vacuum, "Hg.	25.5	25.5	25.5	25.5	25.5	25.5
P _f - Final Flask Vacuum, "Hg.	2.2	1.7	1.5	3.4	3.5	2.6
ppm NO ₂	83.1	83.6	88.7	77.0	67.3	43.3

$$\text{ppm NO}_2 = \frac{29.63 \times \text{mg NO}_2 \times (T_f + 460)}{V_f \times (P_i - P_f)}$$

SRL 1281 25 0472

ORSAT ANALYSIS DATA SHEET

<u>Run No.</u>	<u>Sample Location</u>	<u>Date</u>	<u>Analysis Number</u>	<u>% CO</u>	<u>% CO₂</u>	<u>% O₂</u>
1	Inlet	Feb. 29	1	0.0	0.9	19.4
			2	0.0	0.9	20.0
			<u>3</u>	<u>0.0</u>	<u>0.9</u>	<u>19.6</u>
			Avg.	0.0	0.9	19.7
1	Outlet	Feb. 29	1	0.0	0.9	19.1
			2	0.0	1.0	19.2
			<u>3</u>	<u>0.0</u>	<u>1.0</u>	<u>19.2</u>
			Avg.	0.0	1.0	19.2
2	Inlet	March 1	1	0.0	0.9	18.5
			2	0.0	1.0	18.8
			<u>3</u>	<u>0.0</u>	<u>0.9</u>	<u>18.6</u>
			Avg.	0.0	0.9	18.6
2	Outlet	March 1	1	0.0	0.5	19.7
			2	0.0	0.9	19.8
			<u>3</u>	<u>0.0</u>	<u>0.8</u>	<u>19.6</u>
			Avg.	0.0	0.7	19.7
3	Inlet	March 2	1	0.0	1.0	19.1
			2	0.0	1.0	18.9
			<u>3</u>	<u>0.0</u>	<u>1.0</u>	<u>19.0</u>
			Avg.	0.0	1.0	19.0
3	Outlet	March 2	1	0.0	0.2	20.6
			2	0.0	0.1	20.5
			<u>3</u>	<u>0.0</u>	<u>0.1</u>	<u>20.6</u>
			Avg.	0.0	0.1	20.6



C-1

SRL 1281 25 0472

APPENDIX C

FIELD DATA



SCOTT RESEARCH LABORATORIES, INC.

1315 hop Mills - Inlet to Nov. 6.66 % Moisture 9.0%
 15 Nov - 1-87 cal 7.50 7005

Run One

Sheet one

Date 2/20/72

425.446

Sampling Train (Downstairs)

Sample Point	Time min	Vol. (H ³)	Pitot Tube			Stack Temp.	Cal. Orifice (ΔH in. H ₂ O)	T ₁ °F	T ₂ °F	Draft (Ps in. H ₂ O)	Vac. in. Hg.
			Press	Vac.	Total (ΔP in. H ₂ O)						
A-1	4.00	429.00			0.95"	145°F	1.50	68	68		1.0" Hg
A-2	8.00	431.80			1.10	150°F	1.65	69	72		2.0" Hg
	12.00	434.80			1.20	150	1.70	70	74		4.0" Hg
4	16.00	437.70			0.45"	156	.90	72	72		2.0" Hg
5	20.00	440.00			1.35	155°F	2.00	72	72		4.5" Hg
6	24.00	443.75			1.30	150°F	1.85	70	72		6.0" Hg
7	28.00	446.80			1.35	155°F	1.90	72	74		6.5" Hg
8	32.00	449.00			1.20	155°F	1.80	88	84		7.0" Hg
9	36.00	452.2			1.15	155°F	1.60	92	78		7.0" Hg
10	40.00	455.9			1.20	155	1.70	90	80	Stopper in chamber	6.00
11	44.00	458.4			1.20	150	1.65	78	76		6.00" Hg
12	48.00	461.4			1.10	148	1.55	84	84	1.80" Hg	6.5" Hg
13	52.00	464.2			1.10	145	1.55	92	88	2.1" Hg	7.0
14	56.00	469.9			1.10	145	1.50	92	88		7.5

plus
wristle
grip
100°F
m one
1 cup

Silica Gel Number

Correction Factor

98

Filter Mat. R

Probe Tip Dia. inches

2.00"

1.1.1.1 Temp = 86.94
 Vol = 104.079

Pilot
104 gal
stopper to
change

Form 001
 6/26/70

Inlet - Bishop Mines

Run One

Sheet 2

Date 2/29/72

Sampling Train (Downstairs)

Sample Point	Time	Vol. (H ³)	Pitot Tube		Total (ΔP in. H ₂ O)	Stack Temp.	Cal. Orifice (ΔH in. H ₂ O)	T ₁ °F	T ₂ °F	Draft (Ps in. H ₂ O)	Vac. in. Hg
			Press.	Vac.							
15	60	469.60			1.05	145	1.40	95	80	1.80 "Hg	8.0 "Hg
16	64	472.3			.84	145	1.50	106	82	24.48	7.0 "Hg
17	68	474.3			.94	148	1.35	96	82	1.75	9.0 "Hg
18	72	476.8			.93	145	1.40	96	84	23.8	10.0 "Hg
B-1		479.8			.98	148	1.40	82	82		1.5 "Hg
B-2		482.7			1.10	155	1.70	88	85	1.80	1.5 "
B-3	12	485.8			1.20	150	1.80	94	84	24.48	2.0 "Hg
B-4	16	488.6			1.30	150	1.85	96	84	1.80 "Hg	2.0 "
B-5	20	491.5			1.40	150	2.00	94	84	24.48	5.0 " "
B-6	24	494.4			1.50	155	1.50	95	85	1.75 "Hg	5.0 "
B-7	28	497.3			1.60	155	2.00	100	85	23.8	7.0 "Hg
B-8	32	501.2			1.70	155	2.00	104	86		8.0 "Hg
B-9	36	504.1			1.80	155	2.1	104	86		9.0 "Hg
B-10	40	507.0			1.90	155	2.15	104	86		9.6 "Hg

SEI Co. Cal. No. _____

Filler Wet. R. _____

Corrected Factor _____

Probe Tip Dia. inches _____

Trilet to Sample (Downstairs)

Run One

Sheet three (3)

Date 2/27/72

Sampling Train (Downstairs)

Sample Point	Time	Vol. (H ³)	Pitot Tube			Stack Temp.	Cal. Orifice (ΔH in. H ₂ O)	T ₁ OF	T ₂ OF	Draft (Ps in. H ₂ O)	Vac. in. Hg.
			Press	Vac.	Total (ΔP in. H ₂ O)						
B-11	44	510.20			1.10	150	1.60	82	82	1.75" Hg	10.0" Hg
B-12	48	512.90			1.05	150	1.55	82	88	2.1	10.8" Hg 2.35
B-13	52	515.8			1.10	145	1.60	103	88	1.80	14.0" Hg
B-14	56	518.75			1.10	145	1.60	103	88	2.46	14.5" Hg
B-15	60	521.35			1.6	145	1.40	103	88	1.80	14.8
B-16	64	524.10			1.96	140	1.60	104	88	2.48	17.0" Hg
B-17	68	526.90			1.95	140	1.30	104	88		17.5" Hg
B-18	72	529.52			1.86	140	1.28	104	88		16.5" 3.05
		429.00									
		10.0.526									

Silica Gel Number _____

Filter Wgt. g _____

Correction Factor _____

Probe Tip Dia. inches _____

AVERAGES 1.60 916 82.1

⁶⁻⁵
BISHOP INLET

154.2

WATER VOLUME

Run No. 1 (ONE)

DATE 2/29/72

Bubbler # 1 300

Silica Gel No. Wgt. g 506.3g

2 160

3

Bubbler # 4

Gross 460 ml

Water Added (-) 200 ml

Gross Wgt. (-) 554.2

Net (A) 260 cc

Net (B) 47.9 g

Net (A) 260

48

Net (B) (+)

Total Water 308 cc

$$0.0474 \times 308 = 14.6 \text{ g}$$

Form R & D 109

$$\% \text{ Moist} = \frac{100 \times 14.6}{14.6 + 119.8} = \frac{1460}{134.4} = 10.8$$

134.4

Outlet 1140

Run 1 A

Sheet 1

Date 2/29/72

951,027

Sampling Train (Downstairs)

Sample Point	Time	Vol. (H ³)	Pitot Tube			Stack Temp.	Cal. Orifice (ΔH in. H ₂ O)	T ₁ OF	T ₂ OF	Draft (Ps in. H ₂ O)	Vac. in. Hg.
			Press	Vac.	Total (ΔP in. H ₂ O)						
142	6	956.35			2.70	125	4.1	76	68	1.9	13
3	9	959.55			2.70	"	4.1	76	68	1.6	13
4	12	962.79			2.50	"	3.7	81	68	1.6	13
5	15	965.00			2.00		2.9	85	68	1.40	11
6	18	967.6			1.20		1.8	88	72	1.42	6
7	21	969.55			1.20		1.8	78	74	1.1	6
8	24	971.66			1.20		1.8	81	74	1.05	6
9	27	973.70			1.00		1.5	85	75	1.12	5
10	30	975.71			1.00		1.5	87	76	1.05	5
11	33	977.88			1.20		1.8	90	77	1.05	6
12	36	980.16			1.30		2.0	92	78	1.10	7
13	39	982.21			0.82		1.3	94	79	1.75	5
14	42	983.78			0.50		1.78	87	82	1.25	4
15	45	985.75			0.40		1.62	87	81	1.85	3

A. ¹⁰ ₇₀ ¹⁰ ₇₀

Silica Gel Number _____
Correction Factor 1.98

Filter Wgt. g _____
Probe Tip Dia. inches 1.200

avg 1.15

avg Meter Temp = 89.58
Sampled Vol = 94.178

C-6

1320

Run

1A

Sheet

2

Date

2/29/72

Sampling Train (Downstairs)

Outlet

Sample Point	Time	Vol. (H ³)	Pitot Tube			Stack Temp.	Cal. Orifice (ΔH in. H ₂ O)	T ₁ °F	T ₂ °F	Draft (Ps in. H ₂ O)	Vac. in. Hg.
			Press	Vac.	Total (ΔP in. H ₂ O)						
16	48	986.24			140	125	162	88	82	+1.75	2.5
17	51	987.86			150	"	178	90	82	+1.95	4
18	54	989.34			150	"	178	92	82	+1.75	4
19	57	990.87			155	"	184	93	83	+1.4	4
20	60	992.17			160	"	194	94	84	+1.2	4
21	63	994.12			170	"	1.05	95	85	+1.7	4
22	66	995.67			175	"	1.15	97	85	+2.7	5
23	72	996.805			195	"	1.45	98	86	+4.3	6
24	75										
25											

Silica Gel Number

Filter Wgt. g

Correction Factor

Probe Tip Dia. inches

Run

1 B

Sheet

3

Date

2/29/77

998, 805

Sampling Train (Downstairs)

Outlet

Sample Point	Time	Vol. (H ³)	Pitot Tube			Stack Temp.	Cal. Orifice (ΔH in. H ₂ O)	T ₁ OF	T ₂ OF	Draft (Ps in. H ₂ O)	Vac. in. Hg.
			Press	Vac.	Total (ΔP in. H ₂ O)						
142	6	006.05			2.5	125	4.0	92	87	+1.500	13
3	9	09.34			2.2	"	3.1	102	88	+1.97	12
4	12	12.14			1.7		2.6	104	88	+1.78	10
5	15	14.8			1.5		2.2	105	88	+1.25	9
6	18	17.09			1.2		1.7	105	89	+1.20	7
7	21	19.18			1.2		1.7	105	89	+1.60	7
8	24	21.28			1.0		1.5	104	89	+1.0	6
9	27	23.35			1.0		1.5	104	89	+1.5	6
10	30	25.5			1.2		1.7	104	89	+1.0	6
11	33	27.67			1.2		1.7	805	90	+1.45	6
12	36	29.77			1.0		1.5	105	90	+1.6	6
										2.1	

Silica Gel Number

Correction Factor

.98

Filter Wgt. g

Probe Tip Dia. inches

.200

Outlet

Run 13

Sheet 4

Date 2-9-72

Sampling Train (Downstairs)

Sample Point	Time	Vol. (H ³)	Pitot Tube			Stack Temp.	Cal. Orifice (ΔH in. H ₂ O)	T ₁ OF	T ₂ OF	Draft (Ps in. H ₂ O)	Vac. in. Hg
			Press	Vac.	Total (ΔP in. H ₂ O)						
13	39	31.80			.95	125	1.4	105	92	+2.1	6
14	42	33.49			.60	"	.95	104	92	+1.2	5
15	45	35.05			.55		.84	103	92	+1.5	4
16	48	36.56			.52		.80	102	92	+2.7	4
17	51	38.12			.56		.90	102	92	+4.2	5
18	54	39.675			.52		.80	102	92	+2.7	4
19	57	41.24			.55		.84	102	92	+3.0	4
20	60	42.83			.60		.95	102	92	+4.5	5
21	63	44.62			.85		1.20	103	92	+4.2	5
22	66	46.53			.90		1.4	104	94	+4.7	6
23	72	50.528			1.00		1.5	106	94	+4.2	6

1000.000
951.027
48.973
50.528
99.501

Silica Gel Number _____

Correction Factor _____

Filter Wgt. g _____

Probe Tip Dia. inches _____

BISHOP OUTLET

WATER VOLUME

Run No. 1 (outlet)

DATE 2/29/72

Bubbler # 1 328 ml
(+3 from cyclones)

Silica Gel No. 8 Wgt. g 503.75

2 155 ml

3 10 ml Bubbler # 4 _____

Gross 493

Water Added (-) 200 ml

Gross Wgt. (-) 532.20

Net (A) 293 ml cc

Net (B) 28.45 g
~~112.6~~

Net (A) 293

Net (B) (+) 28

Total Water 321 cc

1% CO₂
19.1% O₂
0% CO

$$0.0474 \times 321 = 15.2 \text{ cf}$$

Form R & D 109

$$\% \text{ moist} = \frac{100 \times 15.2}{15.2 + 97.4} = \frac{1520}{112.6} = 13.5\%$$

112.6 90.73

$$\% \text{ moist} = 100 \times$$

Subject to Scrubbing - ~~11-36~~ 11-36 start

Run 11-36

Sheet One

Date 2/1/76

0 - 530.90

Sampling Train (Downstairs)

Super

Sample Point	Time	Vol. (H ³)	Pitot Tube			Stack Temp.	Cal. Orifice (ΔH in. H ₂ O)	T ₁ °F	T ₂ °F	Draft (Ps in. H ₂ O)	Vac. in. Hg.
			Press	Vac.	Total (ΔP in. H ₂ O)						
A-1	4.0	533.60			1.05	145	1.45	70	70	1.8 <u>6.48</u>	1.0
A-2	8.0	536.23			1.10	145	1.50	74	72		2.0
A-3	12.0	539.00			1.10	145	1.55	82	72	7.0	5.0
A-4	16.0	541.70			1.18	140	1.60	84	72	1.8 70	7.0
A-5	20.0	544.40			1.15	145	1.70	91	73	80	9.0
A-6	24.0	547.10			1.25	145	1.80	98	75	80	11.5
A-7	28.0	549.90			1.25	145	1.80	101	77	1.8 75	11.0
A-8	32.0	552.80			1.25	145	1.80	103	77	75	18.0
A-9	36.0	555.50			1.05	145	1.50	103	80	1.7 <u>23.12</u> 75	18.2
A-10	40.0	558.20			1.10	150	1.55	102	82		19.0
A-11	44.0	559.70			1.15	150	1.60	104	83	1.8	19.0
A-12	48.0	563.00			1.25	145	1.90	92	82	2nd Filter	3.5
A-13	52.0	566.10			1.3	145	1.30	77	78	1.6 <u>21.76</u> 65	3.2
A-14	56.0	568.8			1.35	145	1.30	80	77		3.0

15:05
off
start
15:24

Start
1.00
on
12:38
100
2

Don't forget to correct

Silica Gel

Filter Wgt.

Correction Factor

Probe Tip Dia. inches

1.05 2.60

Avg. Meter Temp = 81.17

1) 0.3950
2) 0.3960
3) -3900

Jet to number

Run TWO

Sheet Two (2)

Date 3/1/72

Sampling Train (Downstairs)

Sample Point	Time	Vol. (H ³)	Pitot Tube			Stack Temp.	Cal. Orifice (ΔH in. H ₂ O)	T ₁ °F	T ₂ °F	Draft (Ps in. H ₂ O)	Vac. in. Hg.
			Press	Vac.	Total (ΔP in. H ₂ O)						
A-5	66.0	569.95			.95	145	1.00	80	79	2.48	3.0
A-16	64.0	571.15			.95	145	1.00	79	78	1.84	4.0
A-17	68.0	574.28			.92	145	1.30	82	79	2.38	5.0
A-18	72.0	576.75			.82	145	1.20	84	80	1.75	5.5
B-1	6	580.30			.94	145	1.30	76	78		1.0
B-2	8	583.00			1.10	145	1.60	78	78		2.0
B-3	12	585.80			1.18	145	1.60	81	77	2.32	4.0
B-4	16	588.60			1.20	145	1.70	82	77		5.5
B-5	20	591.70			1.35	145	1.90	86	76		8.0
B-6	24	594.55			1.20	145	1.70	86	76		8.5
B-7	28	597.40			1.20	145	1.70	86	76		
B-8	32	600.25			1.20	145	1.70	87	76		
B-9	36	603.00			1.20	145	1.70	87	77		14.0
B-10	40	605.85			1.20	145	1.65	80	76	Filter	2.0

13:37

STOP
START
4:15

C-12

check

Filter
W03

Orifice Cal. Number

Correction Factor

Probe No.

Probe

25-2960

3.3900

C-14
Inlet to Scrubber

Bishop Mines

3/1/72

WATER VOLUME

Run No. Two

DATE 3/1/72

Bubbler # 1 340

Silica Gel No. 9

Final wt 541.5 ?
Dwt. w 503.55 gms
Wgt. g 37.95 gms

2 165

Net wt

3 000

Bubbler # 4

Gross

505

Water Added (-) 200

Gross Wgt. (-)

305

Net (A)

cc

Net (B)

37.95

g

Net (A) 305

Net (B) (+) 38

Total Water 343 cc

Outlet

11:52

Run 2 A

Sheet 5

Date 1/3/72

60.895

Sampling Train (Downstairs)

Sample Point	Time	Vol. (H ³)	Pitot Tube			Stack Temp.	Cal. Orifice (ΔH in. H ₂ O)	T ₁ OF	T ₂ OF	Draft (Ps in. H ₂ O)	Vac. in. Hg.
			Press	Vac.	Total (ΔP in. H ₂ O)						
2	7	67.185			3.0	125	4.1	70	68	-1.85	7
	9	74.572			3.0		4.1	82	69	-1.6	7
	12	73.578			2.5		3.5	88	70	-1.7	6
	15	76.275			2.1		2.9	91	72	-1.5	5
	18	78.715			1.5		2.1	92	73	-1.0	4
	21	80.89			1.2		1.7	93	73	-0.83	3
	24	83.03			1.2		1.7	93	74	-0.62	3
	27	85.03			1.0		1.4	94	77	-0.21	3
	30	87.00			1.0		1.4	94	78	-0.3	3
	33	89.09			1.2		1.7	95	80	-0.72	3
12	36	91.21			1.2		1.7	96	82	-0.05	3

C-15

Boro 976
to be corrected
Ambient 68°

Silica Gel Number

Correction Factor 1.9

Filter Wgt. g

Probe Tip Dia. inches

avg. temp = 89.76

Outlet

Run 2A

Sheet 6

Date 1/3/77

91.21

Sampling Train (Downstairs)

1235
010
501 off
320m

1340

Sample Point	Time	Vol. (H ³)	Pitot Tube			Stack Temp.	Cal. Orifice (ΔH in. H ₂ O)	T ₁ OF	T ₂ OF	Draft (Ps in. H ₂ O)	Vac. in. Hg.
			Press	Vac.	Total (ΔP in. H ₂ O)						
3	39	93.20			.175	125	1.0	97	82	- 0	2
4	42	94.95			.142		.69	95	83	+ .02	2
5	45	95.68			.130		.44	90	84	+ .80	2
6	47	96.52			.12		.51	90	84	+ .95	2
7	50	98.04			.13		.51	90	84	- .04	2
8	51	99.30			.14		.57	90	83	+ .22	2
9	52	100.88			.145		.65	90	83	+ .35	2
10	53	101.87			.145		.65	90	83	+ .80	2
11	54	103.30			.155		.79	90	84	+ .15	2
12	55	104.80			.157		.82	92	84	+ .40	2
13	56	107.84			.160	V	.83	94	84	+ .54	2

C-16

Silica Gel Number _____
Correction Factor .97

Filter Wgt. g _____
Probe Tip Dia. inches _____

Outlet

1412

Run _____

Sheet 7

Date _____

107.877

Sampling Train (Downstairs)

Sample Point	Time	Vol. (H ³)	Pitot Tube			Stack Temp.	Cal. Orifice (ΔH in. H ₂ O)	T ₁ OF	T ₂ OF	Draft (Ps in. H ₂ O)	Vac. in. Hg.
			Press	Vac.	Total (ΔP in. H ₂ O)						
2		113.895			2.5	125	3.4	90	87	+ .22	6
		116.855			2.5		3.4	101	88	- .30	7
		119.865			2.0		2.8	104	88	- .30	6
		122.275			1.7		2.4	104	89	- .40	5
		124.578			1.2		1.8	104	90	- .40	5
		126.00			1.2		1.8	104	90	- .22	5
		128.995			1.2		1.8	103	89	- .24	5
		131.20			1.2		1.8	104	89	- .08	5
		134.215			1.3		1.9	104	90	- .50	5
		135.90			1.7		2.4	105	90	- .84	6
		135.151			1.2		1.8	104	90	- .82	5

Silica Gel Number _____

Filter Wgt. g _____

Correction Factor 1.9

Probe Tip Dia. inches _____

Run 25

Outlet

Sheet 8Date 1/3/72

1452

138.151

Sampling Train (Downstairs)

Sample Point	Time	Vol. (H ³)	Pitot Tube		Total (ΔP in. H ₂ O)	Stack Temp.	Cal. Orifice (ΔH in. H ₂ O)	T ₁ OF	T ₂ OF	Draft (Ps in. H ₂ O)	Vac. in. Hg.
			Press	Vac.							
13	39	149.125			195	125	1.3	100	90	-.75	4
14	42	141.68			155		.78	101	90	-.57	3
15	45	143.23			160		.87	99	90	-.35	3
16	48	144.1			150		.75	100	90	-.40	3
17	51	146.15			155		.78	99	90	-.32	3
18	54	147.00			150		.75	99	90	-.32	3
19	57	149.07			155		.78	99	90	-.30	3
20	60	150.61			160		.87	100	90	-.32	3
21	63	152.21			165		.92	101	90	-.40	3
22	66	153.90			175		1.10	101	90	-.35	4
23	72	157.018			160		.87	102	90	-.52	4
		60.895									
		96.123 cf.									

Silica Gel Number

Filter Wgt. g

Correction Factor

Probe Tip Dia. inches

WATER VOLUME*Bishop Int'l*Run No. 2 DATE 1/3/72Bubbler # 1 256+48 Silica Gel No. 7 Wgt. g 503.2
(yellow)# 2 137# 3 7.5 Bubbler # 4 530.00

Gross

448.5503.2Water Added (-) 200.0 Gross Wgt. (-) ↓

Net (A)

248.5 cc

Net (B)

26.80 gNet (A) 248.5Net (B) (+) 26.8275.3Total Water cc256481377.5448

Inlet to scrubber - Bishop Mines

Run Three

Sheet 2

Date 3/2/72

0-626.53

START TIME 10:11 a.m.
Sampling Train (Downstairs)

Sample Point	Time	Vol. (H ³)	Pitot Tube			Stack Temp.	Cal. Orifice (ΔH in. H ₂ O)	T ₁ OF	T ₂ OF	Draft (Ps in. H ₂ O)	Vac. in. Hg.
			Press	Vac.	Total (ΔP in. H ₂ O)						
A-1	40	628.90			0.76	145 ⁷⁵	1.10	67	67		1.0 ¹⁴⁰
A-2	8	631.53			1.10	145	1.45	70	68	1.70	1.0
A-3	12	634.20			1.10	145	1.45	75	69		1.5
A-4	16	637.00			1.20	145	1.60	78	70		3.5
A-5	20	639.80			1.20	145	1.55	80	70	1.70	3.75
A-6	24	642.72			1.30	145	1.65	83	71	23.12	5.0
A-7	28	645.74			1.35	145	1.85	85	73		6.0
A-8	32	648.65			1.25	150	1.80	85	73	1.75	6.0
A-9	36	651.64			1.25	150	1.75	88	74	23.8	7.5
A-10	40	654.30			1.20	150	1.80	90	75		8.5
A-11	44	657.36			1.20	150	1.75	90	76	1.8	8.25
A-12	48	660.25			1.15	150	1.60	90	76	24.48	8.25
A-13	52	663.09			1.15	150	1.60	91	77	1.70	8.25
A-14	56	665.98			1.10	150	1.55	92	78	25.12	8.50

Bishop Elevation

1785

AIRPORT Elev

2867

Silica Gel Number

Correction Factor

Baro. Press.

(Morgan County Airport)
Dunsmuir, Ca.

Filter Wet. g. 110.38

Probe Tip Dia. inches 20

Math Vol = 103.08

Math Temp = 81.67

Form 901
6/26/70

INLET TO SINKHOLE - 815400 MINES

Run 74455

Sheet 1

Date 5/15/70

Sampling Train (Downstairs)

STOP
11:23 AM

Sample Point	Time	Vol. (H ³)	Pitot Tube			Stack Temp.	Cal. Orifice (ΔH in. H ₂ O)	T ₁ OF	T ₂ OF	Draft (Ps in. H ₂ O)	Vac. in. Hg.
			Press	Vac.	Total (ΔP in. H ₂ O)						
A-15	60	668.70			1.05	150°R	1.35	91	77		8.5
A-16	64	671.45			.95	150	1.40	93	78		8.5
A-17	68	674.14			.94	150	1.35	93	78	1.70	8.25
A-18	72	676.81			.93	150	1.30	93	78	2.12	8.25
B-1	4	680.23	Start	677.90	1.10	145	1.55	76	76		1.0
B-2	8	683.00			1.10	145	1.50	83	77	1.70	1.0
B-3	12	685.90			1.20	145	1.70	87	77	2.12	2.5
B-4	16	688.94			1.20	145	1.70	89	77		2.75
B-5	20	691.18			1.30	145	1.85	91	78	1.70	3.5
B-6	24	695.18			1.40	145	1.95	91	78	2.12	4.0
B-7	28	698.32			1.40	145	1.90	89	78		4.0
B-8	32	701.44			1.40	145	1.95	92	78		5.0
B-9	36	704.56			1.35	145	1.85	89	78	1.70	5.5
B-10	40	707.63			1.30	145	1.85	90	77	1.70	6.0

12:00 PM

BISHOP ELEVATOR

Silica Gel

Correction Factor

Filter Wet. g

Probe Tip Dia. inches

1785
DIPLOMA EVEN
2867

BAND PRES.
(MERCER CO.)
BLUEVILLOVA

Run 2Sheet 3Date 3/2/72

Sampling Train (Downstairs)

Sample Point	Time	Vol. (H ³)	Pitot Tube			Stack Temp.	Cal. Orifice (ΔH in. H ₂ O)	T ₁ OF	T ₂ OF	Draft (Ps in. H ₂ O)	Vac. in. Hg.
			Press	Vac.	Total (ΔP in. H ₂ O)						
B-11	44	710.59			1.15	140	1.65	90	77	1.7	6.0"
B-12	48	713.48			1.20	140	1.55	89	77	23.12	6.5
B-13	52	716.33			1.15	138	1.60	88	77	1.65	7.25
B-14	56	719.16			1.10	138	1.50	88	77	22.01	8.0
B-15	60	722.00			1.15	138	1.60	89	77	1.7 21.12	9.0
B-16	64	724.77			1.05	140	1.40	89	78	1.75	9.25
B-17	68	727.47			1.05	140	1.40	90	78	23.8	9.25
B-18	72	730.10			1.05	140	1.30	89	78		9.25

BISHOP ELEVATOR

1785

AIRPORT ELEV

2867

Silica Gel Pumber 501Correction Factor .96BARO PRESS 29.94Filter Wgt. g 0.3985 2nd FILTERProbe Tip Dia. inches .20

INLET TO SK-488w

WATER VOLUME

Bishop Mines
w. v. c.

Run No. Three

Date 3/2/72

Bubbler #1 340

#2 145

Final wt. - 537.8 ?

Silica Gel No. Initial Wgt. g. 501.0 gms

Moisture collect - 36.8 gms

Cyclone collect 40

Bubbler #4 _____

Gross 525

Water Added(-) 200

Gross Wgt.(-)

36.8

Net (A) 325 cc

Net (B) g

Net (A) 325

Net (+) 37
(B)

Total Water 362 cc

Outlet

10.11

Run 157.06Sheet 9Date 2-21-70

Sampling Train (Downstairs)

Sample Point	Time	Vol. (H ³)	Pitot Tube			Stack Temp.	Cal. Orifice (ΔH in. H ₂ O)	T ₁ OF	T ₂ OF	Draft (Ps in. H ₂ O)	Vac. in. Hg.
			Press	Vac.	Total (ΔP in. H ₂ O)						
1	162.88				2.5	125	3.2	75	70	-1.0	6
2	165.775				2.7		3.3	82	70	-2.5	6
3	168.570				2.2		2.7	86	71	-2.5	5
4	171.085				1.9		2.4	89	72	-2.5	5
5	173.48				1.8		2.1	90	74	-2.0	4
6	175.685				1.3		1.7	92	76	-1.5	4
7	177.765				1.2		1.5	92	77	-1.3	4
8	179.860				1.2		1.5	94	78	-1.1	4
9	181.87				1.2		1.5	94	78	-1.1	4
10	183.94				1.3		1.7	94	78	-1.2	4
11	186.371				1.6		2.1	97	81	-1.5	4

C-24

Silica Gel Number 503Filter Wgt. g 1.3725Correction Factor .54Probe Tip Dia. inches .000

Avg Meter Temp = 88.271

Form 001
6/26/70

Jan 20 1970
 10:45
 20.85
 March 60
 Bluefield
 District 5

outlet

1123

Run 3A

Sheet 11

Date 11-2

Sampling Train (Downstairs)

Sample Point	Time	Vol. (H ³)	Pitot Tube			Stack Temp.	Cal. Orifice (ΔH in. H ₂ O)	T ₁ OF	T ₂ OF	Draft (Ps in. H ₂ O)	Vac. in. Hg.
			Press	Vac.	Total (ΔP in. H ₂ O)						
13	39	188.265			.9	125	1.2	98	83	-1.5	3
14	42	193.07			.15		1.65	96	83	-.75	3
15	45	191.53			.43		1.56	96	84	-.55	2
16	48	192.75			.40		1.52	94	83	-.55	2
17	51	193.97			.40		1.52	94	83	-.57	2
18	54	195.25			.47		1.59	95	84	-.60	2
19	57	196.625			.51		1.66	94	84	-.75	2
20	60	198.025			.57		1.71	96	86	-.68	3
21	63	199.600			.70		1.90	96	85	-.85	3
22	66	201.33			.85	1.00	1.10	98	87	-.95	3
23	70	204.78			.80		1.00	98	85	-.90	3

C-25

Silica Gel Number _____

Filter Wgt. g _____

Correction Factor _____

Probe Tip Dia. inches _____

Run 33Sheet OutletDate 5/12/73

011.78

Sampling Train (Downstairs)

Sample Point	Time	Vol. (H ³)	Pitot Tube			Stack Temp.	Cal. Orifice (ΔH in. H ₂ O)	T ₁ °F	T ₂ °F	Draft (Ps in. H ₂ O)	Vac. in. Hg.
			Press	Vac.	Total (ΔP in. H ₂ O)						
		21359			2.7	125	3.3	83	82	-1.5	6
		213565			2.4		3.0	85	82	-1.5	6
		21407			1.8		2.2	98	82	-2.1	5
		216005			1.6		2.0	98	82	-2.0	5
		22109			1.5		1.9	99	83	-1.7	4
		22405			1.3		1.6	90	84	-1.5	4
		22913			1.2		1.5	100	85	-1.4	4
		2272			1.2		1.5	99	85	-1.0	4
		22921			1.3		1.6	99	85	-1.5	4
		2305			1.5		1.9	100	86	-1.7	4
		2307			1.4		1.4	100	85	-1.5	4

Silica Gel Number 81Filter Wgt. g 12.55Correction Factor 1.1Probe Tip Dia. inches 0.25

Run

35

Sheet

12

outlet

Date

2/3/71

233.67

Sampling Train (Downstairs)

Sample Point	Time	Vol. (H ³)	Pitot Tube			Stack Temp.	Cal. Orifice (ΔH in. H ₂ O)	T ₁ °F	T ₂ °F	Draft (Ps in. H ₂ O)	Vac. in. Hg.
			Press	Vac.	Total (ΔP in. H ₂ O)						
13	39	235.82			1.1		1.4	100	85	-1.7	4
14	42	237.45			1.67		1.85	99	85	-1.0	3
15	45	238.95			1.60		1.74	98	85	-0.7	3
16	46	240.40			1.64		1.74	98	85	-0.7	3
17	51	241.83			1.57		1.71	96	85	-1.65	3
18	54	243.375			1.68		1.91	96	85	-1.65	3
19	57	244.95			1.67		1.85	96	86	-1.68	3
20	59	246.46			1.81		1.10	98	86	-1.80	4
21	63	248.600			1.10		1.40	98	86	-1.0	4
22	65	250.780			1.4		1.2	99	87	-1.2	4
24	72	254.900			1.2		1.5	100	87	-1.4	

Silica Gel Number

53.6

Filter Wgt. g

3.085

Correction Factor

1.1

Probe Tip Dia. inches

1.000

BISHOP OUTLETWATER VOLUMERun No. 3 (THREE)DATE 2/3/72

72 (cyclone)

Bubbler # 1 242 mlSilica Gel No. 6 Wgt. g 503.6# 2 126 ml# 3 8 mlBubbler # 4 529 g42 g503

Gross

Water Added (-) 200 mlGross Wgt. (-) 503.6

Net (A)

248

cc

Net (B)

25.4

g

Net (A)

248

Net (B) (+)

25

Total Water

273

cc

$$\begin{array}{r}
 6.14 \\
 1.51 \\
 \hline
 7.65 \\
 2.549 \\
 \hline
 10.199
 \end{array}$$

LABORATORY TEST SHEET

LABORATORY

4ND - GEN - 1128

TEST OF

SO₂

1281-2

TEST ENGINEER

OBSERVERS

DATE

29 Feb 72

TEST EQUIPMENT

EPA

Stack Ident.	Sample Location	Sample #	Time start	Time stop	Sample Volume cu ft	Temp (°F)	Baro. Press.	Meter start	Vol. stop	C SO ₂
						meter/amb				
inlet	A	1	1147	1230	1.27	61/70	28.17	271.84	273.11	Shut down 1205 Restart 1218
outlet	A	1	1356	1430	1.53	69/75	28.17	73.774	75.300	

corrected Volumes

1.22

1.47

32

32

64

LABORATORY TEST SHEET

LABORATORY

4ND-GEN-1128

TEST OF

SO₂

1281-2

TEST ENGINEER

OBSERVERS

DATE

1 MARCH 72

TEST EQUIPMENT

EPA

STACK IDENT	SAMP LOC	SAMP #	TIME		SAMP VOLUME cu ft	TEMP OF air/amb	BAROM PRESSURE	METER		
			START	STOP				START	STOP	
Inlet	A	1	1205	1236	1.14	60/68	28.11	275.88	277.02	CSO ₂
outlet	mid	1	1431	1503	1.35	66/74	28.11	277.50	278.85	5.02 x 10 ⁻⁴

Corrected Values

Inlet	1.09
outlet	1.29

4ND - GEN: 1

TEST OF

So

1281 - 2

TEST ENGINEER

OBSERVERS

DATE _____

2 MARCH

TEST EQUIPMENT

ΕΡΑ

[illegible]

LABORATORY TEST SHEET

LABORATORY

4ND GEN-112

TEST OF

NOx

1281-2

TEST ENGINEER

OBSERVERS

DATE

29 Feb 72

TEST EQUIPMENT

EPA

Stack Ident.	Samp. Location	Sample #	Time	Flask Volume	Temp. (°F)	Baro. Press.	Shake Time	Flask Press. (mm Hg)	Temp (°F)	
Inlet	A	1	1145	2059	66	30.55	0700	+0.7	66	0.520 x 12-5
Outlet	B	1	1157	2113	66	30.55	0700	-1.3	66	0.52 x 12-5
Inlet	A	2	1235	2100	67	30.55	0700	+0.1	66	0.528 x 12-5
Outlet	A	1	1355	2092	75	30.55	0700	-3.5	66	0.509 x 12-5
Inlet	B	1	1410	2116	88	30.55	0700	-1.0	66	0.781 x 12-5
Outlet	A	2	1434	2089	82	30.55	0700	-3.4	66	0.704 x 12-5
						28.17				

Pa = 3 m

BPF

Nox

1 MARCH 72

BOF-2798

Mon.

$p_i = 3 \text{ atm}$

LABORATORY

4ND - GEN - 1128

TEST OF

Nox

TEST ENGINEER

OBSERVERS

DATE _____

2 MAR

TEST EQUIPMENT

✓ MAR 3 1940 1 - 29.32

[illegible]

4ND - GEN - 1128

TEST OF

Over

1291-2

TEST ENGINEER

OBSERVERS

DATE _____

DATE
29 Feb 72

TEST EQUIPMENT

[illegible]

Shut down rooftop
1205 1218

LABORATORY

TEST OF

ORS. AT

TEST ENGINEER

OBSERVERS

DATE _____

1 MAR

TEST EQUIPMENT

[illegible]

4ND¹-GEN-112B

TEST OF

ORSAT

TEST ENGINEER

OBSERVERS

DATE _____

2 MAR

TEST EQUIPMENT

EPA

[illegible]

SRL 1281 25 0472

APPENDIX D

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, 5, 6, and 7). 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, $\text{lb./hr.} = Q_s \times c$, 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 0.87.

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.

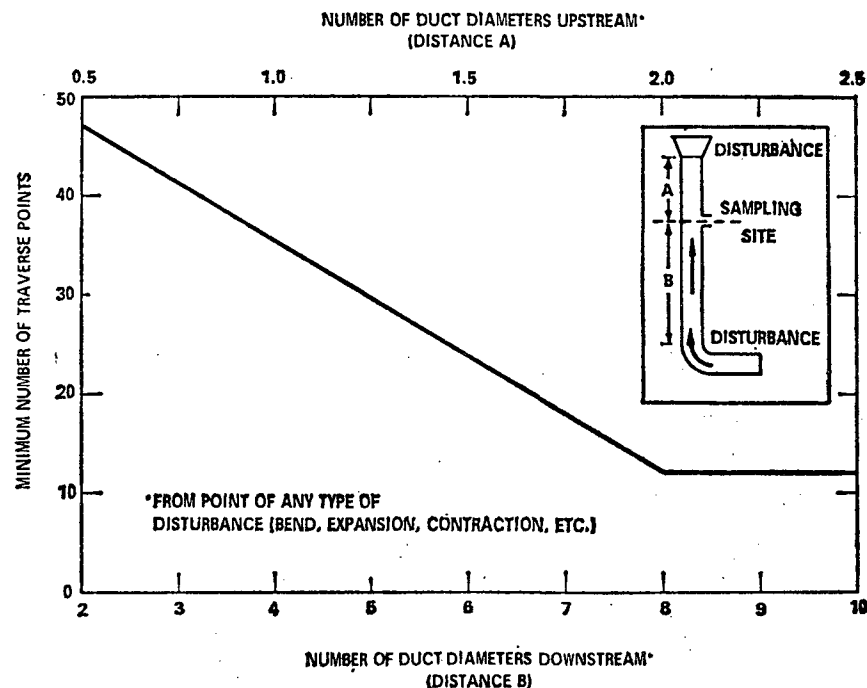


Figure 1-1. Minimum number of traverse points.

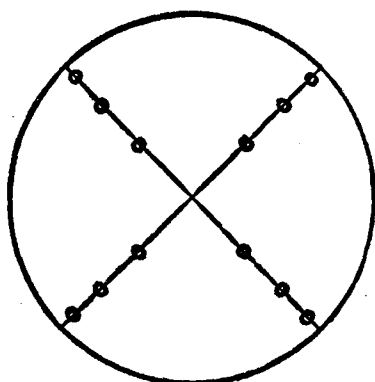


Figure 1-2. Cross section of circular stack divided into 12 equal areas, showing location of traverse points at centroid of each area.

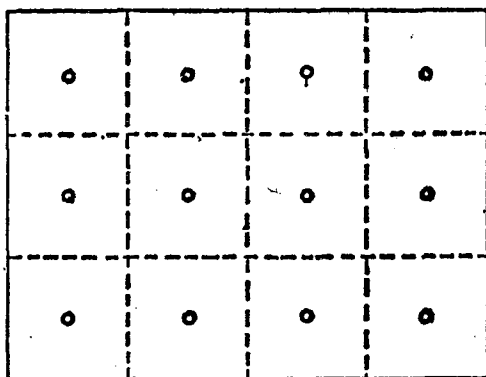


Figure 1-3. Cross section of rectangular stack divided into 12 equal areas, with traverse points at centroid of each area.

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	31.5	27.2
11						93.3	85.4	78.0	70.4	61.2	39.3	32.3
12						97.9	90.1	83.1	76.4	69.4	60.7	39.8
13							94.3	87.5	81.2	75.0	68.5	60.2
14							98.2	91.5	85.4	79.6	73.9	67.7
15								95.1	89.1	83.5	78.2	72.8
16								98.4	92.5	87.1	82.0	77.0
17									95.6	90.3	85.4	80.6
18									98.6	93.3	88.4	83.9
19										96.1	91.3	86.8
20										98.7	94.0	89.5
21											96.5	92.1
22											98.9	94.5
23												96.8
24												98.9

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

3. References.

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

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

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

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

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

1. Principle and applicability.

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

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

cedures for determining compliance with the New Source Performance Standards.

2. Apparatus.

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

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

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

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

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

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

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

3. Procedure.

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

3.2 Measure the static pressure in the stack.

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

4. Calibration.

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

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

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

where:

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

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

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.

$$(V_s)_{avg} = K_p C_p (\sqrt{\Delta p})_{avg} \sqrt{\frac{(T_s)_{avg}}{P_s M_s}} \quad \text{Equation 2-2}$$

where:

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

$K_p = 85.48 \frac{\text{ft.}}{\text{sec.}} \left(\frac{\text{lb.}}{\text{lb. mole} \cdot ^\circ \text{R.}} \right)^{1/2}$ when these units are used.

C_p = Pitot tube coefficient, dimensionless.

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

$(\sqrt{\Delta p})_{avg}$ = 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.

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

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

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

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

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

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

where:

Q_s = Volumetric flow rate, dry basis, standard conditions, $\text{ft.}^3/\text{hr.}$

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.

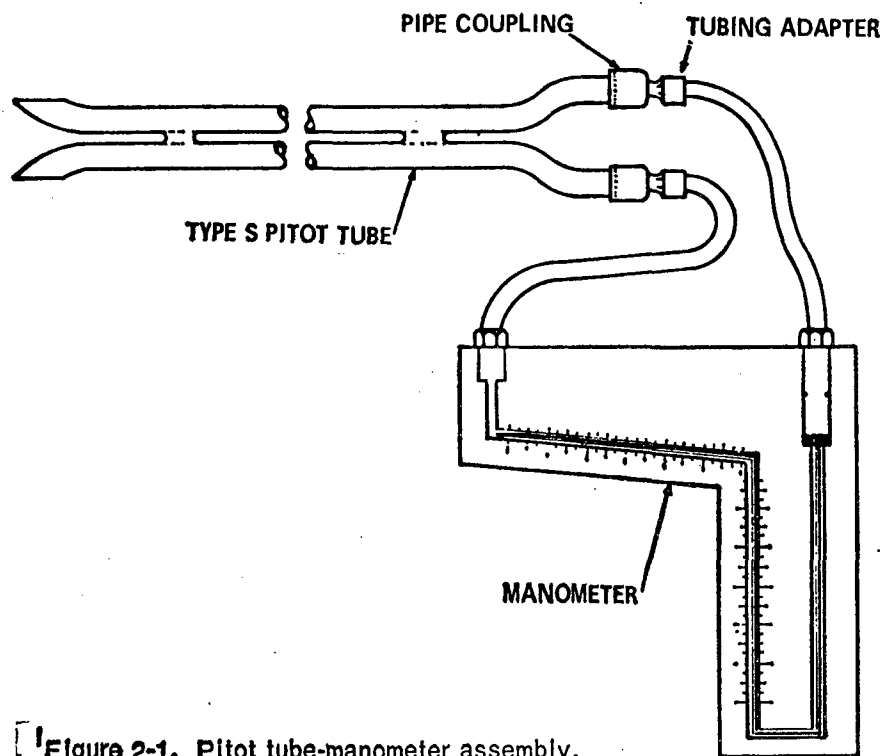


Figure 2-1. Pitot tube-manometer assembly.

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 Pyrex¹ 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 Pyrex¹ 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.

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 CO₂, O₂, 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% CO₂.

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.

$$\% \text{ EA} = \frac{(\% \text{ O}_2) - 0.5(\% \text{ CO})}{0.264(\% \text{ N}_2) - (\% \text{ O}_2) + 0.5(\% \text{ CO})} \times 100$$

equation 3-1

where:

% EA = Percent excess air.

% O₂ = Percent oxygen by volume, dry basis.

% N₂ = 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.

$$M_d = 0.44(\% \text{ CO}_2) + 0.32(\% \text{ O}_2) + 0.28(\% \text{ N}_2 + \% \text{ CO})$$

equation 3-2

where:

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

% CO₂ = Percent carbon dioxide by volume, dry basis.

% O₂ = Percent oxygen by volume, dry basis.

% N₂ = 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.

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

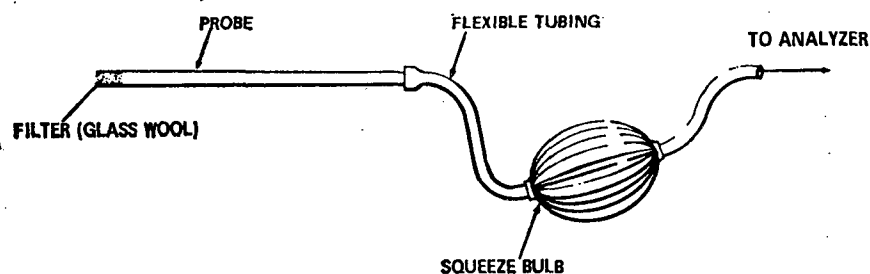


Figure 3-1. Grab-sampling train.

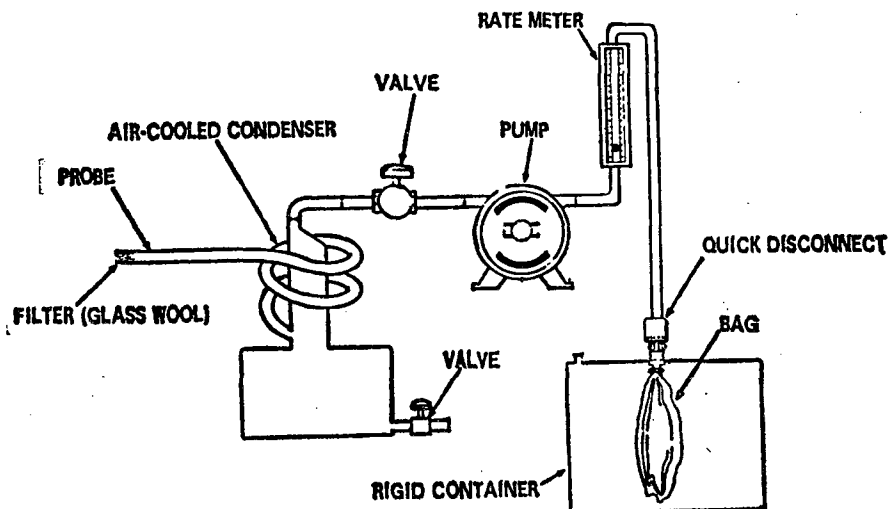


Figure 3-2. Integrated gas sampling train.

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 stream¹ 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 Pyrex² glass sufficiently heated to prevent condensation

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.

$$V_{wc} = \frac{(V_t - V_i) \rho_{H_2O} R T_{std}}{P_{std} M_{H_2O}} = 0.0474 \frac{\text{ft}^3}{\text{ml}} (V_t - V_i) \quad \text{equation 4-1}$$

where:

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

V_t —Final volume of impinger contents, ml.

V_i —Initial volume of impinger contents, ml.

R —Ideal gas constant, 21.83 inches

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.

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.

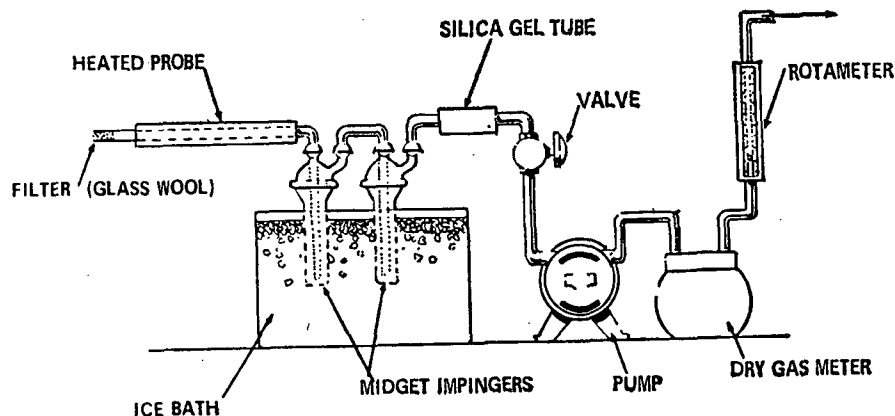


Figure 4-1. Moisture-sampling train.

LOCATION _____ COMMENTS _____
TEST _____
DATE _____
OPERATOR _____
BAROMETRIC PRESSURE _____

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

Figure 4-2. Field moisture determination.

4.2 Gas volume.

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

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.

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

where:

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

V_{wo} = 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—Pyrex¹ 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 825¹, 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—Pyrex¹ 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 1/2-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 BH¹, 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.

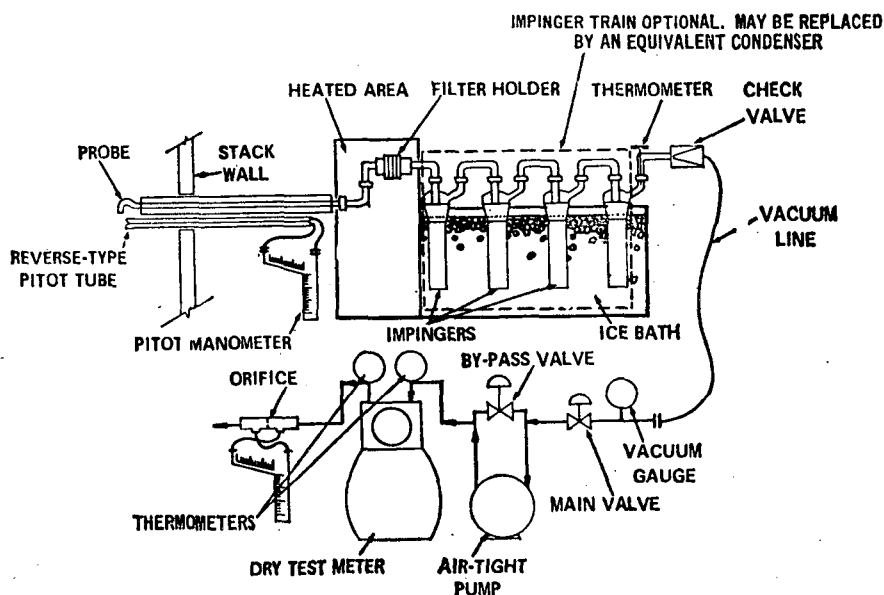


Figure 5-1. Particulate-sampling train.

3.3.2 Desiccant—Drierite¹ 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, desiccate² 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

¹ Trade name.

² Dry using Drierite¹ at 70° F. ± 10° F.

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

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

PLANT _____
 DATE _____
 RUN NO. _____

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

	VOLUME OF LIQUID WATER COLLECTED	
	IMPINGER VOLUME, ml	SILICA GEL WEIGHT, g
FINAL		
INITIAL		
LIQUID COLLECTED		
TOTAL VOLUME COLLECTED		g* 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.

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

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_{mstd} = Volume of gas sample through dry gas meter (standard conditions), cu. ft.

6.7 Isokinetic variation.

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

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

Equation 5-6

where:

I = Percent of isokinetic sampling.

V_{1s} = 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- $^\circ\text{R}$.

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), $^\circ\text{R}$.

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

ΔH = Average pressure drop across the orifice (see Fig. 5-2), inches H₂O.

T_s = Absolute average stack gas temperature (see Fig. 5-2), $^\circ\text{R}$.

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.

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

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

7. Reference.

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

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

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

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

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

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

METHOD 6—DETERMINATION OF SULFUR DIOXIDE EMISSIONS FROM STATIONARY SOURCES

1. Principle and applicability.

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

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

2. Apparatus.

2.1 Sampling. See Figure 6-1.

2.1.1 Probe—Pyrex¹ 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.

necessary only if a sample traverse is required, or if stack gas velocity varies with time.

2.2 Sample recovery.

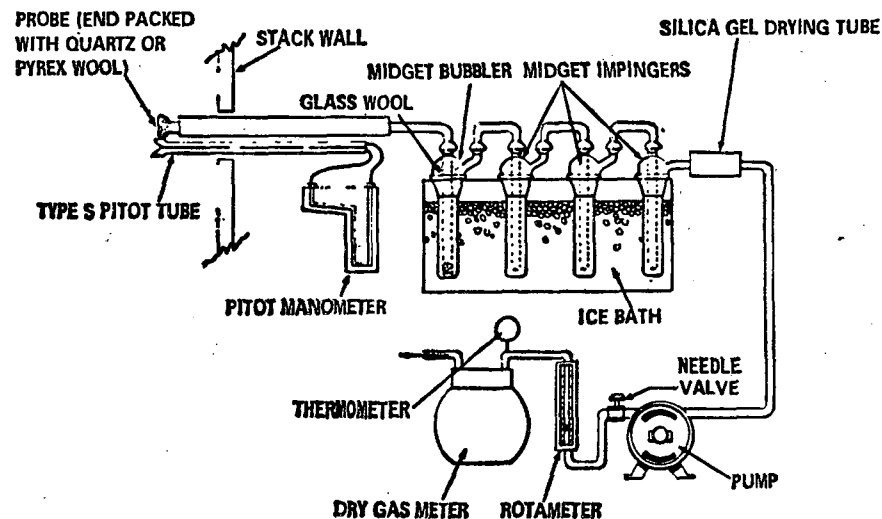


Figure 6-1. SO₂ sampling train.

2.3.1 Pipettes—Transfer type, 5 ml. and 10 ml. sizes (0.1 ml. divisions) and 25 ml. size (0.2 ml. divisions).

2.3.2 Volumetric flasks—50 ml., 100 ml., and 1,000 ml.

2.3.3 Burettes—5 ml. and 50 ml.

2.3.4 Erlenmeyer flask—125 ml.

3. Reagents.

3.1 Sampling.

3.1.1 Water—Deionized, distilled.

3.1.2 Isopropanol, 80%—Mix 80 ml. of isopropanol with 20 ml. of distilled water.

3.1.3 Hydrogen peroxide, 3%—dilute 100 ml. of 30% hydrogen peroxide to 1 liter with distilled water. Prepare fresh daily.

3.2 Sample recovery.

3.2.1 Water—Deionized, distilled.

3.2.2 Isopropanol, 80%.

3.3 Analysis.

3.3.1 Water—Deionized, distilled.

3.3.2 Isopropanol.

3.3.3 Thorin indicator—1-(o-arsenophenylazo)-2-naphthol-3,6-disulfonic acid, disodium salt (or equivalent). Dissolve 0.20 g. in 100 ml. distilled water.

3.3.4 Barium perchlorate (0.01 N)—Dissolve 1.95 g. of barium perchlorate [Ba(ClO₄)₂ · 3H₂O] in 200 ml. distilled water

2.2.1 Glass wash bottles—Two.

2.2.2 Polyethylene storage bottles—To store impinger samples.

2.3 Analysis.

and dilute to 1 liter with isopropanol. Standardize with sulfuric acid. Barium chloride may be used.

3.3.5 Sulfuric acid standard (0.01 N)—Purchase or standardize to ±0.0002 N against 0.01N NaOH which has previously been standardized against potassium acid phthalate (primary standard grade).

4. Procedure.

4.1 Sampling.

4.1.1 Preparation of collection train. Pour 15 ml. of 80% isopropanol into the midget bubbler and 15 ml. of 3% hydrogen peroxide into each of the first two midget impingers. Leave the final midget impinger dry. Assemble the train as shown in Figure 6-1. Leak check the sampling train at the sampling site by plugging the probe inlet and pulling a 10 inches Hg vacuum. A leakage rate not in excess of 1% of the sampling rate is acceptable. Carefully release the probe inlet plug and turn off the pump. Place crushed ice around the impingers. Add more ice during the run to keep the temperature of the gases leaving the last impinger at 70° F. or less.

4.1.2 Sample collection. Adjust the sample flow rate proportional to the stack gas

velocity. Take readings at least every five minutes and when significant changes in stack conditions necessitate additional adjustments in flow rate. To begin sampling, position the tip of the probe at the first sampling point and start the pump. Sample proportionally throughout the run. At the conclusion of each run, turn off the pump and record the final readings. Remove the probe from the stack and disconnect it from the train. Drain the ice bath and purge the remaining part of the train by drawing clean ambient air through the system for 15 minutes.

4.2 Sample recovery. Disconnect the impingers after purging. Discard the contents of the midget bubbler. Pour the contents of the midget impingers into a polyethylene shipment bottle. Rinse the three midget impingers and the connecting tubes with distilled water and add these washings to the same storage container.

4.3 Sample analysis. Transfer the contents of the storage container to a 50 ml. volumetric flask. Dilute to the mark with deionized, distilled water. Pipette a 10 ml. aliquot of this solution into a 125 ml. Erlenmeyer flask. Add 40 ml. of isopropanol and two to four drops of thorin indicator. Titrate to a pink endpoint using 0.01 N barium perchlorate. Run a blank with each series of samples.

5. Calibration.

5.1 Use standard methods and equipment

which have been approved by the Administrator to calibrate the rotameter, pitot tube, dry gas meter, and probe heater.

5.2 Standardize the barium perchlorate against 25 ml. of standard sulfuric acid containing 100 ml. of isopropanol.

6. Calculations.

6.1 Dry gas volume. Correct the sample volume measured by the dry gas meter to standard conditions (70° F. and 29.92 inches Hg) by using equation 6-1.

$$V_{m, std} = V_m \left(\frac{T_{std}}{T_m} \right) \left(\frac{P_{bar}}{P_{std}} \right) = 17.71 \frac{^{\circ}R}{in. Hg} \left(\frac{V_m P_{bar}}{T_m} \right) \text{ equation 6-1}$$

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.

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

6.2 Sulfur dioxide concentration.

$$C_{SO_2} = \left(7.05 \times 10^{-5} \frac{lb.-l.}{g.-ml.} \right) \frac{(V_t - V_{tb})N \left(\frac{V_{soln}}{V_a} \right)}{V_{m, std}} \text{ equation 6-2}$$

where:

C_{SO_2} = Concentration of sulfur dioxide at standard conditions, dry basis, lb./cu. ft.

7.05×10^{-5} = Conversion factor, including the number of grams per gram equivalent of sulfur dioxide (32 g./g.-eq.), 453.6 g./lb., and 1,000 ml./l., lb.-l./g.-ml.

V_t = Volume of barium perchlorate titrant used for the sample, ml.

V_{tb} = Volume of barium perchlorate titrant used for the blank, ml.

N = Normality of barium perchlorate titrant, g.-eq./l.

V_{soln} = Total solution volume of sulfur dioxide, 50 ml.

V_a = Volume of sample aliquot titrated, ml.

$V_{m, std}$ = Volume of gas sample through the dry gas meter (standard conditions), cu. ft., see Equation 6-1.

7. References.

Atmospheric Emissions from Sulfuric Acid Manufacturing Processes, U.S. DHEW, PHS, Division of Air Pollution, Public Health Service Publication No. 999-AP-13, Cincinnati, Ohio, 1965.

Corbett, P. F., The Determination of SO₂ and SO₃ in Flue Gases, Journal of the Institute of Fuel, 24:237-243, 1961.

Matty, R. E. and E. K. Diehl, Measuring Flue-Gas SO₂ and SO₃, Power 101:94-97, November, 1957.

Patton, W. F. and J. A. Brink, Jr., New Equipment and Techniques for Sampling Chemical Process Gases, J. Air Pollution Control Association, 13, 162 (1963).

METHOD 7—DETERMINATION OF NITROGEN OXIDE EMISSIONS FROM STATIONARY SOURCES

1. Principle and applicability.

1.1 Principle. A grab sample is collected in an evacuated flask containing a dilute sulfuric acid-hydrogen peroxide absorbing solution, and the nitrogen oxides, except

nitrous oxide, are measure colorimetrically using the phenoldisulfonic acid (PDS) procedure.

1.2 Applicability. This method is applicable for the measurement of nitrogen oxides 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 7-1.

2.1.1 Probe—Pyrex¹ glass, heated, with filter to remove particulate matter. Heating is unnecessary if the probe remains dry during the purging period.

2.1.2 Collection flask—Two-liter, Pyrex,¹ round bottom with short neck and 24/40 standard taper opening, protected against implosion or breakage.

¹ Trade name.

2.1.3 Flask valve—T-bore stopcock connected to a 24/40 standard taper joint.

2.1.4 Temperature gauge—Dial-type thermometer, or equivalent, capable of measuring 2° F. intervals from 25° to 125° F.

2.1.5 Vacuum line—Tubing capable of withstanding a vacuum of 3 inches Hg absolute pressure, with "T" connection and T-bore stopcock, or equivalent.

2.1.6 Pressure gauge—U-tube manometer, 36 inches, with 0.1-inch divisions, or equivalent.

2.1.7 Pump—Capable of producing a vacuum of 3 inches Hg absolute pressure.

2.1.8 Squeeze bulb—One way.

2.2 Sample recovery.

2.2.1 Pipette or dropper.

2.2.2 Glass storage containers—Cushioned for shipping.

positions. Evacuate the flask to at least 3 inches Hg absolute pressure. Turn the pump valve to its "vent" position and turn off the pump. Check the manometer for any fluctuation in the mercury level. If there is a visible change over the span of one minute, check for leaks. Record the initial volume, temperature, and barometric pressure. Turn the flask valve to its "purge" position, and then do the same with the pump valve. Purge the probe and the vacuum tube using the squeeze bulb. If condensation occurs in the probe and flask valve area, heat the probe and purge until the condensation disappears. Then turn the pump valve to its "vent" position. Turn the flask valve to its "sample" position and allow sample to enter the flask for about 15 seconds. After collecting the sample, turn the flask valve to its "purge" position and disconnect the flask from the sampling train. Shake the flask for 5 minutes.

4.2 Sample recovery.

4.2.1 Let the flask set for a minimum of 16 hours and then shake the contents for 2 minutes. Connect the flask to a mercury filled U-tube manometer, and record the flask pressure and temperature along with the barometric pressure. Transfer the flask contents to a container for shipment or to a 250 ml. beaker for analysis. Rinse the flask with two portions of distilled water (approximately 10 ml.) and add rinse water to the sample. For a blank use 25 ml. of absorbing solution and the same volume of distilled water as used in rinsing the flask. Prior to shipping or analysis, add sodium hydroxide (1N) dropwise into both the sample and the blank until alkaline to litmus paper (about 25 to 35 drops in each).

4.3 Analysis.

4.3.1 If the sample has been shipped in a container, transfer the contents to a 250 ml. beaker using a small amount of distilled water. Evaporate the solution to dryness on a steam bath and then cool. Add 2 ml. phenoldisulfonic acid solution to the dried residue and triturate thoroughly with a glass rod. Make sure the solution contacts all the residue. Add 1 ml. distilled water and four drops of concentrated sulfuric acid. Heat the solution on a steam bath for 3 minutes with occasional stirring. Cool, add 20 ml. distilled water, mix well by stirring, and add concentrated ammonium hydroxide dropwise with constant stirring until alkaline to litmus paper. Transfer the solution to a 100 ml. volumetric flask and wash the beaker three times with 4 to 5 ml. portions of distilled water. Dilute to the mark and mix thoroughly. If the sample contains solids, transfer a portion of the solution to a clean, dry centrifuge tube, and centrifuge, or filter a portion of the solution. Measure the absorbance of each sample at 420 nm. using the blank solution as a zero. Dilute the sample and the blank with a suitable amount of distilled water if absorbance falls outside the range of calibration.

5. Calibration.

5.1 Flask volume. Assemble the flask and flask valve and fill with water to the stopcock. Measure the volume of water to ± 10 ml. Number and record the volume on the flask.

5.2 Spectrophotometer. Add 0.0 to 16.0 ml. of standard solution to a series of beakers. To each beaker add 25 ml. of absorbing solution and add sodium hydroxide (1N) dropwise until alkaline to litmus paper (about 25 to 35 drops). Follow the analysis procedure of section 4.3 to collect enough data to draw a calibration curve of concentration in $\mu\text{g. NO}_x$ per sample versus absorbance.

6. Calculations.

6.1 Sample volume.

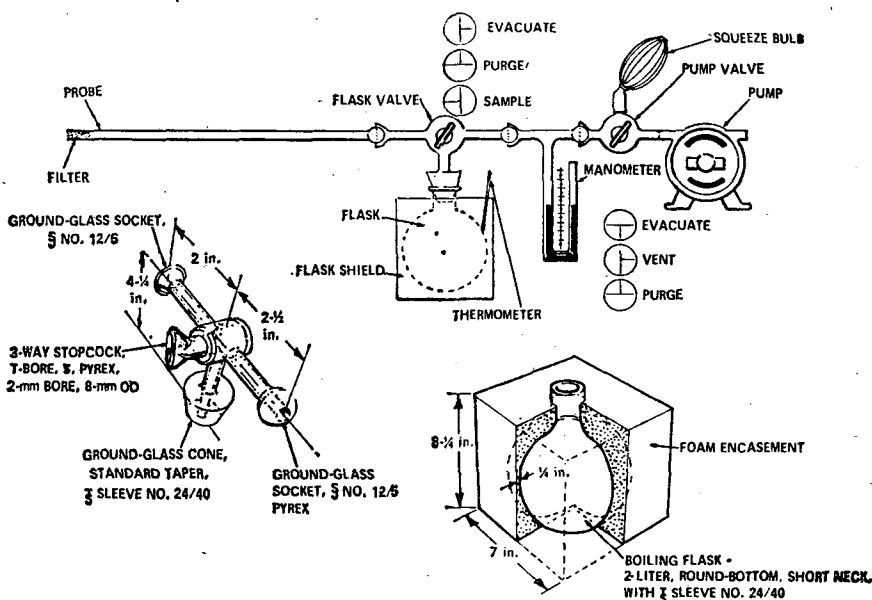


Figure 7-1. Sampling train, flask valve, and flask.

2.2.3 Glass wash bottle.

2.3 Analysis.

2.3.1 Steam bath.

2.3.2 Beakers or casseroles—250 ml., one for each sample and standard (blank).

2.3.3 Volumetric pipettes—1, 2, and 10 ml.

2.3.4 Transfer pipette—10 ml. with 0.1 ml. divisions.

2.3.5 Volumetric flask—100 ml., one for each sample, and 1,000 ml. for the standard (blank).

2.3.6 Spectrophotometer—To measure absorbance at 420 nm.

2.3.7 Graduated cylinder—100 ml. with 1.0 ml. divisions.

2.3.8 Analytical balance—To measure to 0.1 mg.

3. Reagents.

3.1 Sampling.

3.1.1 Absorbing solution—Add 2.8 ml. of concentrated H_2SO_4 to 1 liter of distilled water. Mix well and add 6 ml. of 3 percent hydrogen peroxide. Prepare a fresh solution weekly and do not expose to extreme heat or direct sunlight.

3.2 Sample recovery.

3.2.1 Sodium hydroxide (1N)—Dissolve 40 g. NaOH in distilled water and dilute to 1 liter.

3.2.2 Red litmus paper.

3.2.3 Water—Deionized, distilled.

3.3 Analysis.

3.3.1 Fuming sulfuric acid—15 to 18% by weight free sulfur trioxide.

3.3.2 Phenol—White solid reagent grade.

3.3.3 Sulfuric acid—Concentrated reagent grade.

3.3.4 Standard solution—Dissolve 0.5495 g. potassium nitrate (KNO_3) in distilled water and dilute to 1 liter. For the working standard solution, dilute 10 ml. of the resulting solution to 100 ml. with distilled water. One ml. of the working standard solution is equivalent to 25 $\mu\text{g. nitrogen dioxide}$.

3.3.5 Water—Deionized, distilled.

3.3.6 Phenoldisulfonic acid solution—Dissolve 25 g. of pure white phenol in 150 ml. concentrated sulfuric acid on a steam bath. Cool, add 75 ml. fuming sulfuric acid, and heat at 100° C. for 2 hours. Store in a dark, stoppered bottle.

4. Procedure.

4.1 Sampling.

4.1.1 Pipette 25 ml. of absorbing solution into a sample flask. Insert the flask valve stopper into the flask with the valve in the "purge" position. Assemble the sampling train as shown in Figure 7-1 and place the probe at the sampling point. Turn the flask valve and the pump valve to their "evacuate"

$$V_{sc} = \frac{T_{std}(V_f - V_a)}{P_{std}} \left(\frac{P_f - P_i}{T_f - T_i} \right) = \left(17.71 \frac{^{\circ}\text{R}}{\text{in. Hg.}} \right) (V_f - 25 \text{ ml.}) \left(\frac{P_f - P_i}{T_f - T_i} \right) \text{ Equation 7-1}$$

where:

V_{sc} = Sample volume at standard conditions (dry basis), ml.

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

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

V_f = Volume of flask and valve, ml.

V_a = Volume of absorbing solution, 25 ml.

P_f = Final absolute pressure of flask, inches Hg.

P_i = Initial absolute pressure of flask, inches Hg.

T_f = Final absolute temperature of flask, °R.

T_i = Initial absolute temperature of flask, °R.

6.2 Sample concentration. Read $\mu\text{g. NO}_2$ for each sample from the plot of $\mu\text{g. NO}_2$ versus absorbance.

$$C = \left(\frac{m}{V_{sc}} \right) \left(\frac{1 \text{ lb.}}{\text{cu. ft.}} \right) = \left(6.2 \times 10^{-6} \frac{\text{lb./s.c.f.}}{\mu\text{g./ml.}} \right) \left(\frac{m}{V_{sc}} \right)$$

equation 7-2

where:

C = Concentration of NO_2 as NO_2 (dry basis), lb./s.c.f.

m = Mass of NO_2 in gas sample, $\mu\text{g.}$

V_{sc} = Sample volume at standard conditions (dry basis), ml.

7. References.

Standard Methods of Chemical Analysis. 6th ed. New York, D. Van Nostrand Co., Inc., 1962, vol. 1, p. 329-330.

Standard Method of Test for Oxides of Nitrogen in Gaseous Combustion Products (Phenoldisulfonic Acid Procedure), In: 1968 Book of ASTM Standards, Part 23, Philadelphia, Pa. 1968, ASTM Designation D-1608-60, p. 725-729.

Jacob, M. B., The Chemical Analysis of Air Pollutants, New York, N.Y., Interscience Publishers, Inc., 1960, vol. 10, p. 351-356.

METHOD 8—DETERMINATION OF SULFURIC ACID MIST AND SULFUR DIOXIDE EMISSIONS FROM STATIONARY SOURCES

1. Principle and applicability.

1.1 Principle. A gas sample is extracted from a sampling point in the stack and the acid mist including sulfur trioxide is separated from sulfur dioxide. Both fractions are measured separately by the barium-thorin titration method.

1.2 Applicability. This method is applicable to determination of sulfuric acid mist (including sulfur trioxide) and sulfur dioxide from stationary sources only when specified by the test procedures for determining

compliance with the New Source Performance Standards.

2. Apparatus.

2.1 Sampling. See Figure 8-1. Many of the design specifications of this sampling train are described in APTD-0581.

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

2.1.2 Probe—Pyrex¹ glass with a heating system to prevent visible condensation during sampling.

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

2.1.4 Filter holder—Pyrex¹ glass.

2.1.5 Impingers—Four as shown in Figure 8-1. The first and third are of the Greenburg-Smith design with standard tip. The second and fourth are of the Greenburg-Smith design, modified by replacing the standard tip with a 1/2-inch ID glass tube extending to one-half inch from the bottom of the impinger flask. Similar collection systems, which have been approved by the Administrator, may be used.

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 inch Hg.

¹ Trade name.

2.2 Sample recovery.

2.2.1 Wash bottles—Two.

2.2.2 Graduated cylinders—250 ml., 500 ml.

2.2.3 Glass sample storage containers.

2.2.4 Graduated cylinder—250 ml.

2.3 Analysis.

2.3.1 Pipette—25 ml., 100 ml.

2.3.2 Burette—50 ml.

2.3.3 Erlenmeyer flask—250 ml.

2.3.4 Graduated cylinder—100 ml.

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

2.3.6 Dropping bottle—to add indicator solution.

3. Reagents.

3.1 Sampling.

3.1.1 Filters—Glass fiber, MSA type 1106 BH, or equivalent, of a suitable size to fit in the filter holder.

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

3.1.3 Water—Deionized, distilled.

3.1.4 Isopropanol, 80%—Mix 800 ml. of isopropanol with 200 ml. of deionized, distilled water.

3.1.5 Hydrogen peroxide, 3%—Dilute 100 ml. of 30% hydrogen peroxide to 1 liter with deionized, distilled water.

3.1.6 Crushed ice.

3.2 Sample recovery.

3.2.1 Water—Deionized, distilled.

3.2.2 Isopropanol, 80%.

3.3 Analysis.

3.3.1 Water—Deionized, distilled.

3.3.2 Isopropanol.

3.3.3 Thorin indicator—1-(o-arsonophenylazo)-2-naphthol-3, 6-disulfonic acid, disodium salt (or equivalent). Dissolve 0.20 g. in 100 ml. distilled water.

3.3.4 Barium perchlorate (0.01N)—Dissolve 1.95 g. of barium perchlorate [$\text{Ba}(\text{ClO}_4)_2 \cdot 3 \text{H}_2\text{O}$] in 200 ml. distilled water and dilute to 1 liter with isopropanol. Standardize with sulfuric acid.

3.3.5 Sulfuric acid standard (0.01N)—Purchase or standardize to ± 0.0002 N against 0.01 N NaOH which has previously been standardized against primary standard potassium acid phthalate.

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. Place 100 ml. of 80% isopropanol in the first impinger, 100 ml. of 3% hydrogen peroxide in both the second and third impingers, and about 200 g. of silica gel in the fourth impinger. Retain a portion of the reagents for use as blank solutions. Assemble the train without the probe as shown in Figure 8-1 with the filter between the first and second impingers. Leak check the sampling train at the sampling site by plugging the inlet to the first impinger and pulling a 15-inch Hg vacuum. A leakage rate not in excess of 0.02 c.f.m. at a vacuum of 15 inches Hg is acceptable. Attach the probe and turn on the probe heating system. Adjust the probe heater setting during sampling to prevent any visible condensation. Place crushed ice around the impingers. Add more ice during the run to keep the temperature of the gases leaving the last impinger at 70° F. or less.

4.1.3 Train operation. For each run, record the data required on the example sheet shown in Figure 8-2. 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. Start the pump and immediately adjust the flow to isokinetic conditions. Maintain isokinetic sampling throughout the sampling period. Nomographs are available which aid in the

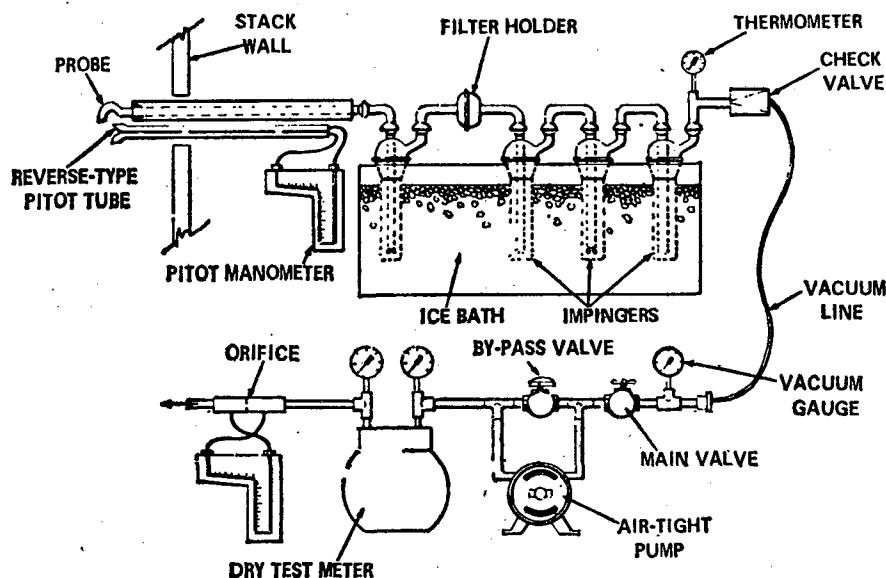


Figure 8-1. Sulfuric acid mist sampling train.

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APPENDIX E

LABORATORY REPORT

E.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 laboratory facility, the nozzle was disconnected from the probe and very carefully washed with acetone, using a fine bristled brush. All acetone washings were collected in a clean glass jar, the jar itself being placed on a large piece of clean aluminum foil. The probe was then washed 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 a graduated cylinder and noting the volume. The impingers were not dismantled and all transfers and washings were performed through the inlet and outlet ports. All of the glassware in the back half of the filter, up to the fourth impinger was then carefully washed with distilled water and the washings collected. This was followed by an acetone wash which was again collected in a separate jar.



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

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

Container #1: Filter

Container #2: Acetone wash front half from filter

Container #3: Water wash back half from filter

Container #4: Silica gel

Container #5: Acetone wash back half from filter

E.2 LABORATORY HANDLING AND ANALYSIS, PARTICULATE

E.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 the 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 fine particles adhering to the container or foil. All transfers were performed near the balance and the weight reported to the nearest 0.1 mg. The plastic dishes were then sealed for shipment.



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E.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.

E.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.



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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 Tables E-1 and E-2.

E.3 ORSAT ANALYSIS

A total of six integrated bag samples were analyzed by Orsat during the three day test period. The Tedlar sample bags had a capacity of about 5 liters and were equipped with Teflon sample tubes fitted with airtight syringe caps. Prior to sampling, each bag was flushed with pure, dry nitrogen and sealed with the syringe cap.

At the end of each sampling day two sample bags (one inlet and one outlet) were returned to the field laboratory where they were analyzed for CO, CO₂ and O₂ by Orsat.

Each bag was connected to the Orsat analyzer by carefully removing the syringe cap and inserting the Teflon tube securely into the Orsat sample tube. The Orsat analyzer was then purged by squeezing the Tedlar bag and forcing the sample through the Orsat bypass. Successive 100 ml. samples were drawn into the Orsat sample burette and then passed





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TABLE E-1 - SUMMARY OF WEIGHT MEASUREMENTS
(INLET)

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	Run 1					Run 2					Run 3				
	Final (g)	Tare (g)	Gross (mg)	Blank (mg)	Net (mg)	Final (g)	Tare (g)	Gross (mg)	Blank (mg)	Net (mg)	Final (g)	Tare (g)	Gross (mg)	Blank (mg)	Net (mg)
Container #1a (Filter)	8.1980	7.9490	249.0	-	249.0	8.0475	7.9875	60.0	-	60.0	8.1905	8.0310	159.5	-	159.5
Container #1b (Filter)	0.1670	0.1425	24.5	-	24.5	8.2605	8.2020	58.5	-	58.5	8.2450	8.2025	42.5	-	42.5
Container #1c (Filter)	-	-	-	-	-	8.3600	8.2255	134.5	-	134.5	-	-	-	-	-
Container #2a (Acetone wash front half)	144.2365	88.8970	55339.5	0.5	55339.0	153.0405	88.6855	64354.0	1.0	64353.0	134.5280	97.2925	37235.5	0.5	37235.0
Container #2b (Acetone wash front half)	-	-	-	-	-	26.4980	7.4780	19020.0	0	19020.0	-	-	-	-	-
Container #3a (Organic Extract)	85.1300	85.1260	4.0	1.0	3.0	88.5230	88.4900	33.0	1.0	32.0	82.1495	82.1425	7.0	1.0	6.0
Container #3b (Water after extraction)	87.5585	87.5320	26.5	5.5	21.0	82.3830	82.3450	38.0	5.5	32.5	80.8645	80.8910	26.5	4.5	22.0
Container #5 (Acetone wash back half)	82.1360	82.0290	107.0	0	107.0	87.4180	87.4060	12.0	0	12.0	89.3630	89.3540	9.0	0	9.0
Probe, cyclone, filter (mg)					55612.5	Probe, cyclone, filter (mg)				83626.0	Probe, cyclone, filter (mg)				37437.0
Total (mg)					55743.5	Total (mg)				83702.5	Total (mg)				37474.0

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TABLE E-2 - SUMMARY OF WEIGHT MEASUREMENTS
(OUTLET)

	Run 1					Run 2					Run 3				
	Final (g)	Tare (g)	Gross (mg)	Blank (mg)	Net (mg)	Final (g)	Tare (g)	Gross (mg)	Blank (mg)	Net (mg)	Final (g)	Tare (g)	Gross (mg)	Blank (mg)	Net (mg)
Container #1 (Filter)	7.9805	7.9407	39.80	-	39.80	7.9885	7.9370	51.50	-	51.50	7.7625	7.7325	30.00	-	30.00
Container #2 (Acetone wash front half)	86.2676	86.2092	58.40	0.14	58.26	82.7500	82.7250	25.00	0.18	24.82	85.3515	85.3040	47.50	0.14	47.36
Container #3a (Organic Extract)	86.3675	86.3630	4.50	1.47	3.03	86.8954	86.8910	4.40	1.47	2.93	86.8100	86.8090	1.00	1.47	0.00
Container #3b (Water after extraction)	88.9760	88.9620	14.00	5.93	8.07	87.0973	87.0915	5.80	4.10	1.70	84.6882	84.6810	7.20	4.11	3.09
Container #5	97.3862	97.3740	12.20	0.07	12.13	89.3688	89.3600	8.80	0.06	8.74	83.5695	83.5606	8.90	0.07	8.83
	Probe, cyclone, filter (mg)				98.06	Probe, cyclone, filter (mg)				76.32	Probe, cyclone, filter (mg)				77.36
	Total (mg)				121.29	Total (mg)				89.69	Total (mg)				89.28

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through each of the three absorbing solutions (potassium hydroxide - CO_2 , alkaline pyrogallate - O_2 , and cuprous chloride - CO). Repetitive passes were made through each absorbing solution until good duplication of results occurred. At least three 100 ml. samples were analyzed from each Tedlar sample bag. The data recorded for each Orsat analysis is included as Table E-3.

E.4 SO_2 ANALYSIS

A total of six SO_2 gas samples were taken during the course of the test program. Following each sampling period the impinger train was disconnected from the sample probe and purged with ambient air for fifteen minutes at the same flow rate used during the test. The inlet and outlet connections of the impinger train were then sealed with tape to prevent contamination and transported to the field laboratory for transfer. Upon arrival at the field laboratory, the outside surfaces of the impinger train were washed with water and then wiped clean to remove any coal dust that had accumulated during the test. The isopropanol bubbler was then carefully disconnected from the impinger section of the train and its contents discarded. The next two impingers were individually disconnected and the hydrogen peroxide solutions were transferred to separate polyethylene bottles with distilled water washes. The glass connecting tubes were then rinsed with distilled water and the washes added to their respective polyethylene bottles. The final transfer step involved rinsing the third impinger with distilled water and adding this wash to the number two impinger solution. The polyethylene bottles were tightly capped and labeled for shipment to the laboratory.



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TABLE E-3 - ORSAT ANALYSIS DATA

Run #1 - February 29, 1972

Sample Location	Sample Number	Component	Analysis Number	Burette Volume (ml.)		
				Initial	Final	Difference
Inlet	1	CO ₂	1	100.0	99.1	0.9
			2		99.1	0.9
			1	99.1	80.1	19.0
		O ₂	2		79.7	19.4
			3		79.7	19.4
			1	79.7	79.7	0.0
	2	CO	2		79.7	0.0
			1	100.0	99.1	0.9
			2		99.1	0.9
		O ₂	1	99.1	79.7	19.4
			2		79.1	20.0
			3		79.1	20.0
	3	CO	1	79.1	79.1	0.0
			2		79.1	0.0
			1	100.0	99.1	0.9
		CO ₂	2		99.1	0.9
			1	99.1	81.1	18.0
			2		79.5	19.6
Outlet	1	CO	3		79.5	19.6
			1	79.5	79.5	0.0
			2		79.5	0.0
		CO ₂	1	100.0	99.1	0.9
			2		99.1	0.9
			1	99.1	80.1	19.0
	2	O ₂	2		80.0	19.1
			3		80.0	19.1
			1	80.0	80.0	0.0
		CO	2		80.0	0.0
			1	100.0	99.0	1.0
			2		99.0	1.0
	3	O ₂	1	99.0	80.2	18.8
			2		79.8	19.2
			3		79.8	19.2
		CO	1	79.8	79.8	0.0
			2		79.8	0.0
			1	100.0	99.0	1.0
	3	CO ₂	2		99.0	1.0
			1	99.0	80.3	18.7
			2		79.8	19.2
		O ₂	3		79.8	19.2
			1	79.8	79.8	0.0
			2		79.8	0.0



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TABLE E-3 - ORSAT ANALYSIS DATA
(continued)

Run #2 - March 1, 1972

Sample Location	Sample Number	Component	Analysis Number	Burette Volume (ml.)		
				Initial	Final	Difference
Inlet	1	CO ₂	1	100.0	99.1	0.9
			2		99.1	0.9
		O ₂	1	99.1	81.6	17.5
			2		80.8	18.3
			3		80.6	18.5
			4		80.6	18.5
		CO	1	80.6	80.6	0.0
			2		80.6	0.0
	2	CO ₂	1	100.0	99.1	0.9
			2		99.0	1.0
			3		99.0	1.0
		O ₂	1	99.0	81.0	18.0
			2		80.2	18.8
			3		80.2	18.8
		CO	1	80.2	80.2	0.0
			2		80.2	0.0
	3	CO ₂	1	100.0	99.1	0.9
			2		99.1	0.9
		O ₂	1	99.1	80.8	18.3
			2		80.5	18.6
			3		80.5	18.6
		CO	1	80.5	80.5	0.0
			2		80.5	0.0
Outlet	1	CO ₂	1	100.0	99.5	0.5
			2		99.5	0.5
		O ₂	1	99.5	80.0	19.5
			2		79.8	19.7
			3		79.8	19.7
		CO	1	79.8	79.8	0.0
			2		79.8	0.0
	2	CO ₂	1	100.0	99.5	0.5
			2		99.2	0.8
			3		99.1	0.9
			4		99.1	0.9
		O ₂	1	99.1	80.0	19.1
			2		79.8	19.3
			3		79.3	19.8
			4		79.3	19.8
		CO	1	79.3	79.3	0.0
			2		79.3	0.0



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TABLE E-3 - ORSAT ANALYSIS DATA

Run #2 - March 1, 1972

(continued)

<u>Sample Location</u>	<u>Sample Number</u>	<u>Component</u>	<u>Analysis Number</u>	<u>Burette Volume (ml.)</u>		
				<u>Initial</u>	<u>Final</u>	<u>Difference</u>
Outlet	3	CO ₂	1	100.0	99.2	0.8
			2		99.2	0.8
		O ₂	1	99.2	79.8	19.4
			2		79.6	19.6
			3		79.6	19.6
		CO	1	79.6	79.6	0.0
			2		79.6	0.0



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TABLE E-3 - ORSAT ANALYSIS DATA

Run #3 - March 2, 1972

Sample Location	Sample Number	Component	Analysis Number	Burette Volume (ml.)		
				Initial	Final	Difference
Inlet	1	CO ₂	1	100.0	99.0	1.0
			2		99.0	1.0
		O ₂	1	99.0	80.5	18.5
			2		80.3	18.7
			3		79.9	19.1
			4		79.9	19.1
		CO	1	79.9	79.9	0.0
			2		79.9	0.0
	2	CO ₂	1	100.0	99.0	1.0
			2		99.0	1.0
		O ₂	1	99.0	80.8	18.2
			2		80.1	18.9
			3		80.1	18.9
		CO	1	80.1	80.1	0.0
			2		80.1	0.0
	3	CO ₂	1	100.0	99.0	1.0
			2		99.0	1.0
		O ₂	1	99.0	80.2	18.8
			2		80.0	19.0
			3		80.0	19.0
		CO	1	80.0	80.0	0.0
			2		80.0	0.0
Outlet	1	CO ₂	1	100.0	99.8	0.2
			2		99.8	0.2
		O ₂	1	99.8	79.2	20.6
			2		79.2	20.6
		CO	1	79.2	79.2	0.0
			2		79.2	0.0
	2	CO ₂	1	100.0	99.9	0.1
			2		99.9	0.1
		O ₂	1	99.9	79.4	20.5
			2		79.4	20.5
		CO	1	79.4	79.4	0.0
			2		79.4	0.0
	3	CO ₂	1	100.0	99.9	0.1
			2		99.9	0.1
		O ₂	1	99.9	79.3	20.6
			2		79.3	20.6
		CO	1	79.3	79.3	0.0
			2		79.3	0.0



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All SO₂ samples were analyzed by the Barium-Thorin Titration procedure. Each sample was transferred to either a 50 or 100 ml. volumetric flask with distilled water washes and then diluted to volume. A suitable aliquot of either 5 or 10 ml. was chosen and then pipeted to a 250 ml. Erlenmeyer flask. Isopropanol was then added to each sample in 4 to 1 proportions (isopropanol to sample aliquot) by volume. The titration was performed in the presence of four drops of Thorin indicator with a previously standardized solution of 0.0111 N barium perchlorate. A solution blank was titrated with each set of samples analyzed. Each sample was titrated twice or until good duplication of results was obtained. Table E-4 lists all titration data recorded. The titer volumes for each impinger sample pair were then summed and the normality of the sample solution was computed by the following formula:

$$N_s = \frac{V_T \times N_T}{V_s}$$

where:

V_T = Volume of titer (ml.)

N_T = Normality of titer (0.0111)

V_s = Volume of sample aliquot (ml.)

From this information the milligrams of SO₂ per sample were calculated using the formula:

$$\text{mg SO}_2 = V_d \times N_s \times \text{meq. wt. SO}_2$$

where:

V_d = Sample dilution volume (ml.)

N_s = Normality of sample solution

meq. wt. SO₂ = 32

The mg SO₂ for each sample were then converted to ppm as shown in Appendix B.



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TABLE E-4 - SO₂ ANALYSIS DATA

<u>Sample Location</u>	<u>Impinger Number</u>	<u>Dilution Vol.(ml.)</u>	<u>Analysis Number</u>	<u>Sample Aliq. (ml.)</u>	<u>Volume Titer (ml.)</u>	<u>Sample Normalty</u>
Run #1 - February 29, 1972						
Inlet	1	50	1	10	0.90	} 9.99 x 10 ⁴
			2	10	0.90	
	2	50	1	10	0.00	
			2	10	0.00	
Outlet	1	50	1	10	0.025	} 0.56 x 10 ⁴
			2	10	0.025	
	2	50	1	10	0.025	
			2	10	0.025	
Run #2 - March 1, 1972						
Inlet	1	50	1	5	29.80	} 1.53 x 10 ⁻¹
			2	5	29.94	
	2	50	1	5	38.70	
			2	5	39.00	
Outlet	1	100	1	10	39.30	} 0.97 x 10 ⁻²
			2	10	39.52	
			3	10	39.59	
	2	100	1	10	47.75	
			2	10	48.05	
			3	10	48.10	
Run #3 - March 2, 1972						
Inlet	1	100	1	10	3.20	} 0.82 x 10 ⁻²
			2	10	3.22	
	2	100	1	10	4.20	
			2	10	4.20	
Outlet	1	100	1	10	2.50	} 0.66 x 10 ⁻²
			2	10	2.44	
			3	10	2.44	
	2	100	1	10	3.48	
			2	10	3.51	



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E.5 NO_x ANALYSIS

Immediately after each NO_x flask sample was taken, the flask containing the absorbing solution and the gas sample was shaken for five minutes. The flask was then allowed to sit until the following morning when it was shaken again for two minutes. Following this final shake, the flask pressure was measured with a mercury manometer. Each flask was then carefully wiped off and the stopcocks removed. The absorbing solutions were then transferred to glass shipping bottles with two 10 ml. washes of distilled water. Just prior to shipping, the samples were neutralized with 1.0 N sodium hydroxide (approximately 40 drops). At this time solution blanks were made for each set of samples. The blanks contained 25 ml. of NO_x absorbing solution and 20 ml. of distilled water and were neutralized with 1.0 N sodium hydroxide. At the end of the test period all samples were transported to the laboratory for analysis.

All NO_x samples were analyzed by the Phenoldisulfonic acid procedure. Prior to analysis, a calibration curve was established for a suitable range of NO_x concentrations. From a standard potassium nitrate solution with an equivalent concentration of 25 µg NO₂ per ml. four aliquots of 4, 8, 12 and 16 ml. were added to respective 250 ml. beakers. Twenty-five ml. of NO_x absorbing solution was added to each of these beakers and the analysis procedure described below was followed. These solutions were read against a blank containing no standard solution and a calibration curve of % absorbance versus µg NO₂ was plotted.



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Upon arrival at the laboratory, each sample was transferred to a 250 ml. beaker and evaporated to dryness on a steam bath. After cooling, 2 ml. of phenoldisulfonic acid was added and each sample was triturated thoroughly with a glass stirring rod. One ml. of distilled water and four drops of concentrated sulfuric acid were added and the samples were returned to the steam bath for three minutes. The samples were then cooled and 20 ml. of distilled water was added. Concentrated ammonium hydroxide was then added dropwise until each sample was alkaline to litmus paper. The samples were transferred to 100 ml. volumetric flasks with distilled water and portions of each solution were read at 420 m μ on a Bausch and Lomb Spectronic 20 Colorimeter. The solution blanks run with each set of samples were used for the colorimeter zero reference. The absorbances read for each sample were then converted to $\mu\text{g NO}_2$ via the previously established calibration curve. NO_x concentrations were calculated as ppm NO_2 following the procedure described in Appendix B. Table E-5 lists all the absorbance data for NO_x .



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TABLE E-5 - NO_x ANALYSIS DATA

<u>Run No.</u>	<u>Date</u>	<u>Sample Location</u>	<u>Sample Port</u>	<u>Absorbance @ 420 mμ</u>	<u>NO_x Conc. (μg NO₂)</u>
1	Feb. 29	Inlet	A	0.298	222.5
			A	0.296	221.0
			B	0.288	215.0
		Outlet	A	0.231	172.5
			A	0.228	172.0
			B	0.241	177.6
2	Mar. 1	Inlet	A	0.310	231.0
			A	0.320	238.0
			B	0.258	192.5
		Outlet	Mid	0.280	208.0
			Mid	0.143	107.5
			Mid	0.249	186.0
3	Mar. 2	Inlet	A	0.340	254.3
			A	0.356	266.3
			B	0.382	285.7
		Outlet	Mid	0.304	227.4
			Mid	0.264	197.4
			Mid	0.179	133.9



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APPENDIX F

TEST LOG

On Monday, February 28, 1972, the Scott team arrived at the Bishop plant of Consolidation Coal Company in Bishop, West Virginia, and began to set up the test equipment. The special testing platforms which were required had been erected by Consolidation Coal Co. and were in place.

Both particulate train control panels were set up in the same area. This area was next to the inlet sample location. The outlet sample location was approximately 30 feet above this area.

Once the equipment had been put in place, preliminary velocity and temperature traverses were performed at both test locations. It was discovered that the pump in the outlet control system was leaking. This was corrected by substituting another pump which was satisfactory. The equipment was then returned to the motel and prepared for the first test. All of the glassware was set up in the sampling boxes before going to the test site. An eight foot probe was used at both locations for the particulate sample.

On Tuesday, February 29, 1972, the team arrived at the plant and set the equipment in place for the test.

The particulate sample trains were started at 1140. Figure F-1, "Summary of Test Program", shows the times that the various samples were taken. The inlet sample probe was located at 36 different traverse points for four minutes each. The outlet sample probe was located at



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48 traverse points for three minutes each. At 1200 the pitot tube in the inlet stack became plugged with dirt and moisture. It was cleaned and the test continued at 1205. Again at 1220 the pitot tube became clogged and improper ΔP 's were observed. The test was stopped and a new umbilical line was attached. The pitot tube was cleaned and the test was resumed at 1243. At 1320 the test was stopped and the probe was moved from one port to the other. The filter in the inlet sample train was also changed because the vacuum was becoming excessively high. The test was resumed at 1346 and ran until 1505.

The Orsat sample system was set up at the inlet location and was started at 1142. It was stopped from 1205 until 1218 and then ran until 1255. The system was transferred to the outlet location and a sample was collected from 1352 until 1452.

The SO_2 sampling apparatus was set up at the inlet location and a sample was collected from 1147 to 1230 except for the period from 1205 to 1218. The system was then moved to the outlet location and a sample collected from 1356 to 1430. Grab NO_x samples were collected from the inlet location at 1145, 1235, and 1410. NO_x samples were collected from the outlet location at 1157, 1355, and 1434. All testing was completed by 1505.

The sample boxes were removed and returned to the motel where the particulate samples were transferred to sample bottles and the system prepared for the next test. While cleaning the glassware it was observed that the probe used at the inlet location was broken. Thus, a 10 foot probe was prepared for the test the next day. The break did not have an



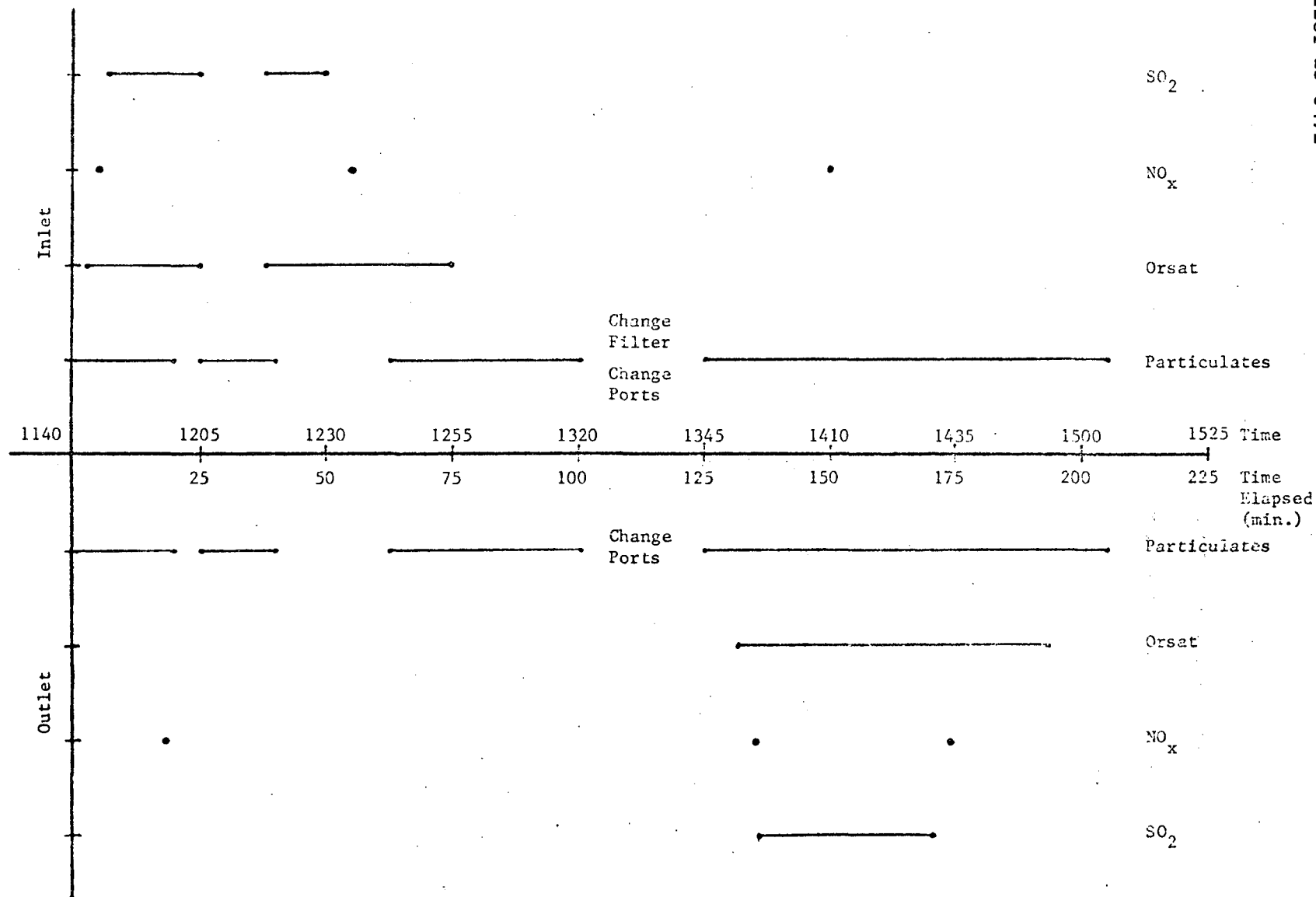


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FIGURE F-1 - SUMMARY OF TEST PROGRAM

Run #1 - February 29, 1972

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F-3

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adverse effect on the first test as evidenced by the heating tape on the outside of the probe not having been broken; and further, it is suspected that the probe may have been broken during removal from the test site following the test. It was also observed that a very slight amount of particulate matter managed to get past the filter in both trains. It was found that the filters were just a fraction too small. This was corrected on later tests by using larger filters.

The Orsat samples were analyzed and the SO_2 samples were transferred to sample bottles. The NO_x samples were transferred to sample bottles the next morning.

On Wednesday, March 1, 1972, the team arrived at the plant and set up the equipment for the second test. At this point it was necessary to install additional scaffolding at the outlet location in order that Research Cottrell personnel could perform tests simultaneously with the Scott team.

The particulate test trains were started at 1156. Although the pitot tube at the inlet location periodically became plugged with dirt and moisture, the problem was easily corrected by blowing out the line with an air supply which Consolidation Coal Co. provided.





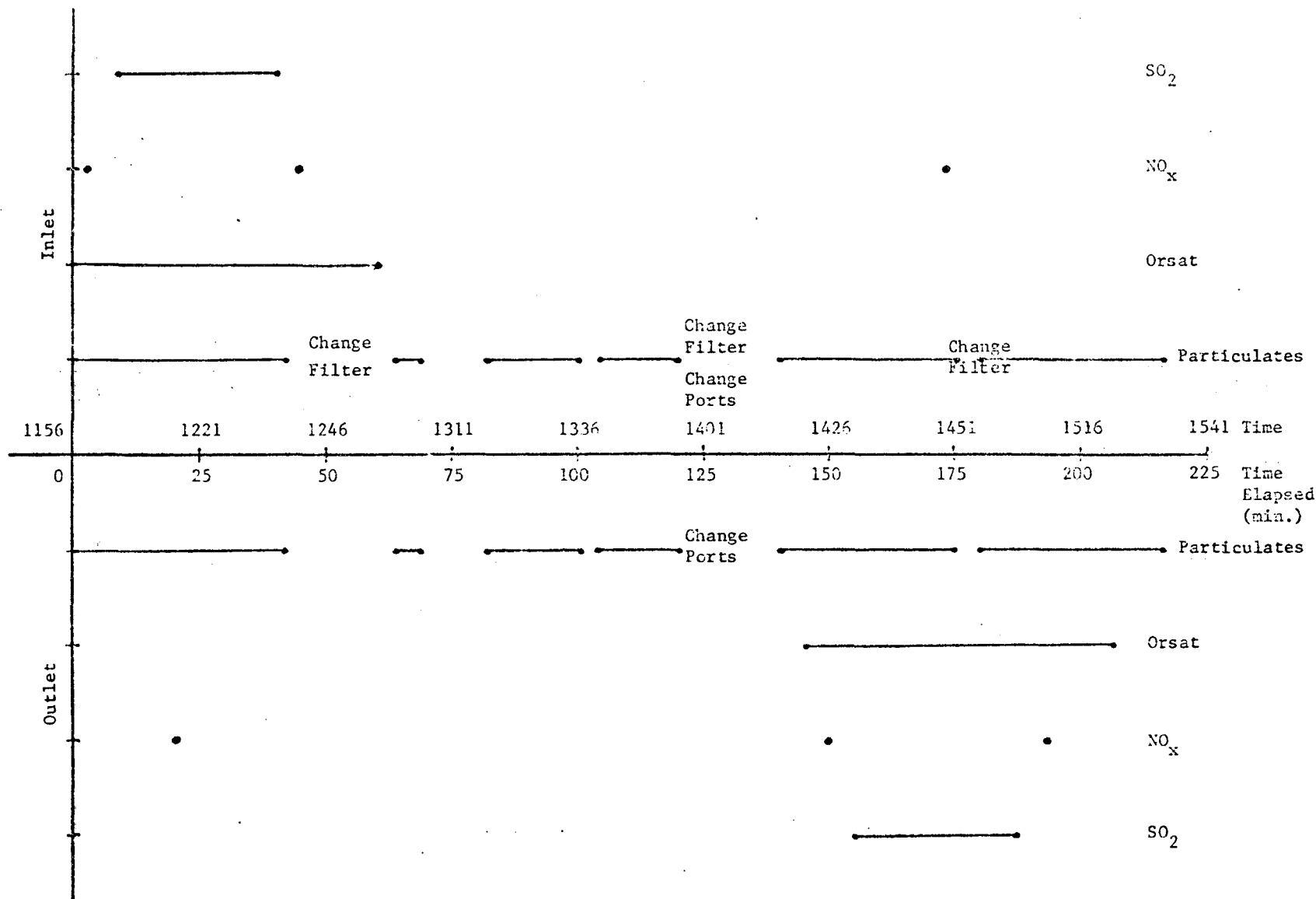
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FIGURE F-2 - SUMMARY OF TEST PROGRAM

Run #2 - March 1, 1972

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F-5

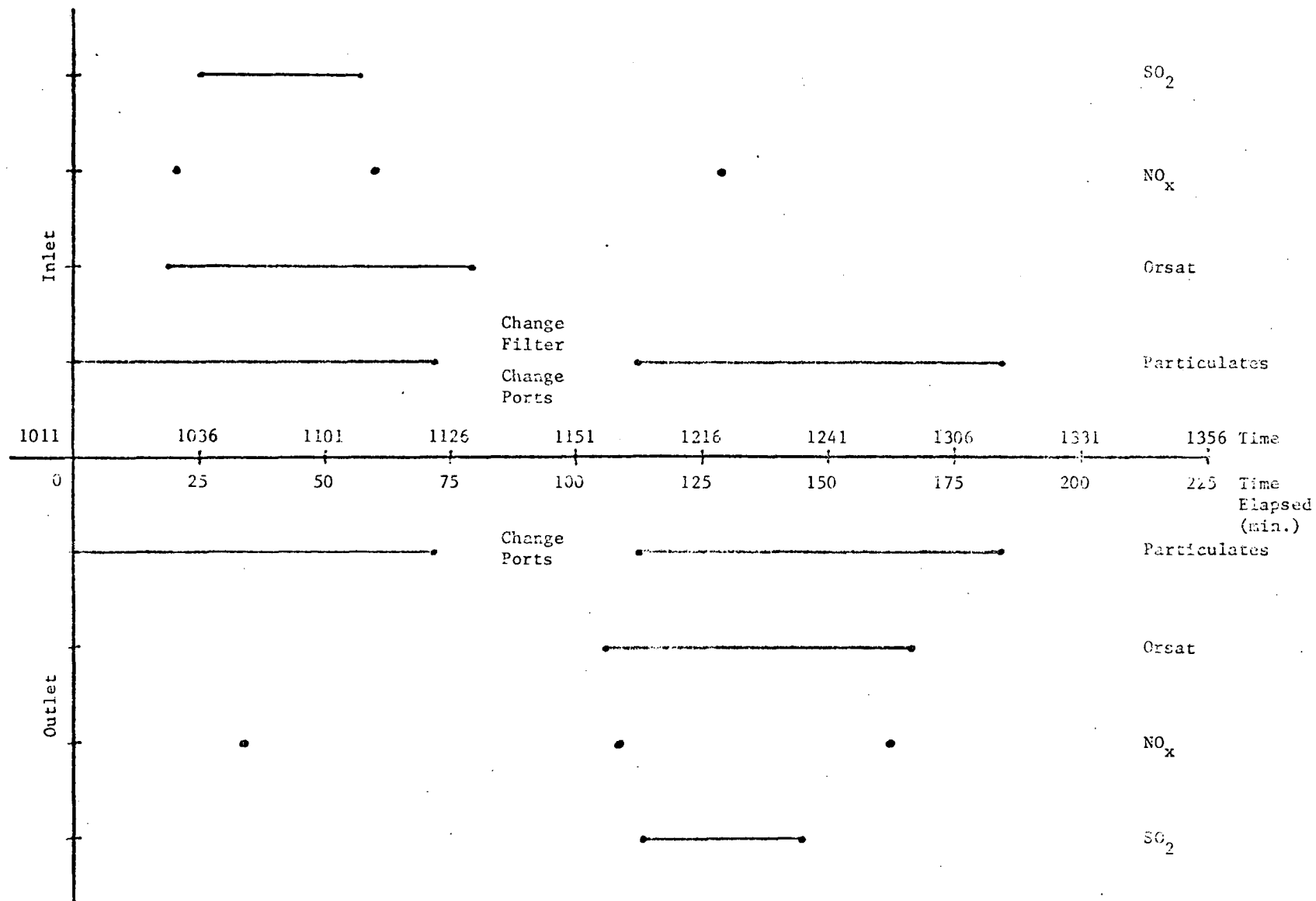




SCOTT RESEARCH LABORATORIES, INC.

FIGURE F-3 - SUMMARY OF TEST PROGRAM

Run #3 - March 2, 1972



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The inlet filter became heavily loaded with material so the test was stopped at 1238 and the filter changed. The test resumed at 1300 but had to be stopped at 1305 because the pump in the inlet system apparently had been over taxed and stopped. The pump was dismantled and the problem corrected. The test resumed at 1324 and ran until 1337. The inlet pitot tube was cleaned and the test resumed at 1340 and run until 1356 when it was stopped in order to change the sample probe from one port to the other. The inlet filter was also changed at this time. The test was resumed at 1415 and ran until 1451. It was stopped at this point in order to change the inlet filter which had become heavily loaded. The test resumed at 1456 and ran until 1532 when the test was completed.

The times that the other samples were collected are summarized in Figure F-2, "Summary of Test Program". An inlet Orsat sample was collected from 1156 to 1256. An outlet Orsat sample was collected from 1421 to 1522. The inlet SO_2 sample was collected from 1205 to 1236. The outlet SO_2 sample was collected from 1431 to 1503. The inlet NO_x samples were collected at 1159, 1240 and 1449 while the outlet NO_x samples were collected at 1215, 1425, and 1509.

All sampling was completed by 1532. The sampling trains were dismantled and returned to the motel for clean up and sample transfer.

All sample transfers and clean up operations were performed as described for the first run. The entire system was prepared for the test the next day.

The Scott team arrived at the test site on Thursday, March 2, 1972, and assembled the equipment for the third run. Leak tests were performed on both the inlet and outlet trains and were found to be



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satisfactory. The particulate tests were started at 1011. The sample continued until 1123 when it was stopped in order to change ports. In addition, the filter was changed in the inlet sampling train because of the high loading. When the leak test was performed a leak rate was discovered. Although the leak test was acceptable it appears the slight leak was due to the introduction of the new filter which was in a different filter holder.

The particulate test was resumed in the other port at 1203 and ran until 1315. The other sampling times are summarized and shown in Figure 3.

The inlet SO_2 sample was collected from 1036 to 1108 while the outlet SO_2 sample was collected from 1204 to 1236. The inlet Orsat sample was taken from 1030 to 1130 and the outlet Orsat sample was taken from 1157 to 1257. The inlet NO_x samples were taken at 1031, 1111, and 1219. The outlet NO_x samples were taken at 1045, 1159, and 1253. All testing was completed by 1315.

The sampling trains were removed and the remaining equipment was disassembled and removed from the test site. The samples were taken back to the motel where the sampling clean up procedures described earlier were followed.



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APPENDIX G

PROJECT PARTICIPANTS AND TITLES

The personnel taking part in the project include:

Thomas Ward	Project Officer - EPA
Charles Sedman	Project Engineer - EPA
Norman Troxel	Senior Engineer - SRL
Joseph Wilson	Field Team Leader - SRL
Nosh Mistry	Field Team Leader - SRL
Jyotin Sachdev	Engineer - SRL
William Blakeslee	Chemist - SRL
William Scott	Technician - SRL
Duane Gulick	Technician - SRL
Zenophon Tomaras	Chemist - SRL
Margaret Husic	Technician - SRL
Louis Reckner	Manager, Atmospheric Chemistry and Industrial Emissions Department - SRL

