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

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

Background Report Reference

AP-42 Section Number: 11.10

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US EPA

March 1973

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73-CCL-4

SCOTT RESEARCH LABORATORIES, INCORPORATED

SRL 1361 15 0373

Environmental Protection Agency
Test No. 73-CCL-4
Thomas Ward, Project Test Officer
Valley Camp Coal Company
Triadelphia, West Virginia, H. William Blakeslee

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

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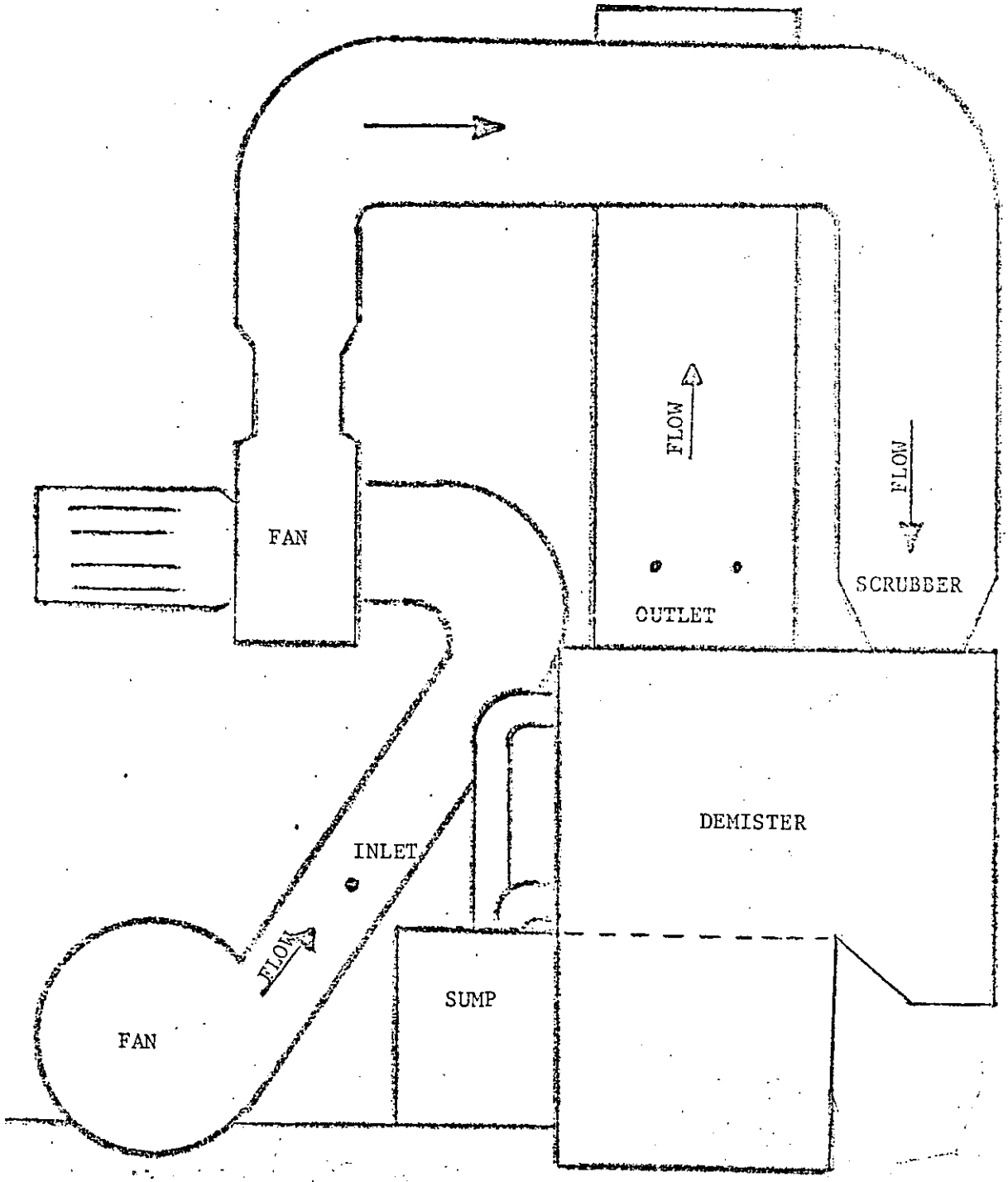
1.0 INTRODUCTION

Scott Research Laboratories, Inc. performed source sampling tests at the Triadelphia, West Virginia plant of the Valley Camp Coal Company on March 14 and 15, 1973. This plant uses two American Air Filter Co. scrubbers modified by Valley Camp Coal Company to control the exhaust gas emissions from its coal cleaning and preparation operation.

The exhaust gas emissions were tested for sulfur dioxide (SO_2) concentrations at the inlet and outlet of one of the two wet scrubbers simultaneously. During each test period, coal and water samples were taken at representative locations throughout the process stream. Three complete runs were performed at the plant, and in addition, a calibrated cylinder of sulfur dioxide was analyzed in the same manner at Plumsteadville by Scott technicians and at Triadelphia by the Contract Monitor.

Figure 1-1 shows the sampling locations at the plant.



SYSTEM NUMBER 1

(HIGH ENERGY SCRUBBER)

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FIGURE 1-1 SAMPLE PORT LOCATIONS

2.0 SUMMARY OF RESULTS

A summary of test results is presented in Table 2-1. This shows good correlation between the tests. The reduced values in the third test possibly could be explained by the fact that the process had been shut down to rebrick the furnace. However, plant personnel estimated that only 30 minutes were required to attain equilibrium process conditions following such a start-up; and the test was started 1½ hours after the start-up.

TABLE 2-1 SUMMARY OF TEST RESULTS

RUN NUMBER:	1-0	2-0	3-0	1-1	2-1	3-1	Scott Std.*	EPA Std.*
Sample Point Pocation	Outlet	Outlet	Outlet	Inlet	Inlet	Inlet		
Sample Date	3/14/73	3/14/73	3/15/73	3/14/73	3/14/73	3/15/73	3/14/73	3/14/73
Sample Gas Volume, liters	30	30	30	27	30	33	14	12
Stack Gas Temp., ^{o}F	127							
Stack Gas Vel., fpm	2509.56							
Stack Gas Volume, acfm	100382							
Sulfur Dioxide, ppm	196.55	243.60	160.74	399.65	366.94	308.87	529.76	469

* Run on a calibrated cylinder of 532 ppm SO_2

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3.0 PROCESS DESCRIPTION AND OPERATION

The Triadelphia preparation plant was built by the Link Belt Company and consists of two process streams. In each, coal from a deep mine is separated and cleaned and then dried on a Link Belt Fluid-Flo Dryer. The larger fines from the dryer effluent gas stream are trapped in a cyclone and are mixed into the dryer product stream. The dryer product stream is approximately 200 tons per hour. Another 65 tons per hour bypass the drier and are mixed into the product, for a total production of 265 tons per hour. Part of the undried product stream is shunted periodically into the feed hopper for the furnace heating the drier. The furnace can burn a maximum of 6000 pounds of coal per hour and was calculated to be burning $4000 \begin{smallmatrix}+1200\\-0\end{smallmatrix}$ pounds per hour during these tests.

The fines not trapped by the cyclone are scrubbed by an American Air Filter scrubber modified by Valley Camp Coal Company. The scrubber water is recirculated through a thickner. The fans driving this scrubber are rated at 108,000 cfm at 140°F and were operated at design rate. The measured flow at the scrubber outlet was 100,382 cfm at 127°F.

The plant stores raw coal from the mines in large storge bins. The plant has the capacity to clean all the stored coal in about six hours with both process streams operational.

The control panel of the plant was monitored during each test, and the data are presented in Table 3-1. Figure 3-1 represents the drying and scrubbing operations at the plant.

During the tests coal samples were taken at the points labeled A, B, C, and D on Figure 3-1. Water samples were taken at E and F. The samples were proportioned at intervals during each test and were mixed following the test. The sampling times are listed in Table 3-2. Sulfur analysis data for the coal and water samples are presented in Table 3-3.

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TABLE 3-1 PLANT OPERATION DATA

	Run 1	Run 2	Run 3
Drier Exhaust Temp., °F	225	225	225
Furnace Temp., °F	890	890	840
Product Feed (Dried), TPH	194	195	190

TABLE 3-2 PRODUCT MATERIAL SAMPLING TIMES

	A	B	C	D	E&F
Run 1	1401	1400	1358		1403
	1409	1407	1405	1405	-
	1415	1412	1411		1414
	1421	1418	1417		1420
	1427	1425	1423	1426	1426
	1436	1433	1430		1435
Run 2	1539	1536	1533		1537
	1545	1542	1540		
	1551	1548	1546		1550
	1557	1554	1552		1555
	1605	1605	1604		1606
Run 3	1310	1306	1302		1309
	1316	1314	1312	1315	1315
	1324	1320	1318		
	1331	1330	1322		1322
	1345	1340	1336		

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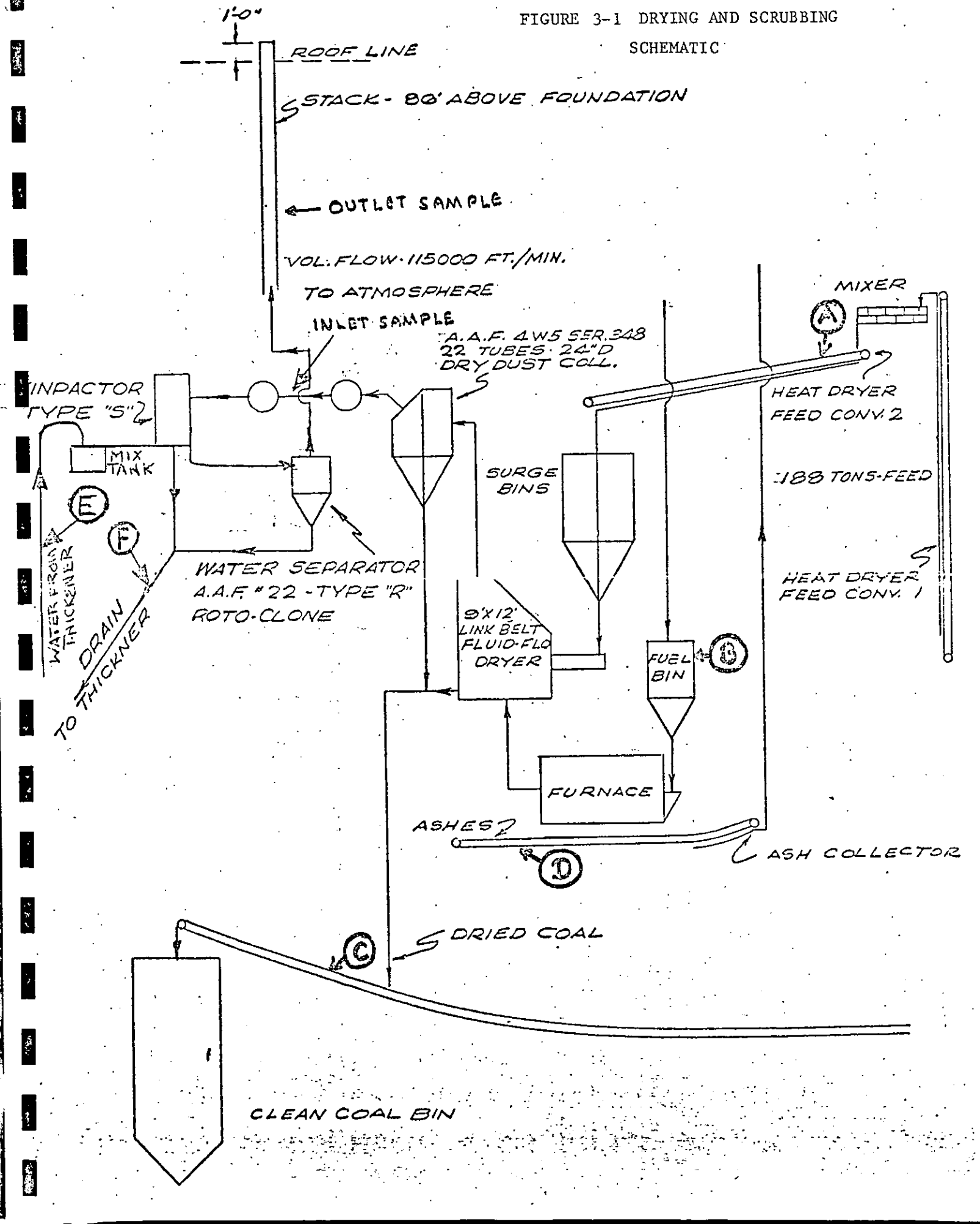
TABLE 3-3 SULFUR ANALYSES, % BY WEIGHT

Figure 3-1 Point Reference	Description	Run 1	Run 2	Run 3
E	Water from thickener	0.23	0.19	0.20
F	Drain to thickener	0.25	0.20	0.20
A	Dryer Feed (wet coal)	3.2	3.3	3.22
C	Product (dried caol)	3.3	3.16	3.52
B	Furnace fuel (wet coal)	3.27	3.6	2.95
D	Furnace ash	0.34	0.37	0.78

FIGURE 3-1 DRYING AND SCRUBBING SCHEMATIC



4.0 LOCATIONS OF SAMPLING POINTS

The exhaust gases from the coal cleaning operation pass through two fans in series into the scrubber. They are then exhausted to the atmosphere through a 5' x 8' rectangular stack.

The inlet sampling port was placed at the only convenient location possible between the blowers. Two outlet ports were placed on the straight vertical portion of the exhaust stack. This measured 5' x 8' and the sample ports were placed 3' in from each side on the long dimension. Figure 1-1 shows the general locations of the ports. Figure 4-1 shows the points traversed for the flow measurement of the outlet stack. The traverse points were selected in accordance with the method given in the Federal Register, Volume 36, No. 24 for rectangular stacks.

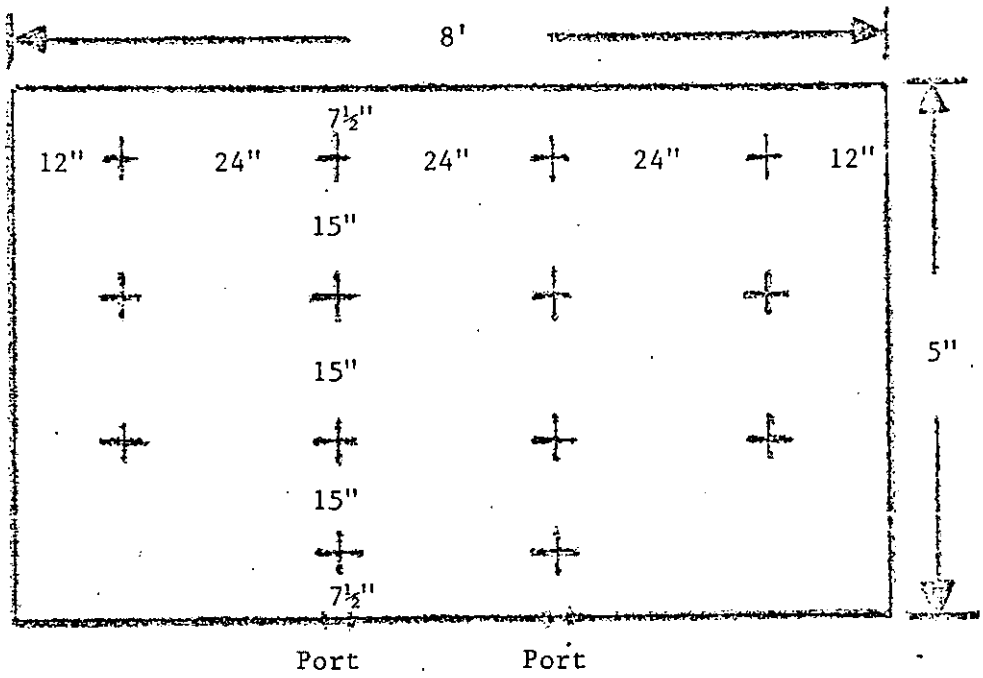


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FIGURE 4-1 LOCATION OF FLOW TRAVERSE POINTS

5.0 SAMPLING AND ANALYTICAL PROCEDURES

5.1 FLOW MEASUREMENT

The stack gas velocity and flow rate were measured at the outlet according to Method 2, "Determination of Stack Gas Velocity and Volumetric Flow rate (Type S Pitot Tube)", and published in the Federal Register. This was done once preceding the first test.

5.2 SO_2 SAMPLING AND ANALYTICAL PROCEDURES

All SO_2 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 SO_3 present in the sample stream. The SO_2 was collected in the next two impingers, each containing 15 ml. of 3% H_2O_2. The third impinger was used to trap any overflow from the two SO_2 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 train was flushed for fifteen minutes with dry nitrogen and then the SO_2 samples were transferred to polyethylene bottles with distilled water washes. A blank was prepared by filling and transferring a train in the same manner. 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 SO_2.

Two tests were made with the above set up and procedure with the exception that the probe was replaced with an inlet tube from a cylinder of standardized 532 ppm SO_2 supplied by the Gas Department of Scott Research Laboratories, Inc. This cylinder was analyzed both before and immediately following the Triadelphia project. The final analysis run on March 19, 1973 was 532 ppm SO_2.

One sample of the standard was made by the Scott field crew immediately preceding the trip to Triadelphia. The second test was made by the EPA contract monitor at Triadelphia. The first test was within 1% of the actual concentration. In addition, it showed that more than 95% of the SO_2 is trapped in the first bubbler.

5.3 PLANT PROCESS SAMPLES

Six samples were taken during each run: Three were coal samples, one was ash, and two were water. These were turned over to the EPA Contract Monitor at the end of the field work for analysis by EPA.

APPENDIX A

COMPLETE FIELD RESULTS

WITH EXAMPLE CALCULATIONS

Sulfur Dioxide Emission Data

Project No. 1361

Run No.	1 INLET	1 OUTLET	2 INLET	2 OUTLET	3 INLET	3 OUTLET	
Date	3/14	3/14	3/14	3/14	3/15	3/15	
mg SO_2	28.02	15.15	28.37	18.75	26.96	12.70	
T_m - Average Meter Temp, °F	80.8°	87°	84.2°	87°	89.8°	72°	
P_b - Barometric Pressure, " Hg abs.	29.145	29.145	29.145	29.145	29.095	29.095	
V_m - Vol. of Sample, ft^3	0.953	1.0607	1.0593	1.0593	1.1652	1.0593	
ppm SO_2	399.6	196.6	366.9	243.6	305.9	160.7	

$$\text{ppm } SO_2 = \frac{0.7332 \times \text{mg } SO_2 \times (T_m + 460)}{P_b \times V_m}$$

$$\frac{.7332 \times 28.0166 \times (80.6 + 460)}{29.145 \times 0.9534} = 399.65 \text{ ppm } SO_2$$

Sulfur Dioxide Emission Data

Project No. 1361

Run No.	Scott STD. SO_2	EPA STD. SO_2					
Date	3/16	3/14					
mg SO_2 Bubbler #1	19.43	14.59					
mg SO_2 Bubbler #2	0.84	0.61					
T_m - Average Meter Temp, °F	58.1°	60.0°					
P_b - Barometric Pressure, " Hg abs.	29.410	29.145					
V_m - Vol. of Sample, ft^3	.494	.424					
ppm SO_2	529.16	469.3					

$$\text{ppm } SO_2 = \frac{0.7332 \times \text{mg } SO_2 \times (T_m + 460)}{P_b \times V_m}$$

APPENDIX B

FIELD DATA

PRELIMINARY VELOCITY TRAVERSE

PLANT Valley Camp Coal Co., Wheeling, W. Va.
DATE 2/14/73
LOCATION OUTLET
STACK I.D. 8x5'
BAROMETRIC PRESSURE, in. Hg 29.145 ; 82.5°F
STACK GAUGE PRESSURE, in. H_2O 0.0
OPERATORS Tom Wark & J. Dachdev

OUTLET (3'x 5')

TRAVERSE POINT NUMBER	VELOCITY HEAD (Δp_s), in. H_2O	STACK TEMPERATURE (T_s), °F
1	0.23	127
2	0.23	
3	0.33	
4	0.67	
5	0.98	
6	0.48	
7	0.41	
8	0.19	
9	0.25	
10	0.40	
11	0.86	
12	0.93	
13	0.45	
14	0.36	
	6.79	
	A_v = 0.485 ≈ 0.49	
Probe	set in 3'	
AVERAGE		

0.485
14 | 6.79
56
119
112
70

SCHEMATIC OF TRAVERSE POINT LAYOUT

INLET

TRAVERSE POINT NUMBER	VELOCITY HEAD (Δp_s), in. H_2O	STACK TEMPERATURE (T_s), °F
AVERAGE		

EPA (Dur) 233
4/72

LABORATORY

LABORATORY TEST SHEET

AND-GEN-1128

TEST OF SO_2 - 1361

TEST ENGINEER W. SCOTT, J. SACHDEV OBSERVERS

DATE 3/14 + 15

TEST EQUIPMENT EPA

STACK IDENT.	TEST #	START TIME	STOP TIME	DATE	SAMP VOL	METER TEMP °C	DRY BULB °F	WET BULB	[illegible]		
INLET	1	1403	1438	3/14	27 l.	27	83	65	[illegible]		
INLET	2	1532	1606	3/14	30 l.	29	88	66	[illegible]		
INLET	3	1300	1338	3/15	33 l.	21	75	66	[illegible]		
OUTLET	1	1400	1429	3/14	30.04	30.5	82.5	65	[illegible]		
OUTLET	2	1540	1612	3/14	30.0	30.5	82.5	66	[illegible]		
OUTLET	3	1255	1333	3/15	30.0	22.5	75	66	[illegible]		

APPENDIX C

STANDARD SAMPLING PROCEDURES

The sampling procedures used during the test are the same as those published in the Federal Register, Volume 36, Number 247, Thursday, December 23, 1971. These methods are as follows: Methods 1, 2, and 6.

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APPENDIX D LABORATORY REPORT

Including blanks and three simultaneous inlet-outlet tests, a total of twelve SO_2 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 nitrogen 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.

All SO_2 samples were analyzed by the Barium-Thorin Titration procedure. Each sample was transferred to either a 50 or 100 ml. volumetric flash 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 D-1 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 SO_2 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. SO_2 = 32

The mg SO_2 for each sample were then converted to ppm as shown in Appendix A.

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TABLE D-1 SO_2 ANALYSIS DATA

$BaCl_2$ = .0096N

Sample	ml.	Aliquot ml.	Titer ml.	titer-dup.
Lab Blank		10	.05	
Field Blank	40	10	.05	
Inlet #1	96	10	9.5	9.5
Inlet #2	105	10	8.75	8.85
Inlet #3	77	10	11.4	11.4
Outlet #1	85	10	5.8	5.8
Outlet #2	100	10	6.1	6.1
Outlet #3	81	10	5.1	5.1
Unknown Bubbler #1 (diluted to 50 ml.)	50	10	9.5	9.5
Unknown Bubbler #2 (diluted to 50 ml.)	50	10	0.4	0.4
Cyl. (532 ppm SO_2)				
Bubbler #1	50	10	12.65	12.65
Bubbler #2	50	10	0.55	0.55

APPENDIX E

TEST LOG

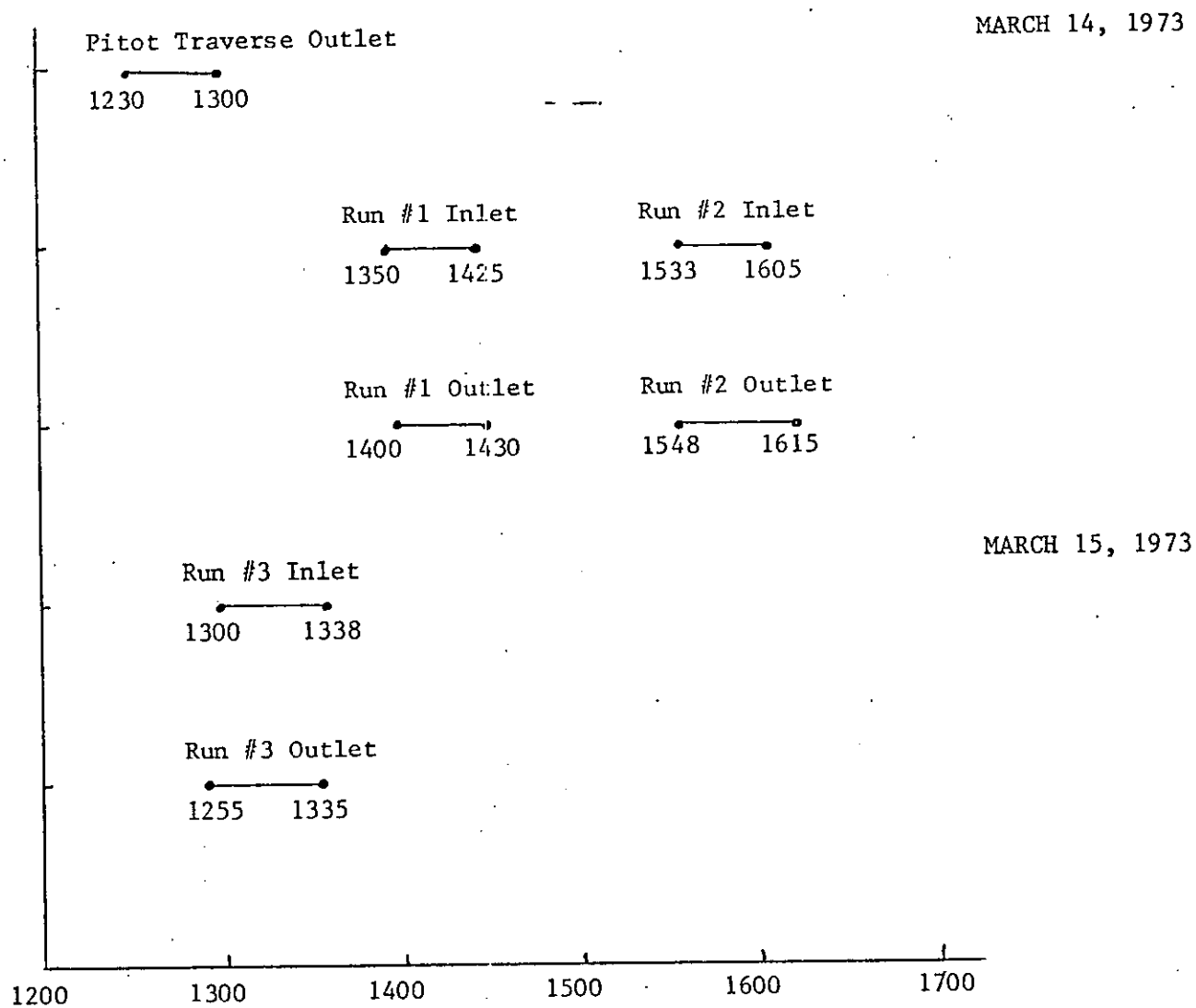
The Scott team consisting of three field workers arrived at the Triadelphia plant of the Valley Camp Company on Wednesday, March 14, 1973. They immediately began to transfer equipment to the roof of the plant since adequate access was available to the sampling ports.

Once the equipment was in place, a velocity and temperature traverse was performed at the outlet location. The equipment was then set up for the first test. While this was going on, the field team leader familiarized himself with the locations for the coal and water samples.

The first tests commenced at 1350 and concluded about 1440. A second set of equipment was used for the second tests, and these were started about 1530 and concluded about 1610. The four trains were then transferred to a local motel for cleanup and transfer.

On Thursday, March 15, the plant was not operational due to a fire brick collapse in the furnace. This was repaired and the plant was started at 1130. Tests were started at 1300 and concluded at 1340. Figure E-1 indicates the test durations on March 14 and 15, 1973.

FIGURE E-1 SUMMARY OF TEST PROGRAM



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APPENDIX F

PROJECT PARTICIPANTS AND TITLES

The personnel taking part in the project include:

Thomas Ward	Project Officer - EPA
William Blakeslee	Field Team Leader - SRL
Jyotin Sachdev	Engineer - SRL
William Scott	Technician - SRL
Margaret Husic	Technician - SRL
Norman Troxel	Senior Engineer - SRL
Louis R. Reckner	Manager, Atmospheric Chemistry & Industrial Emissions Dept. - SRL