

# MRI REPORT

SOURCE TESTING  
EPA TASK NO. 6

STANDARD OIL OF CALIFORNIA COMPANY  
El Segundo, California

by

Chatten Cowherd

Midwest Research Institute  
Kansas City, Missouri 64110

EPA Contract No. 68-02-0228  
(MRI Project No. 3585-C)

SOURCE TESTING  
EPA TASK NO. 6

71-PC-21

STANDARD OIL OF CALIFORNIA COMPANY  
El Segundo, California

by

Chatten Cowherd

Midwest Research Institute  
Kansas City, Missouri 64110

EPA Contract No. 68-02-0228  
(MRI Project No. 3585-C)

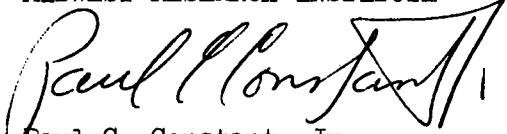
PREFACE

The work reported herein was conducted by Midwest Research Institute (MRI), pursuant to a Task Order issued by the Environmental Protection Agency (EPA) under the terms of EPA Contract No. 68-02-0228.

Mr. E. P. Shea served as the Project Chief and directed the MRI Field Team consisting of: Messrs. Ed Trompeter, Bob Conkling, Gary Kelso, Bill Shutts, Reid Flippin, Bob Stultz, and Henry Maloney. Mr. Fred Bergman, assisted by Messrs. Mike Hammons and Terry Howard, performed the pollutant analyses at the MRI laboratories. Dr. Chatten Cowherd, Jr., prepared this Final Report.

Approved for:

MIDWEST RESEARCH INSTITUTE



Paul C. Constant, Jr.  
Program Manager

28 April 1972

## I. TABLE OF CONTENTS

	<u>Page</u>
II. Introduction . . . . .	2
III. Summary of Results . . . . .	5
IV. Process Description. . . . .	12
V. Location of Sampling Points. . . . .	13
VI. Process Operations . . . . .	16
VII. Sampling and Analytical Procedures. . . . .	17
Appendix A - Particulate Results . . . . .	24
Appendix B - Gaseous Results . . . . .	38
Appendix C - Operation Results . . . . .	46
Appendix D - Field Data. . . . .	47
Appendix E - Standard Sampling Procedures. . . . .	98
Appendix F - Laboratory Report . . . . .	110
Appendix G - Test Log. . . . .	115
Appendix H - Project Participants and Titles . . . . .	117

## II. INTRODUCTION

Under the Clean Air Act of 1970, as amended, the Environmental Protection Agency is charged with establishment of performance standards for stationary source categories which may contribute significantly to air pollution. A performance standard is a standard for emissions of air pollutants which reflect emission limitations attainable through the best emission reduction systems that have been adequately demonstrated (taking into account economic considerations).

The development of realistic performance standards requires accurate data on pollutant emissions within the various source categories. In the petroleum refining industry, the catalyst regeneration system at the Standard Oil of California's refinery in El Segundo, California, was designated by EPA as representative of a well controlled operation, and was thereby selected for the emission testing program. This report presents the results of the testing which was performed by Midwest Research Institute at the Standard Oil refinery.

At Standard's El Segundo refinery, effluent from the catalyst regenerator, which is part of the fluid catalytic cracking system, is treated in the following sequence of steps prior to being discharged to the atmosphere. Flow from the regenerator passes in two parallel streams through Buell cyclones followed by heat exchangers. The two streams are then combined into a single stream which passes through a Cottrell electrostatic precipitator and then through a CO boiler. These treatment steps

eliminate most of the entrained particulate matter and the carbon monoxide produced by the regeneration process, prior to the discharge of effluent gases through the CO boiler stack. Measured pollutant emissions from the catalyst regeneration process consist of particulates, carbon monoxide, sulfur dioxide, and oxides of nitrogen.

On 9 December 1971, two members of the MRI field team arrived at the testing site. Their first assignment was to transfer the testing equipment from the airport to the job site. They also carried out general preparatory tasks and supervised the alteration to the stack and work platform which was performed by Standard Oil. The NDIR (nondispersive infrared) instrument was delivered to Beckman for recalibration and installation of cells (at MRI's expense) to increase the sensitivity for the determination of carbon monoxide. High wind conditions on 9 and 10 December 1971 forced a postponement of the installation of the sampling rails for the particulate train until 13 December 1971. The remainder of the MRI field team arrived on the morning of 13 December 1971, with the exception of one man who arrived the following day.

Source testing was performed on 14, 15 and 16 December 1971. At the CO Boiler stack location four particulate runs were conducted. During each period of particulate sampling, three separate gas sampling trains were operated for the determination of nitrogen oxides, sulfur dioxide, and gas composition by Orsat analysis. At the other test location--the feed duct to the CO boiler--moisture determinations were made and integrated gas samples were collected for Orsat analysis.

Samples of the stack effluent were collected at an elevation of about four stack diameters above the inlet breeching (inside diameter of the stack was 13 ft 10 in.) A network of 40 sampling points was used for the collection of particulate samples, as specified by the Federal Register, "Standards of Performance for New Stationary Sources," 17 August 1971.

Samples of the boiler feed gases were collected through a valve which was attached to the 4 ft diameter duct at a distance of about 40 ft from any flow obstruction.

A number of factors delayed sampling activities in the course of the testing: (1) the chemicals which were to have been delivered to site by the supplier did not arrive on time. Consequently, MRI made a pickup on the morning of 14 December 1971, resulting in a delay of about 4 hr; (2) a process upset occurred during the change-over period of the first particulate test on 14 December 1971. This caused a 2-hr delay in sampling activities; (3) a team from Standard Oil was testing simultaneously with the MRI team, causing several interruptions in the MRI testing activity. This resulted in delays of 2-1/2 to 3 hr on 2 days, 14 and 15 December 1971.

The following sections of this report treat: (1) the summary of results; (2) the description of the process; (3) the location of sampling points; (4) process operating conditions; and (5) sampling and analytical procedures.

### III. SUMMARY OF RESULTS

Tables I, II, and III present a summary of results from the particulate and gas emission testing. As shown in Table I, there is a significant variation in the measured particulate grain loading and emission rate. The partial grain loading rate (gr/SCF dry) varies from 0.0307 to 0.0653, with an average of 0.0437 for the four runs; the total grain loading rate varies from 0.044 to 0.177, with an average of 0.114 for the four runs. The partial emission rate (lb/hr) of the particles collected varies from 51.4 to 110, with an average of 73.4 for the four runs; the total emission rate varies from 77.3 to 296, with an average of 191 for the four runs.

The filters shown in Figure 1, indicate the probable cause of the above variations. Filters Nos. 51, Test 1; 52, Test 2; and 55, Test 4; show a reddish brown to black coloration, indicating the presence of organic matter that is not present on the grayish colored Filters Nos. 53, 30% of Test 2; and 54, Test 3. Runs Nos. 1 and 4 had high grain loading values and used Filters Nos. 51 and 55, respectively. Run No. 2 used Filter No. 52 (70% of the time) and Filter No. 53 (30% of the time), and had below average grain loading. Run No. 3 used Filter No. 54 which collected no dark material, and had the lowest partial grain loading.

Table II shows the stack gas composition, measured in conjunction with the particulate test runs for CO, NO<sub>x</sub> as NO<sub>2</sub>, and SO<sub>2</sub>. CO was

TABLE I

SUMMARY OF RESULTS (PARTICULATE EMISSIONS)  
CO Boiler Stack Standard Oil of California, El Segundo

NAME	DESCRIPTION	UNITS	1	2	3	4
	DATE OF RUN		12-14-71	12-15-71	12-16-71	12-16-71
QS	STK FLOWRATE, DRY,STD CN	DSCFM	196403	186383	204987	195766
QA	ACTUAL STACK FLOWRATE	ACFM	590164	544673	568075	586199
PMOS	PERCENT MOISTURE BY VOL		24.7	23.2	20.6	25.9
PCO2	PERCENT CO2 BY VOL, DRY		7.0	7.0	10.2	13.1
P02	PERCENT O2 BY VOL, DRY		12.4	12.4	7.4	3.8
CO	CONC OF CO , DRY	PPM	0.0	0.0	0.0	5.0
<b>PARTICULATES -- PARTIAL CATCH</b>						
MF	PARTICULATE WT-PARTIAL	MG	219.85	211.33	109.42	228.85
CAN	PART. LOAD-PTL,STD CN	GR/DSCF	.04555	.03234	.03116	.06445
CAT	PART. LOAD-PTL,STK CN	GR/ACF	.01515	.01106	.01124	.02151
CAW	PARTIC EMIS-PARTIAL	LB/HR	76.63	51.63	54.71	108.08
<b>PARTICULATES -- TOTAL CATCH</b>						
MT	PARTICULATE WT-TOTAL	MG	663.43	636.98	157.04	619.46
CAO	PART. LOAD-TTL,STD CN	GR/DSCF	.13744	.09746	.04472	.17445
CAU	PART. LOAD-TTL,STK CN	GR/ACF	.04571	.03333	.01613	.05822
CAX	PARTIC EMIS-TOTAL	LB/HR	231.23	155.61	78.53	292.55
IC	PERC IMPINGER CATCH		66.9	66.8	30.3	63.1

TABLE II  
SUMMARY OF RESULTS (STACK GAS COMPOSITION)<sup>a/</sup>

<u>Run</u>	<u>Date</u>	<u>CO<sup>b/</sup></u> <u>(ppm/vol)</u>	<u>NO<sub>x</sub> as NO<sub>2</sub></u>		<u>SO<sub>2</sub></u>	
			<u>(lb/dscf)</u>	<u>(ppm, dry)</u>	<u>(lb/dscf)</u>	<u>(ppm, dry)</u>
1	12/14/71	-	$1.31 \times 10^{-5}$	108	-	-
2	12/15/71	-	$1.39 \times 10^{-5}$	114	$2.23 \times 10^{-5}$	132
			$1.47 \times 10^{-5}$	121		
			$1.24 \times 10^{-5}$	102		
			$1.46 \times 10^{-5}$	120		
3	12/16/71	-	$1.72 \times 10^{-5}$	142	$5.48 \times 10^{-5}$	324
			$1.97 \times 10^{-5}$	162		
			$1.67 \times 10^{-5}$	138		
4	12/16/71	5	$1.75 \times 10^{-5}$	144	$6.09 \times 10^{-5}$	360
			$1.64 \times 10^{-5}$	135		

<sup>a/</sup> Excluding Orsat analysis.

<sup>b/</sup> Determined with NDIR instrument and corrected for CO<sub>2</sub> interference.

TABLE III  
SUMMARY OF RESULTS (FEED LINE GAS COMPOSITION)

<u>Run</u>	<u>Date</u>	<u>Percent by Volume (dry)</u>			<u>Vol. % Moisture</u>
		<u>CO<sub>2</sub></u>	<u>O<sub>2</sub></u>	<u>CO</u>	
1F	12/14/71	10.2	1.2	8.4	-
2F	12/15/71	10.8	2.0	8.1	3.0
3F	12/16/71	11.2	1.2	8.3	2.2
4F	12/16/71	11.0	1.1	8.1	

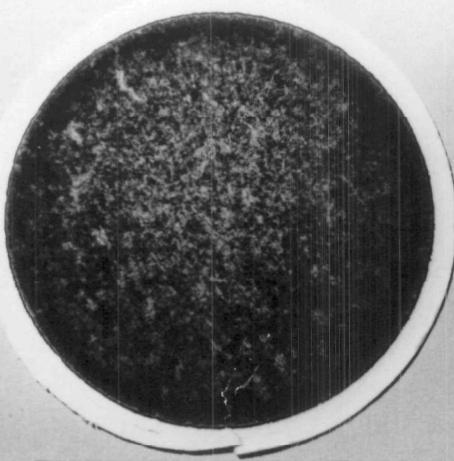


Table I Test 1 Filter 51



Table I Test 2 Filter 52



Table I Test 2 Filter 53

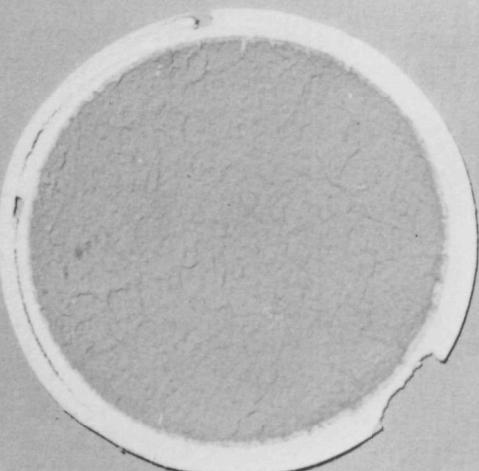


Table I Test 3 Filter 54

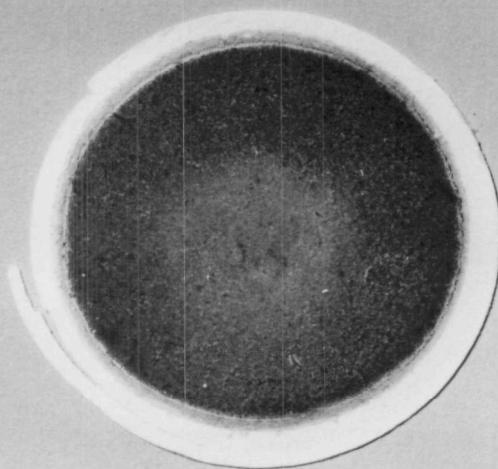


Table I Test 4 Filter 55

Figure 1 - Filters Used in Particulate Sampling  
Standard Oil, El Segundo, California

measured to be 5 ppm, by dry volume, on Test No. 4.  $\text{NO}_x$  as  $\text{NO}_2$  varied from 108 to 162 ppm by volume (dry) with an average value of 129 ppm.  $\text{SO}_2$  varied from 132 to 360 ppm by volume (dry) with an average value of 272 ppm. The integrated gas samples from Tests 1 to 3 were no good, therefore, we were unable to obtain values for CO on these tests.

Table III shows the feed line gas composition, sampled with an integrated gas bag and measured by Orsat analysis. The average values for the gas composition (expressed as percent by volume, dry) were:  $\text{CO}_2$ , 10.8%;  $\text{O}_2$ , 1.4%; and CO, 8.2%.

The  $\text{CO}_2$ ,  $\text{O}_2$ , and excess air values shown in Table I are obviously in error for Tests 1 through 3. The probe used to collect these samples was not long enough to reach a good sampling point in the stack. The probe tip was only 2-3 in. inside the stack wall, and the port was not airtight while the sample was being collected from the negative pressure stack. The port collar was 11 in. long and the wall of the stack was 1 in. thick. The gas probe used for collecting the samples was 18 in long. On Test No. 4, a 6-ft glass-lined probe was used to withdraw the gas sample from the stack and fill the gas bag. This probe was inserted so that the tip was 4 ft inside the stack and a special effort was made to insure that the port opening was covered. The results from Test 4 are much more reliable and values for  $\text{CO}_2$ ,  $\text{O}_2$ , and excess air prove that this sample was a good sample. Unfortunately the refinery was not running Orsat analysis on the stack gases while we were testing, so we

were unable to use their values instead of our obviously incorrect values.

A summary of process operating data during each test period will be presented by EPA.

IV. PROCESS DESCRIPTION

This section is to be prepared by EPA.

## V. LOCATION OF SAMPLING POINTS

Figure 2 shows the location of the sampling stations on the feed line to the CO boiler and on the boiler stack. At the feed line sampling location, samples for moisture and Orsat analysis were taken through an existing 3/4-in. valve. The positive pressure of the feed line made it unnecessary to use a pump to draw the sample.

Particulate samples were collected from the effluent at an elevation of 55 ft (about four stack diameters) above the inlet breeching. The inside stack diameter was 13 ft 10 in. Sampling was conducted for equal amounts of time at each of 40 separate sampling points--spatially distributed so that equal areas of the stack cross section were sampled for equal amounts of time (see Table IV). Samples for SO<sub>2</sub> and NO<sub>x</sub> analysis were collected from a point at a distance of 30 in. from the inside wall of the stack. The integrated gas samples for Orsat analysis were collected from a point 2-3 in. from the inside stack wall.

14

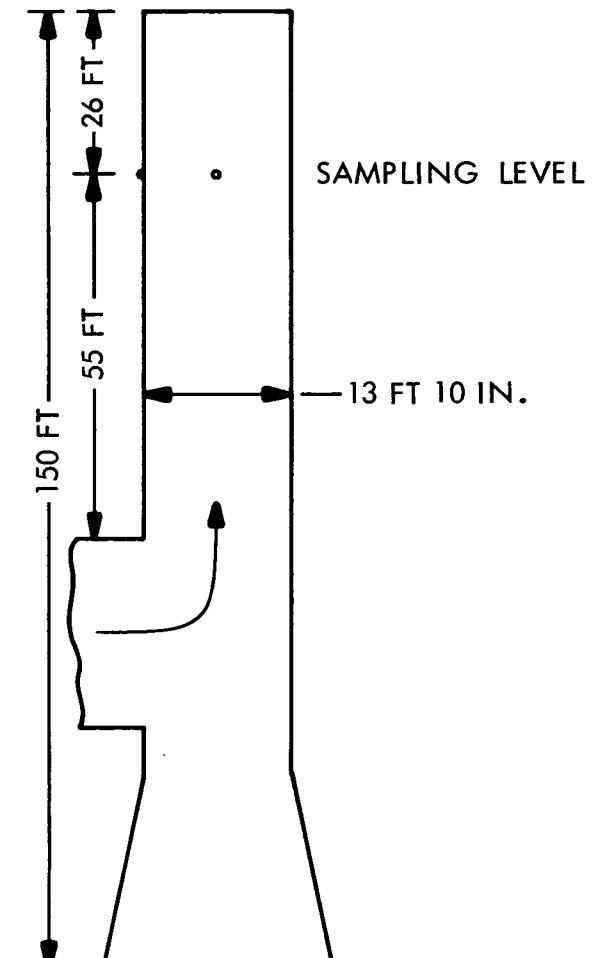
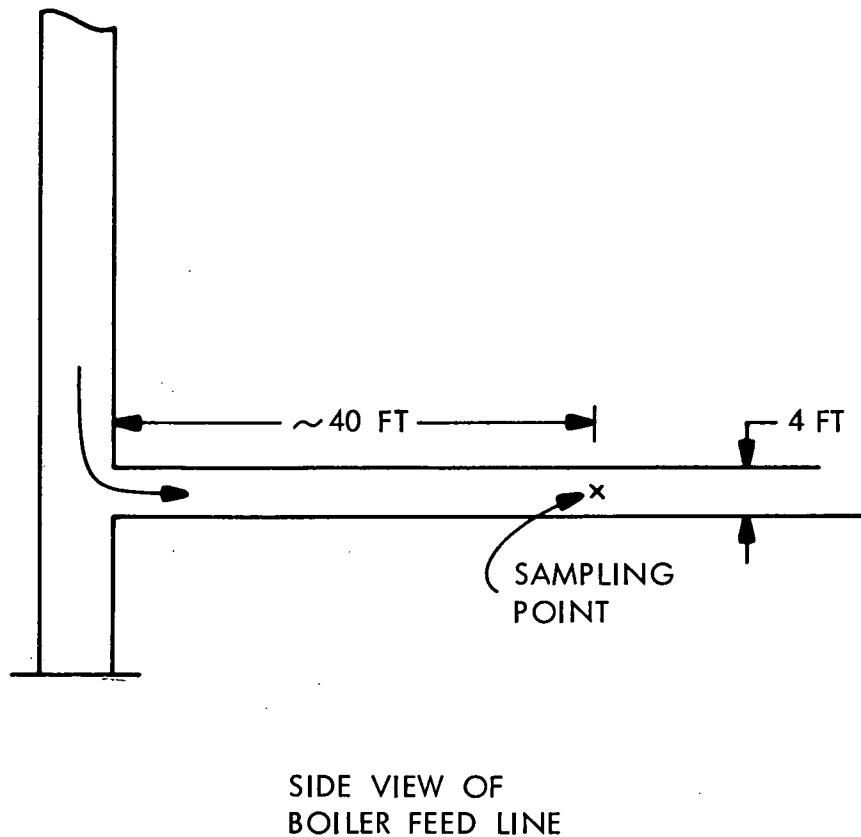


Figure 2 - Location of Sampling Station

TABLE IV

SAMPLING POINTS IN CO BOILER STACK, STANDARD OIL OF CALIFORNIA  
COMPANY, EL SEGUNDO, CALIFORNIA

Inside Diameter - 166 in.

<u>Point No.</u>	<u>Distance From Inside Wall (in.)</u>	<u>Distance From Outside Port (in.)</u>	
1	2-1/8		13-5/8
2	6-3/8		17-7/8
3	11-1/8		22-5/8
4	16		27-1/2
5	21-3/8		32-7/8
6	27-3/8		38-7/8
7	33-3/4		45-1/4
8	41-1/2		53
9	50-7/8		62-3/8
10	64-1/4		75-3/4
11	102		113-1/2
12	115		126-1/2
13	124-1/4		135-3/4
14	132-1/8		143-5/8
15	139-1/2	<u>Calculated</u>	<u>Calculated</u>
16 <sup>a/</sup>	142-7/8	144-5/8	154-3/8 156-1/8
17 <sup>a/</sup>	146-1/4	150	157-3/4 161-1/2
18 <sup>a/</sup>	149-3/4	154-7/8	161-1/4 166-3/8
19 <sup>a/</sup>	152-1/4	159-5/8	163-3/4 171-1/8
20 <sup>a/</sup>	154-3/4	163-7/8	166-1/4 175-3/8

a/ Due to length of port extension we were unable to reach past 155 in.

inside the stack so these values were decreased to compensate for  
this.

VI. PROCESS OPERATIONS

This section is to be prepared by EPA.

## VII. SAMPLING AND ANALYTICAL PROCEDURES

### A. Particulates

For the particulate sampling, the Research Appliance Company\* Model 2343 "Staksamplr" equipment was used. The sampling train meets the specification of the Federal Register, 36, 17 August 1971. Otherwise, the procedures for sampling and analysis of particulates conform to the methods specified in the Federal Register.

The network of sampling points at the particulate station has been described earlier in this report. The number of points on a traverse, the sampling time at each point, and the sequence in which points were sampled were worked out in consultation with the EPA Field Officer. Preliminary measurements were made at the stack location to determine the approximate temperature and velocity profiles along each traverse. Also, a gas sample was passed through an ice cooled condenser attached to the RAC umbilical cord, for the purpose of determining the approximate moisture in the stack gases.

### B. Nitrogen Oxides

The equipment and procedures used for the collection of samples of nitrogen oxides and subsequent chemical analysis are those which are described in the Federal Register.

---

\* Mention of a specific company or product does not constitute endorsement by EPA.

C. Sulfur Dioxide

The equipment and procedures used for the collection of sulfur dioxide samples and their subsequent analysis are essentially the same as those specified in the Federal Register. The gas sampling train for sulfur dioxide, which deviates from the train design that is specified in the Federal Register, is shown in Figure 3. This train design was approved by EPA prior to the test. The calculation method was accordingly modified by using the meter pressure instead of barometric pressure. The rate of sampling was controlled by adjusting a micrometer valve which acted as a critical orifice. The sampling rate was set at a constant value for any testing period.

D. Integrated Gas Samples

The equipment and procedure used for the collection of a cumulative or integrated gas sample are essentially the same as specified in the Federal Register. The gas sampling train, which deviates from the train design that is specified on the Register, is shown in Figure 4. This train design was approved by EPA prior to the test. The rate of sampling was controlled by adjusting a micrometer valve which acted as a critical orifice. The sampling rate was set at a constant value for any testing period, such that a total volume of gases between 1 and 2 cu ft were collected.

Analyses for carbon dioxide, oxygen, and carbon monoxide were performed in the field within a few hours after the sampling was completed using an Orsat apparatus.

#### E. CO Analysis

A Beckman nondispersive infrared spectrophotometer, with a maximum scale reading corresponding to a 150 parts per million of carbon monoxide, was used for the determination of carbon monoxide in the integrated gas samples collected from the stack. The instrument was modified by installing 15.5 in. CO and reference cells and optical filters. The optical filter removed all interference from ammonia. The instrument was calibrated by using pure nitrogen as the zero gas and reference standards of 22, 41, and 83 ppm CO in nitrogen. It was also calibrated by Beckman when they installed the new cells and filters. CO<sub>2</sub> at the levels (9-10%) found in the stack gases interferes with the analysis and gives high readings for CO. We purchased a standard CO<sub>2</sub> (9-11%) gas and made several runs to determine the correction. The correction of 10 ppm CO was subtracted from the reading determined in analyzing the stack gases for CO. The gas stream to the NDIR was dried before analysis was made, so all CO analyses were performed on a dry gas. Figure 5 shows the analytical setup.

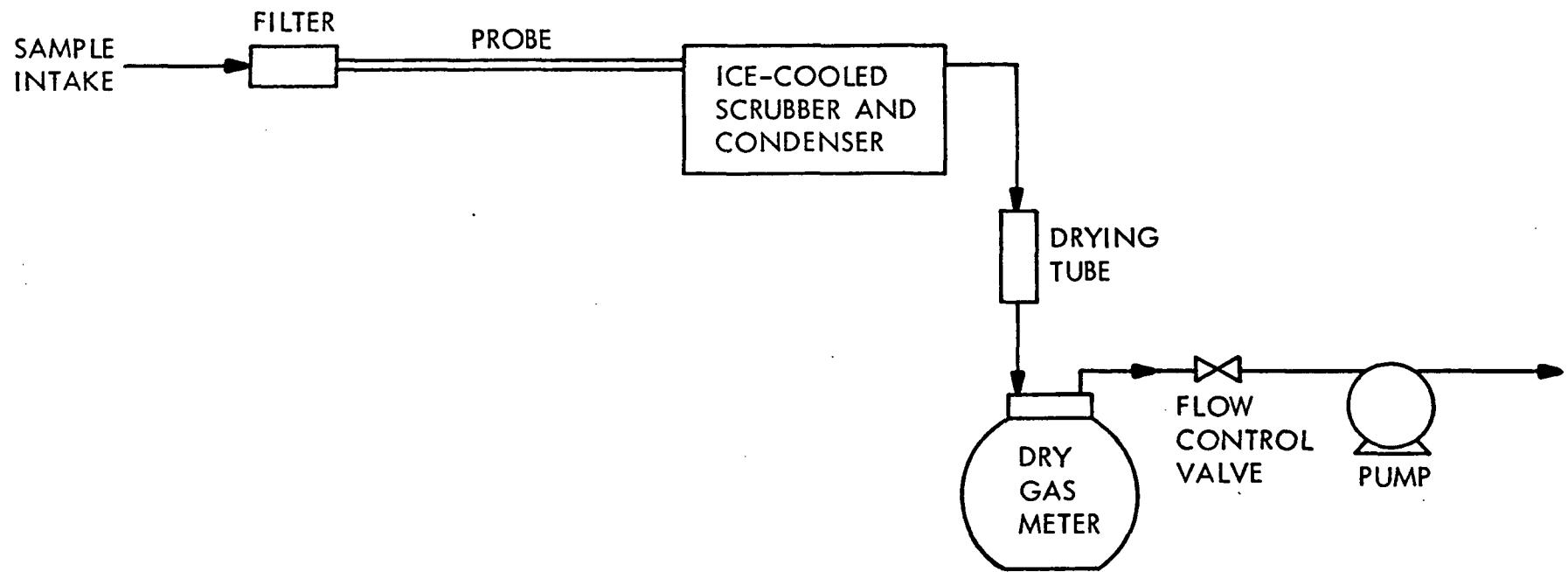


Figure 3 -  $\text{SO}_2$  Sampling Train

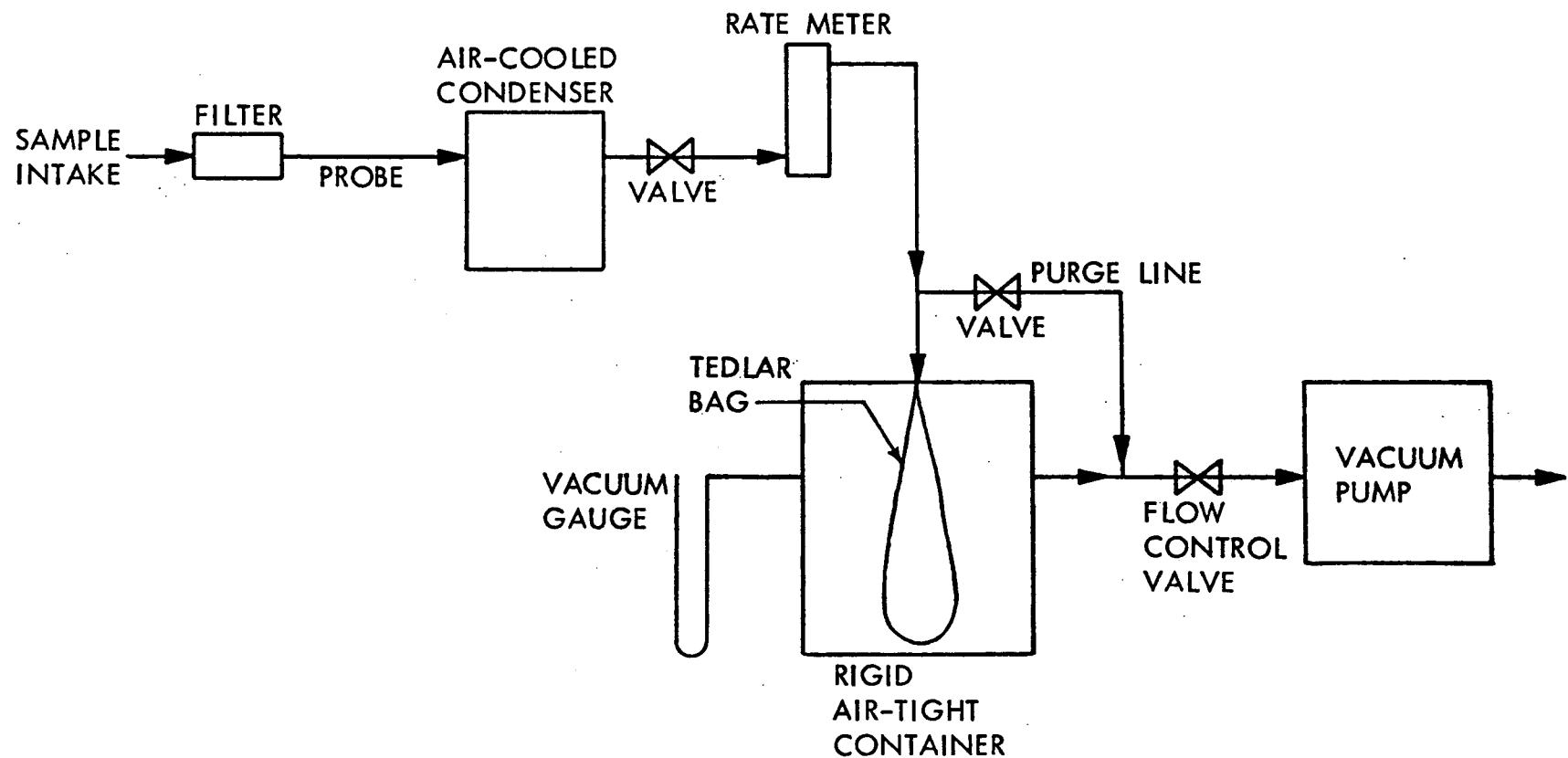


Figure 4 - Integrated Gas Sampling Train

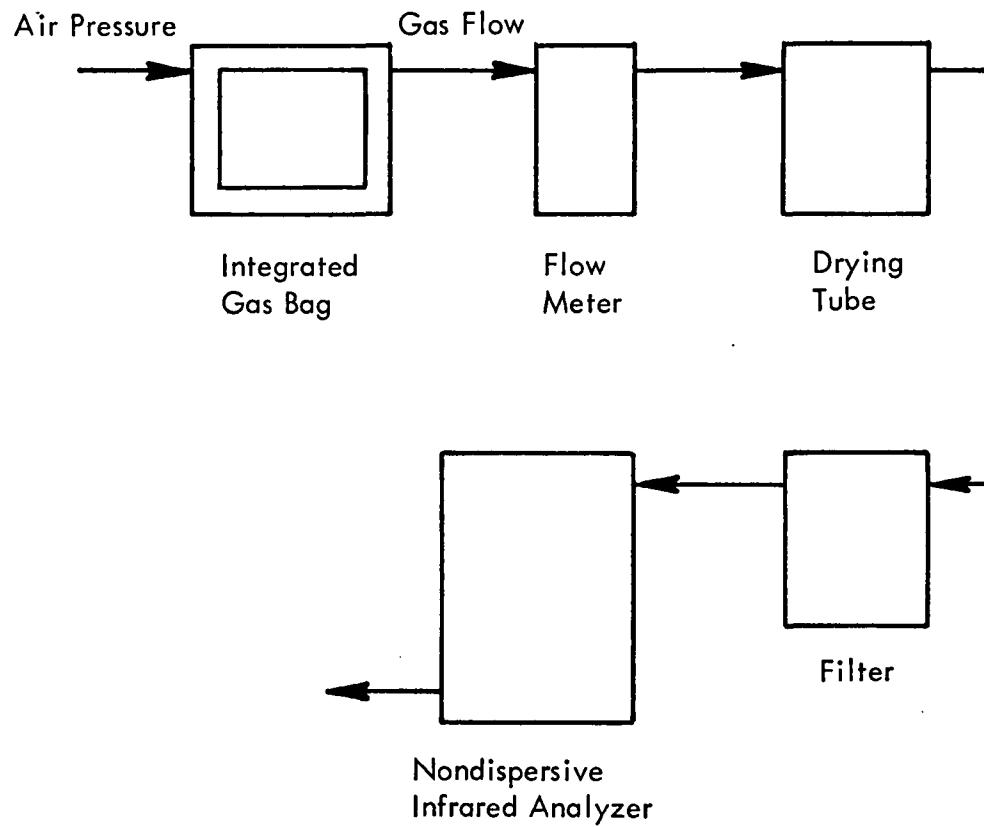


Figure 5 - CO Analysis Train

F. Moisture in the Feed Line

The equipment and procedures used for the determination of the moisture content of the feed line gases are essentially the same as specified in the Federal Register. The gas sampling train, which deviates from the train design that is specified in the Register, consisted of copper tubing which connected the sample valve to an ice cooled condenser followed by a silica gel drying tube and a dry test meter. Gas flow was caused by the positive pressure which existed in the feed duct. This train design was approved by EPA prior to the test.

## APPENDIX A

### PARTICULATE RESULTS

Table A-I lists the complete results of the particulate tests.

Table A-II lists the equations for the calculations. Also shown in Table A-II are example calculations for Run No. 1. Table A-III lists the input data for the particulate runs. The excess CO<sub>2</sub> and O<sub>2</sub> are in error for Runs 1, 2, and 3. The probe used to collect the integrated sample for CO<sub>2</sub>, O<sub>2</sub>, and CO was too short and was only in the stack about 2-3 in. The possibility of air leakage into the probe was great.

The operation of the CO boiler by the refinery was erratic during Tests Nos. 1, 2, and 4, as evidenced by the organic material collected on the filters. On Test No. 3, North port, the pitot readings were low during one half of the time suggesting the possibility of a leak. While changing the filter on Test No. 2, North port, the sample train was jostled and the glass connections between the two water impingers were broken. These two impingers were carefully transported to the field laboratory and replaced by two new water impingers. The material from all four water impingers was saved and analyzed.

TABLE A-I

## PARTICULATE EMISSION DATA

NAME	DESCRIPTION	UNITS	1	2	3	4
			12-14-71	12-15-71	12-16-71	12-16-71
DN	PROBE TIP DIAMETER	IN	.250	.250	.250	.250
TT	NET TIME OF RUN	MIN	160.0	240.0	120.0	120.0
PB	BAROMETRIC PRESSURE	IN.HG	29.97	30.05	30.38	30.40
PM	Avg ORIFICE PRES DROP	IN.H2O	.816	.672	.745	.769
VM	VOL DRY GAS-METER COND	DCF	76.46	101.93	55.41	54.83
TM	Avg GAS METER TEMP	DEG.F	84.8	77.7	90.1	78.9
VMSTD	VOL DRY GAS-STK COND	OSCF	74.63	101.05	54.30	54.88
VW	TOTAL H2O COLLECTED	ML	517.0	645.0	296.5	404.0
VWV	VOL H2O VAPUR-STD COND	SCF	24.51	30.57	14.05	19.15
PMOS	PERCENT MOISTURE BY VOL		24.7	23.2	20.6	25.9
MD	MOLE FRACTION DRY GAS		.753	.768	.794	.741
PCO2	PERCENT CO2 BY VOL, DRY		7.0	7.0	10.2	13.1
P02	PERCENT O2 BY VOL, DRY		12.4	12.4	7.4	3.8
CO	CONC OF CO , DRY	PPM	0.0	0.0	0.0	5.0
PN2	PERCENT N2 BY VOL, DRY		80.6	80.6	82.4	83.1
MWD	MOLECULAR WT-DRY STK GAS		29.62	29.62	29.93	30.25
MW	MOLECULAR WT-STK GAS		26.74	26.92	27.47	27.08
CP	PITOT TUBE COEFFICIENT		.850	.850	.850	.850
DPS	AVG STK VELOCITY HEAD	IN.H2O	.549	.483	.537	.560
TS	AVG STACK TEMPERATURE	DEG.F	738.9	732.3	722.8	733.5
NP	NET SAMPLING POINTS		40	40	40	40
PST	STATIC PRES OF STACK	IN.HG	-.04	-.04	-.04	-.04
PS	STACK PRESSURE, ABSOLUTE	IN.HG	29.93	30.01	30.34	30.36
VS	AVG STACK GAS VFLOCITY	FPM	3929	3626	3782	3903
AS	STACK AREA	IN2	21629	21629	21629	21629
QS	STK FLOWRATE, DRY,STD CN	DSCFM	196403	186383	204987	195766
QA	ACTUAL STACK FLOWRATE	ACFM	590164	544673	568075	586199
PERI	PERCENT ISOKINETIC		104.3	99.3	97.0	102.7
B	ANISO CORRECTION FACTOR		1.000	1.000	1.000	1.000
MF	PARTICULATE WT-PARTIAL	MG	219.85	211.33	109.42	228.85
MT	PARTICULATE WT-TOTAL	MG	663.43	636.98	157.04	619.46
IC	PERC IMPINGER CATCH		66.9	66.8	30.3	63.1
CAN	PART. LOAD-PTL,STD CN	GR/DSCF	.04555	.03234	.03116	.06445
CAO	PART. LOAD-TTL,STD CN	GR/DSCF	.13744	.09746	.04472	.17445
CAT	PART. LOAD-PTL,STK CN	GR/ACF	.01515	.01106	.01124	.02151
CAU	PART. LOAD-TTL,STK CN	GR/ACF	.04571	.03333	.01613	.05822
CAW	PARTIC EPIIS-PARTIAL	LB/HR	76.63	51.63	54.71	108.08
CAX	PARTIC EPIIS-TOTAL	LB/HR	231.23	155.61	78.53	292.55
EA	PERCENT EXCESS AIR		139.7	139.7	51.6	21.0

TABLE A-II

## EXAMPLE PARTICULATE CALCULATIONS

## 1. VOLUME OF DRY GAS SAMPLED AT STANDARD CONDITIONS

$$\begin{aligned} VMSTD &= \frac{17.71 * VM * (PB + PM/13.6)}{TM+460} \\ &= \frac{17.71 * 76.46 * (29.97 + .816/13.6)}{84.8+460} = 74.63 \text{ DSCF} \end{aligned}$$

## 2. VOLUME OF WATER VAPOR AT STANDARD CONDITIONS

$$VWV = 0.0474 * VW = 0.0474 * 517.0 = 24.51 \text{ SCF}$$

## 3. PERCENT MOISTURE IN STACK GAS

$$\begin{aligned} PMOS &= \frac{100 * VWV}{VMSTD+VWV} = \frac{100 * 24.51}{74.63+24.51} = 24.7 \text{ PERCENT} \end{aligned}$$

## 4. MOLE FRACTION OF DRY STACK GAS

$$\begin{aligned} MD &= \frac{100 - PMOS}{100} = \frac{100 - 24.7}{100} = .753 \end{aligned}$$

## 5. AVERAGE MOLECULAR WEIGHT OF DRY STACK GAS

$$\begin{aligned} MWd &= (PCO2 * 44/100) + (PO2 * 32/100) \\ &\quad + (PN2 + PCO * 28/100) \\ &= (7.0 * 44/100) + (12.4 * 32/100) \\ &\quad + (80.6 * 28/100) = 29.62 \end{aligned}$$

## 6. MOLECULAR WEIGHT OF STACK GAS

$$\begin{aligned} MW &= MWd * MD + 18 * (1 - MD) \\ &= 29.62 * .753 + 18 * (1 - .753) = 26.74 \end{aligned}$$

TABLE A-II (Continued)

7. STACK GAS VELOCITY AT STACK CONDITIONS

$$\begin{aligned} VS &= \frac{4360 * \text{SQRT}(DPS * (TS+460)) * \text{SQRT}(1/(PS*MW))}{\text{SQRT}(1/(29.93 * 26.74))} = 3929 \text{ FPM} \\ &= 4360 * \text{SQRT}( .549 * ( 738.9+460)) * \text{SQRT}(1/(29.93 * 26.74)) = 3929 \text{ FPM} \end{aligned}$$

8. STACK GAS VOLUMETRIC FLOW AT STANDARD CONDITIONS, DRY BASIS

$$\begin{aligned} QS &= \frac{0.123 * VS * AS * MD * PS}{TS+460} \\ &= \frac{0.123 * 3929 * 21629 * .753 * 29.93}{738.9 + 460} = 196403 \text{ DSCFM} \end{aligned}$$

9. STACK GAS VOLUMETRIC FLOW AT STACK CONDITIONS

$$\begin{aligned} QA &= \frac{QS * (TS+460)}{17.71 * PS * MD} \\ &= \frac{196403 * ( 738.9+460)}{17.71 * 29.93 * .753} = 590164 \text{ ACFM} \end{aligned}$$

10. PERCENT ISOKINETIC AND ANISO CORRECTION FACTOR

$$\begin{aligned} PERI &= \frac{1032 * (TS+460) * VMSTD}{VS * TT * PS * MD * (DN * DN)} \\ &= \frac{1032 * ( 738.9+460) * 74.63}{3929 * 160.0 * 29.93 * .753 * .250 * .250} = 104.3 \text{ PERCENT} \\ &= 1.000 \end{aligned}$$

TABLE A-II (Continued)

11. PARTICULATE LOADING -- PROBE, CYCLONE, AND FILTER  
(AT STANDARD CONDITIONS)

$$\begin{aligned} \text{CAN} &= 0.0154 * (\text{MF}/\text{VMSTD}) * \text{B} \\ &= 0.0154 * (219.85 / 74.63) * 1.000 = .04555 \text{ GR/DSCF} \end{aligned}$$

12. PARTICULATE LOADING -- TOTAL  
(AT STANDARD CONDITIONS)

$$\begin{aligned} \text{CAO} &= 0.0154 * (\text{MT}/\text{VMSTD}) * \text{B} \\ &= 0.0154 * (663.43 / 74.63) * 1.000 = .13744 \text{ GR/DSCF} \end{aligned}$$

13. PARTICULATE LOADING -- PROBE, CYCLONE, AND FILTER  
(AT STACK CONDITIONS)

$$\begin{aligned} &17.71 * \text{CAN} * \text{PS} * \text{MD} \\ \text{CAT} &= \frac{\text{TS} + 460}{=} \\ &17.71 * .0455 * 29.93 * .753 \\ &= \frac{738.9 + 460}{=} = .01515 \text{ GR/ACF} \end{aligned}$$

14. PARTICULATE LOADING -- TOTAL  
(AT STACK CONDITIONS)

$$\begin{aligned} &17.71 * \text{CAO} * \text{PS} * \text{MD} \\ \text{CAU} &= \frac{\text{TS} + 460}{=} \\ &17.71 * .1374 * 29.93 * .753 \\ &= \frac{738.9 + 460}{=} = .04571 \text{ GR/ACF} \end{aligned}$$

TABLE A-II (Concluded)

15. PARTICULATE EMISSION RATE

-- PROBE, CYCLONE, AND FILTER

$$C_{AN} = 0.00857 * C_{AO} * Q_S$$

$$= 0.00857 * .0455 * 196403 = 76.63 \text{ LB/HR}$$

16. PARTICULATE EMISSION RATE

-- TOTAL

$$C_{AX} = 0.00857 * C_{AO} * Q_S$$

$$= 0.00857 * .1374 * 196403 = 231.23 \text{ LB/HR}$$

17. PERCENT EXCESS AIR AT SAMPLING POINT

$$EA = \frac{100. * (P_{O2} - 0.5 * P_{CO})}{0.264 * P_{N2} - P_{O2} + 0.5 * P_{CO}}$$

$$EA = \frac{100. * (12.4 - 0.5 * 0.0)}{0.264 * 80.6 - 12.4 + 0.5 * 0.0}$$

= 139.7 PERCENT

TABLE A-III  
PARTICULATE DATA AND CALCULATED VALUES

RUN-				DATE- 12-14-71							
ATMOS TEMP (DG.F)	ATMOS PRES (I.HG)	STACK VAC (ML)	H2O COND (ML)	PARTIC WT-PTL (MG)	PARTIC WT-TTL (MG)	STACK AREA (FT2)	INIT VOL (DCF)	PERC O2 DRY	PERC CO2 DRY	PERC CO DRY	PITOT TUBE COEF
60.0	29.97	.50	517.0	219.85	663.43	150.20	130.09	12.4	7.0	0.0	.850

PORT- POINT	SAMP TIME (MIN)	METER VOL (DCF)	DELTA P (I.H20)	DELTA H (D.F)	TEMP IN (D.F)	TEMP OUT (D.F)	TRAIN VAC (I.HG)	STACK TEMP (D.F)	BOX TEMP (D.F)	PROBE T DIA (IN)	VEL (FPM)
N 1	4.00	131.40	.325	.493	59.0	59.0	3.5	720.0	65.0	.250	3016.6
N 2	4.00	132.82	.365	.550	63.0	59.0	3.5	725.0	65.0	.250	3203.6
N 3	4.00	134.48	.390	.586	74.0	60.0	4.0	730.0	65.0	.250	3318.5
N 4	4.00	136.23	.440	.665	76.0	61.0	4.0	734.0	65.0	.250	3530.7
N 5	4.00	138.00	.455	.680	82.0	62.0	4.0	732.0	65.0	.250	3587.4
N 6	4.00	139.83	.470	.708	85.0	65.0	4.0	733.0	65.0	.250	3647.5
N 7	4.00	141.63	.450	.678	89.0	66.0	4.5	734.0	65.0	.250	3570.6
N 8	4.00	143.47	.465	.700	91.0	68.0	4.5	737.0	65.0	.250	3634.2
N 9	4.00	145.33	.480	.723	92.0	70.0	4.5	737.0	67.0	.250	3692.3
N 10	4.00	147.22	.495	.734	93.0	71.0	5.0	733.0	68.0	.250	3743.3
N 11	4.00	149.14	.555	.823	94.0	73.0	5.5	730.0	68.0	.250	3958.7
N 12	4.00	151.24	.600	.888	95.0	75.0	6.0	731.0	69.0	.250	4117.8
N 13	4.00	153.27	.675	1.000	96.0	75.0	7.5	723.0	70.0	.250	4352.9
N 14	4.00	155.44	.710	1.050	98.0	76.0	8.0	724.0	70.0	.250	4466.2
N 15	4.00	157.66	.730	1.090	100.0	77.0	9.5	726.0	70.0	.250	4532.5
N 16	4.00	159.88	.760	1.140	102.0	77.0	10.0	726.0	70.0	.250	4624.7
N 17	4.00	162.13	.810	1.200	103.0	78.0	10.5	727.0	70.0	.250	4776.4
N 18	4.00	164.41	.760	1.140	104.0	79.0	10.5	725.0	70.0	.250	4622.7
N 19	4.00	166.72	.770	1.145	104.0	79.0	11.0	725.0	70.0	.250	4653.0
N 20	4.00	168.94	.740	1.100	106.0	80.0	10.0	724.0	70.0	.250	4559.5
W 1	4.00	170.54	.460	.690	62.0	62.0	11.0	757.0	68.0	.250	3644.6
W 2	4.00	172.29	.490	.730	69.0	63.0	13.5	772.0	66.0	.250	3784.7
W 3	4.00	174.12	.520	.755	78.0	64.0	15.0	774.0	66.0	.250	3902.0
W 4	4.00	176.00	.550	.790	86.0	65.0	14.5	783.0	66.0	.250	4027.6
W 5	4.00	177.90	.575	.830	93.0	67.0	14.5	778.0	64.0	.250	4109.8

TABLE A-III (Continued)

RUN- 1 DATE- 12-14-71

PORT- POINT	SAMP TIME (MIN)	METER VOL (DCF)	DELTA P (I.H2O)	DELTA H (I.H2O)	TEMP IN (D.F)	TEMP OUT (D.F)	TRAIN VAC (I.HG)	STACK TEMP (D.F)	BOX TEMP (D.F)	PROBE T DIA (IN)	VEL (FPM)
W 6	4.00	179.78	.565	.820	98.0	69.0	14.0	768.0	62.0	.250	4057.5
W 7	4.00	181.54	.470	.675	102.0	70.0	13.0	753.0	62.0	.250	3678.0
W 8	4.00	183.54	.475	.684	104.0	72.0	14.0	747.0	62.0	.250	3688.3
W 9	4.00	185.34	.440	.660	107.0	74.0	13.5	744.0	62.0	.250	3545.4
W 10	4.00	187.18	.480	.716	108.0	76.0	14.0	758.0	62.0	.250	3724.6
W 11	4.00	188.91	.450	.675	110.0	78.0	14.0	753.0	63.0	.250	3598.9
W 12	4.00	190.71	.540	.805	111.0	80.0	14.5	748.0	63.0	.250	3934.2
W 13	4.00	192.65	.550	.815	112.0	81.0	14.5	746.0	64.0	.250	3967.2
W 14	4.00	194.60	.550	.815	114.0	82.0	15.0	742.0	65.0	.250	3960.6
W 15	4.00	196.54	.540	.805	114.0	84.0	15.0	734.0	65.0	.250	3911.4
W 16	4.00	198.60	.580	.870	116.0	85.0	15.0	728.0	65.0	.250	4043.5
W 17	4.00	200.51	.570	.850	117.0	85.0	14.5	725.0	65.0	.250	4003.4
W 18	4.00	202.57	.580	.870	117.0	87.0	14.5	723.0	65.0	.250	4034.9
W 19	4.00	204.54	.540	.805	117.0	88.0	13.5	719.0	65.0	.250	3886.7
W 20	4.00	206.55	.580	.870	117.0	88.0	14.0	735.0	65.0	.250	4055.3

TABLE A-III (Continued)

## PARTICULATE DATA AND CALCULATED VALUES

RUN- 2 DATE- 12-15-71

ATMOS TEMP (DG.F)	ATMOS PRES (I.HG)	STACK VAC (ML)	H2O COND (ML)	PARTIC WT-PTL (MG)	PARTIC WT-TTL (MG)	STACK AREA (FT2)	INIT VOL (DCF)	PERC O2 DRY	PERC CO2 DRY	PERC CO DRY	PITOT TUBE COEF
60.0	30.05	.50	645.0	211.33	636.98	150.20	212.75	12.4	7.0	0.0	.850

PORT- POINT	SAMP TIME (MIN)	METER VOL (DCF)	DELTA P (I.H2O)	DELTA H (D.F)	TEMP IN (D.F)	TEMP OUT (D.F)	TRAIN VAC (I.HG)	STACK TEMP (D.F)	BOX TEMP (D.F)	PROBE T DIA (IN)	VEL (FPM)
W 1	0.00	214.44	.175	.250	68.0	69.0	2.0	708.0	58.0	.250	2192.2
W 2	6.00	215.13	.200	.281	74.0	70.0	2.0	708.0	58.0	.250	2343.6
W 3	6.00	218.05	.245	.350	78.0	71.0	2.5	717.0	58.0	.250	2603.9
W 4	6.00	220.14	.285	.404	85.0	72.0	3.0	716.0	58.0	.250	2807.2
W 5	6.00	222.24	.290	.410	87.0	74.0	3.0	706.0	58.0	.250	2819.7
W 6	6.00	224.29	.280	.396	85.0	75.0	3.0	711.0	58.0	.250	2776.5
W 7	6.00	226.32	.280	.396	82.0	76.0	3.0	715.0	58.0	.250	2781.3
W 8	6.00	228.72	.490	.692	82.0	75.0	3.5	722.0	59.0	.250	3690.2
W 9	6.00	231.47	.550	.768	84.0	75.0	4.0	716.0	60.0	.250	3899.7
W 10	6.00	234.23	.545	.765	85.0	75.0	4.0	722.0	60.0	.250	3891.8
W 11	6.00	236.90	.490	.692	84.0	74.0	4.0	732.0	60.0	.250	3705.8
W 12	6.00	239.50	.475	.664	82.0	74.0	4.0	731.0	60.0	.250	3647.1
W 13	6.00	242.06	.460	.647	81.0	72.0	4.0	742.0	60.0	.250	3605.6
W 14	6.00	244.60	.450	.642	80.0	72.0	4.5	741.0	60.0	.250	3564.7
W 15	6.00	247.22	.460	.647	81.0	72.0	6.0	742.0	60.0	.250	3605.6
W 16	6.00	249.98	.450	.642	81.0	72.0	7.0	735.0	60.0	.250	3555.8
W 17	6.00	252.35	.460	.647	80.0	70.0	8.0	732.0	60.0	.250	3590.6
W 18	6.00	254.79	.475	.665	81.0	70.0	9.0	735.0	60.0	.250	3653.2
W 19	6.00	257.44	.495	.700	82.0	70.0	9.5	730.0	60.0	.250	3721.6
W 20	6.00	260.06	.490	.695	84.0	71.0	10.0	725.0	60.0	.250	3694.9
N 1	6.00	261.94	.270	.378	59.0	58.0	6.0	710.0	60.0	.250	2725.4
N 2	6.00	264.07	.370	.511	67.0	59.0	8.5	713.0	60.0	.250	3194.5
N 3	6.00	266.15	.410	.575	71.0	60.0	10.5	726.0	60.0	.250	3381.3
N 4	6.00	268.86	.430	.600	74.0	62.0	13.0	723.0	60.0	.250	3458.4
N 5	6.00	271.35	.450	.630	78.0	63.0	15.0	726.0	60.0	.250	3542.4

TABLE A-III (Continued)

RUN- 2 DATE- 12-15-71

PORT- POINT	SAMP (MIN)	METER (DCF)	DELTA (I.H2O)	DELTA (I.H2O)	TEMP (D.F)	TEMP (D.F)	TRAIN (I.HG)	STACK (D.F)	BOX (D.F)	PROBE (IN)	VEL (FPM)
N 6	6.00	273.84	.450	.630	79.0	65.0	16.5	727.0	60.0	.250	3543.9
N 7	6.00	270.33	.460	.640	80.0	66.0	18.0	730.0	60.0	.250	3587.6
N 8	6.00	278.80	.440	.613	80.0	68.0	19.5	733.0	60.0	.250	3513.1
N 9	6.00	281.23	.455	.630	82.0	68.0	23.0	731.0	60.0	.250	3569.5
N 10	6.00	283.89	.490	.675	69.0	68.0	3.0	748.0	60.0	.250	3730.6
N 11	6.00	286.63	.585	.800	79.0	69.0	4.2	751.0	60.0	.250	4081.3
N 12	6.00	289.55	.600	.825	88.0	71.0	4.5	752.0	60.0	.250	4135.0
N 13	6.00	292.66	.750	1.020	95.0	73.0	5.0	752.0	60.0	.250	4623.1
N 14	6.00	295.76	.780	1.070	96.0	75.0	5.1	753.0	60.0	.250	4716.6
N 15	6.00	298.91	.760	1.040	102.0	77.0	5.1	749.0	60.0	.250	4648.0
N 16	6.00	302.09	.750	1.020	104.0	79.0	5.5	747.0	60.0	.250	4613.5
N 17	6.00	305.23	.720	.980	105.0	80.0	5.5	743.0	60.0	.250	4512.8
N 18	6.00	308.36	.710	.970	107.0	83.0	5.5	738.0	60.0	.250	4472.0
N 19	6.00	311.49	.700	.960	106.0	85.0	5.5	740.0	60.0	.250	4444.1
N 20	6.00	314.68	.690	.945	106.0	86.0	5.6	738.0	60.0	.250	4408.6

TABLE A-III (Continued)

## PARTICULATE DATA AND CALCULATED VALUES

RUN- 3 DATE- 12-16-71

ATMOS TEMP (DG.F)	ATMOS PRES (I.HG)	STACK VAC (I.H2O)	420 COND (ML)	PARTIC WT-PTL (MG)	PARTIC WT-TTL (MG)	STACK AREA (FT2)	INIT VOL (DCF)	PERC O2 DRY	PERC CO2 DRY	PERC CO DRY	PERC TUBE COEF
65.0	30.38	.50	296.5	109.42	157.04	150.20	314.59	7.4	10.2	0.0	.850

PORT- POINT	SAMP TIME (MIN)	METER VOL (DCF)	DELTA P (I.H2O)	DELTA H (D.F.)	TEMP IN (D.F.)	TEMP OUT (D.F.)	TRAIN VAC (I.HG)	STACK TEMP (D.F.)	BOX TEMP (D.F.)	PROBE T DIA (IN)	VEL (FPM)
N 1	3.00	315.48	.250	.352	64.0	64.0	3.2	700.0	63.0	.250	2570.5
N 2	3.00	316.52	.330	.462	66.0	63.0	3.2	703.0	63.0	.250	2957.1
N 3	3.00	317.72	.370	.519	72.0	65.0	3.2	723.0	63.0	.250	3158.0
N 4	3.00	318.92	.420	.590	76.0	64.0	3.8	718.0	63.0	.250	3357.5
N 5	3.00	320.15	.450	.634	80.0	66.0	3.8	716.0	63.0	.250	3472.4
N 6	3.00	321.40	.421	.612	84.0	66.0	4.0	716.0	63.0	.250	3358.7
N 7	3.00	322.66	.445	.630	87.0	68.0	4.0	717.0	63.0	.250	3454.5
N 8	3.00	323.96	.445	.630	90.0	69.0	4.0	718.0	63.0	.250	3456.0
N 9	3.00	325.20	.450	.634	94.0	70.0	4.0	720.0	63.0	.250	3478.3
N 10	3.00	326.48	.460	.642	95.0	72.0	4.0	721.0	63.0	.250	3518.2
N 11	3.00	327.05	.570	.790	98.0	74.0	4.5	723.0	63.0	.250	3919.7
N 12	3.00	329.26	.590	.815	99.0	75.0	5.0	722.0	63.0	.250	3986.2
N 13	3.00	330.75	.610	.840	102.0	77.0	5.0	720.0	64.0	.250	4049.7
N 14	3.00	332.23	.670	.925	105.0	78.0	5.2	725.0	64.0	.250	4253.2
N 15	3.00	333.90	.690	.945	107.0	80.0	5.5	723.0	64.0	.250	4312.6
N 16	3.00	335.45	.710	.980	110.0	80.0	5.8	725.0	64.0	.250	4378.3
N 17	3.00	337.10	.750	1.030	112.0	82.0	6.0	726.0	65.0	.250	4501.9
N 18	3.00	338.70	.750	1.030	114.0	84.0	6.0	721.0	65.0	.250	4492.4
N 19	3.00	340.31	.720	.985	116.0	85.0	6.0	718.0	65.0	.250	4396.0
N 20	3.00	341.85	.670	.925	119.0	86.0	5.5	718.0	65.0	.250	4240.6
W 1	3.00	342.91	.300	.427	78.0	78.0	1.1	700.0	65.0	.250	2815.9
W 2	3.00	344.18	.470	.655	82.0	81.0	1.5	716.0	65.0	.250	3548.7
W 3	3.00	345.56	.500	.700	86.0	79.0	1.7	728.0	65.0	.250	3678.9
W 4	3.00	347.12	.550	.760	92.0	79.0	1.5	732.0	65.0	.250	3864.9
W 5	3.00	348.45	.570	.785	98.0	80.0	1.5	738.0	65.0	.250	3944.5

TABLE A-III (Continued)

RUN# 3 DATE- 12-16-71

PORT- POINT	SAMP (MIN)	METER (DCF)	DELTA (I.H2O)	DELTA (I.H2O)	TEMP (D.F)	TEMP (D.F)	TRAIN (I.HG)	STACK (D.F)	BOX (D.F)	PROBE (IN)	VEL (FPM)
W 6	3.00	349.91	.580	.800	102.0	80.0	1.5	734.0	65.0	.250	3972.3
W 7	3.00	351.38	.560	.775	105.0	81.0	1.5	738.0	65.0	.250	3909.7
W 8	3.00	352.84	.570	.785	110.0	82.0	1.5	734.0	65.0	.250	3937.9
W 9	3.00	354.38	.550	.760	111.0	84.0	1.5	738.0	65.0	.250	3874.6
W 10	3.00	355.79	.530	.732	112.0	84.0	4.2	737.0	65.0	.250	3801.9
W 11	3.00	357.15	.480	.673	112.0	85.0	4.0	733.0	65.0	.250	3612.1
W 12	3.00	358.50	.490	.688	114.0	87.0	4.2	732.0	65.0	.250	3648.0
W 13	3.00	359.92	.530	.735	115.0	86.0	4.5	731.0	65.0	.250	3792.4
W 14	3.00	361.28	.580	.800	116.0	88.0	5.0	733.0	65.0	.250	3970.6
W 15	3.00	362.73	.560	.775	117.0	89.0	5.0	726.0	65.0	.250	3890.1
W 16	3.00	364.17	.570	.785	118.0	89.0	5.0	725.0	65.0	.250	3923.0
W 17	3.00	365.66	.630	.870	119.0	90.0	5.3	725.0	65.0	.250	4124.3
W 18	3.00	367.15	.590	.820	120.0	91.0	5.2	727.0	65.0	.250	3994.6
W 19	3.00	358.59	.570	.785	122.0	91.0	5.0	729.0	65.0	.250	3929.6
W 20	3.00	370.00	.520	.728	121.0	92.0	5.0	720.0	65.0	.250	3739.1

TABLE A-III (Continued)

## PARTICULATE DATA AND CALCULATED VALUES

				RUN-	4 DATE- 12-16-71							
ATMOS TEMP (DG.F)	ATMOS PRES (I.HG)	STACK VAC (I.H2O)	H2O COND (ML)	PARTIC WT-PTL (MG)	PARTIC WT-TTL (MG)	STACK AREA (FT2)	INIT VOL (DCF)	PERC O2 DRY	PERC CO2 DRY	PERC CO DRY	PITOT TUBE COEF	
60.0	30.40	.50	404.0	228.85	619.46	150.20	370.35	3.8	13.1	0.0	.850	
PORT-POINT	SAMP TIME (MIN)	METER VOL (DCF)	DELTA P (I.H2O)	DELTA H (D.F)	TEMP IN (D.F)	TEMP OUT (D.F)	TRAIN VAC (I.HG)	STACK TEMP (D.F)	BOX TEMP (D.F)	PROBE T DIA (IN)	VEL (FPM)	
W 1	3.00	371.46	.340	.478	62.0	62.0	3.0	700.0	64.0	.250	3018.5	
W 2	3.00	372.71	.500	.692	64.0	62.0	3.6	723.0	64.0	.250	3696.6	
W 3	3.00	374.06	.570	.790	70.0	63.0	4.0	728.0	64.0	.250	3955.2	
W 4	3.00	375.47	.590	.820	74.0	62.0	4.1	733.0	64.0	.250	4032.4	
W 5	3.00	376.88	.580	.810	78.0	63.0	4.2	728.0	64.0	.250	3989.7	
W 6	3.00	378.29	.620	.850	82.0	64.0	4.2	735.0	64.0	.250	4137.2	
W 7	3.00	379.71	.610	.840	85.0	65.0	4.1	734.0	64.0	.250	4101.9	
W 8	3.00	381.16	.630	.870	87.0	66.0	4.1	734.0	64.0	.250	4168.6	
W 9	3.00	382.59	.590	.820	90.0	67.0	4.1	736.0	64.0	.250	4037.5	
W 10	3.00	383.97	.560	.780	90.0	68.0	4.1	731.0	64.0	.250	3925.3	
W 11	3.00	385.33	.540	.752	90.0	69.0	4.0	733.0	64.0	.250	3857.8	
W 12	3.00	386.67	.510	.712	91.0	70.0	4.0	732.0	64.0	.250	3747.5	
W 13	3.00	388.03	.550	.760	91.0	72.0	4.0	735.0	65.0	.250	3896.6	
W 14	3.00	389.43	.570	.790	93.0	73.0	4.3	739.0	65.0	.250	3973.5	
W 15	3.00	390.87	.620	.850	94.0	74.0	4.5	736.0	65.0	.250	4138.9	
W 16	3.00	392.30	.590	.820	94.0	75.0	4.5	733.0	65.0	.250	4032.4	
W 17	3.00	393.75	.610	.840	95.0	76.0	4.7	735.0	65.0	.250	4103.7	
W 18	3.00	395.18	.570	.790	96.0	76.0	4.5	734.0	65.0	.250	3965.2	
W 19	3.00	396.62	.600	.830	98.0	77.0	4.9	730.0	65.0	.250	4061.4	
W 20	3.00	398.02	.560	.780	98.0	78.0	4.8	730.0	65.0	.250	3923.6	
N 1	3.00	399.01	.240	.342	64.0	66.0	3.0	700.0	65.0	.250	2536.0	
N 2	3.00	400.07	.350	.490	68.0	67.0	3.5	707.0	65.0	.250	3071.8	
N 3	3.00	401.21	.380	.530	72.0	66.0	3.5	731.0	65.0	.250	3233.5	
N 4	3.00	402.41	.420	.580	75.0	68.0	4.0	735.0	65.0	.250	3405.1	
N 5	3.00	403.65	.440	.625	80.0	68.0	4.0	738.0	65.0	.250	3489.6	

TABLE A-III (Concluded)

RUN- 4 DATE- 12-16-71

PORT-POINT	SAMP TIME (MIN)	METER VOL (DCF)	DELTA P (I.H2O)	DELTA H (D.F)	TEMP IN (D.F)	TEMP OUT (D.F)	TRAIN VAC (I.HG)	STACK TEMP (D.F)	BOX TEMP (D.F)	T DIA (IN)	PROBE VEL (FPM)
N 6	3.00	404.91	.450	.630	82.0	70.0	4.0	738.0	65.0	.250	3529.0
N 7	3.00	406.16	.430	.605	84.0	70.0	4.2	736.0	65.0	.250	3446.9
N 8	3.00	407.39	.420	.585	85.0	70.0	4.2	737.0	65.0	.250	3408.0
N 9	3.00	408.63	.455	.640	86.0	70.0	4.8	737.0	65.0	.250	3547.1
N 10	3.00	410.10	.490	.685	88.0	72.0	5.2	741.0	65.0	.250	3687.2
N 11	3.00	411.43	.560	.755	90.0	72.0	8.0	744.0	65.0	.250	3946.7
N 12	3.00	412.84	.620	.831	92.0	74.0	9.5	741.0	65.0	.250	4147.5
N 13	3.00	414.26	.670	.895	93.0	74.0	12.2	743.0	65.0	.250	4315.1
N 14	3.00	415.76	.690	.930	96.0	75.0	15.0	742.0	65.0	.250	4377.2
N 15	3.00	417.30	.730	.980	98.0	75.0	17.5	741.0	65.0	.250	4500.4
N 16	3.00	418.87	.770	1.030	100.0	76.0	19.0	739.0	65.0	.250	4618.3
N 17	3.00	420.45	.750	.995	102.0	77.0	20.0	738.0	65.0	.250	4556.0
N 18	3.00	422.04	.730	.980	103.0	78.0	21.0	739.0	65.0	.250	4496.7
N 19	3.00	423.60	.740	.985	102.0	78.0	21.1	737.0	65.0	.250	4523.6
N 20	3.00	425.18	.740	.985	104.0	80.0	13.0	731.0	65.0	.250	4512.3

## APPENDIX B

### GASEOUS RESULTS

The results of the testing for NO<sub>x</sub> and SO<sub>2</sub> in the stack gases are shown in Tables B-I through B-VI. These tables also include the raw field data and example calculations.

The results of the moisture and Orsat analyses of samples from the feed line location and the Orsat analyses of samples from the stack location were presented in Section III of this report. The equations for moisture calculations are included in Table A-II. Gas concentrations determined by Orsat analysis required no additional calculations. The results of the CO analysis of the stack gases, as determined by a Beckman nondispersive infrared spectrophotometer, were given in Table II, Section III, in this report.

TABLE B-I

## WORK DATA

NAME	DESCRIPTION	UNITS	1-N1	2-N1	2-N2	2-N3	2-N4
DATE			12-14-71	12-15-71	12-15-71	12-15-71	12-15-71
PORT			N	N	N	W	W
POINT			6	6	6	6	6
VF-VA	VOLUME--FLASK+VALVE-AB-SOLN	ML	2092.00	2116.00	2076.00	2056.00	2083.00
PI	INIT. ABS. PRES.--FLASK	IN.HG	3.30	3.20	3.20	2.90	2.90
TI	INIT. ABS. TEMP.--FLASK	DEG.R	522.0	524.0	524.0	530.0	524.0
PF	FINAL ABS. PRES.--FLASK	IN.HG	29.99	30.09	28.99	30.09	30.09
TF	FINAL ABS. TEMP.--FLASK	DEG.R	524.0	524.0	524.0	524.0	524.0
VSC	SAMP. VOL.--STD. CN, DRY	ML	1886.63	1923.49	1809.93	1892.08	1914.62
M	MASS OF NO <sub>2</sub> IN SAMPLE	MICROGM	400.0	430.0	430.0	380.0	450.0
CNOX	CONC. OF NO <sub>2</sub> AS NO <sub>2</sub>	LB/DSCF	.00001315	.00001386	.00001473	.00001245	.00001457

TABLE B-I (Concluded)

## NOX DATA

NAME	DESCRIPTION	UNITS	3-N1	3-N2	3-N3	4-N1	4-N2
	DATE		12-16-71	12-16-71	12-16-71	12-16-71	12-16-71
	PORT		W	N	N	W	W
	POINT		6	6	6	6	6
VF-VA	VOLUME--FLSK+VALVE-AR.SOLN	ML	2084.00	2088.00	2094.00	2083.00	2092.00
PI	INIT. ABS. PRES.--FLASK	IN.HG	2.80	2.50	3.20	2.80	2.20
TI	INIT. ABS. TEMP.--FLASK	DEG.R	538.0	532.0	529.0	526.0	522.0
PF	FINAL ABS. PRES.--FLASK	IN.HG	29.90	29.65	29.90	30.50	29.65
TF	FINAL ABS. TEMP.--FLASK	DEG.R	524.0	524.0	524.0	526.0	526.0
VSC	SAMP. VOL.-STD. CN, DRY	ML	1914.33	1919.04	1892.18	1943.11	1932.71
M	MASS OF NO <sub>2</sub> IN SAMPLE	MICROGM	530.0	610.0	510.0	550.0	510.0
CNOX	CONC. OF NOX AS NO <sub>2</sub>	LB/DSCF	.00001717	.00001971	.00001671	.00001755	.00001636

04

TABLE B-II

## PROX. RAW DATA

TEST	INIT. BARO PRESSURE (IN.HG)	INIT. FLASK VACUUM (IN.HG)	FINAL BARO PRESSURE (IN.HG)	FINAL FLASK VACUUM (IN.HG)
1-N1	30.00	26.70	29.99	0.00
2-N1	30.00	26.80	29.99	-.10
2-N2	30.00	26.80	29.99	1.00
2-N3	30.00	27.10	29.99	-.10
2-N4	30.00	27.10	29.99	-.10
3-N1	30.30	27.50	30.40	.50
3-N2	30.30	27.80	30.40	.75
3-N3	30.30	27.10	30.40	.50
4-N1	30.40	27.60	30.40	-.10
4-N2	30.40	28.20	30.40	.75

TABLE B-III  
EXAMPLE NOX CALCULATIONS

1. SAMPLE VOLUME AT STANDARD CONDITIONS, DRY BASIS

$$VSC = \frac{530 * (VF-VA)}{29.92} * \left( \frac{PF}{TF} - \frac{PI}{TI} \right)$$

$$= 17.71 * (VF-VA) * \left( \frac{PF}{TF} - \frac{PI}{TI} \right)$$

$$= 17.71 * (2092.00) * \left( \frac{29.99}{524.0} - \frac{3.30}{522.0} \right)$$

$$= 1886.63 \text{ ML}$$

42

2. CONCENTRATION OF NOX AS NO<sub>2</sub>

$$CNOX = \frac{M}{VSC} * \frac{1}{1.6 * 10^{44}}$$

$$= \frac{M}{VSC} * 0.000062$$

$$= \frac{400.0}{1886.63} * 0.000062 = .00001315 \text{ LB/SCF}$$

TABLE B-IV

SO<sub>2</sub> DATA

NAME	DESCRIPTION	UNITS	2-S1	3-S1	4-S1
DATE			12-15-71	12-16-71	12-16-71
PORT			W	N	W
POINT			6	6	6
SAMPLE			147/148	149/150	151/152
VM	VOL. OF DRY GAS-METER CN.	CU.FT	2.07	1.64	.68
TM	AVG. DRY GAS METER TEMP.	DEG.R	520.00	525.00	516.00
PM	AVG. ABS. METER PRES.	IN.HG	30.05	30.36	30.40
VMSTD	VOL. OF DRY GAS-STD. CN.	CU.FT	2.12	1.68	.71
VT	VOL. OF TITRANT-SAMPLE	ML	7.80	14.20	7.00
VTB	VOL. OF TITRANT-ABS.BLANK	ML	.80	.60	.60
N	NORMALITY OF TITRANT	G-EQ/L	.00960	.00960	.00960
VSOLN	TTL. SOLUTION VOLUME	ML	100.0	100.0	100.0
VA	VOL. SAMP. ALIQUOT TITRD	ML	10.0	10.0	10.0
CSO <sub>2</sub>	CONC. OF SO <sub>2</sub> - STD. CN	LB/DSCF	.00002233	.00005476	.00006095

TABLE B-V

SO<sub>2</sub> RAW DATA

TEST	INIT.DRY TEST MTR. (CU.FT)	FINAL DRY TEST MTR. (CU.FT)	BARO. PRES. (IN.HG)	METER VACUUM (IN.HG)
2-S1	5.165	7.238	30.05	0.00
3-S1	7.944	9.585	30.36	0.00
4-S1	10.735	11.416	30.40	0.00

TABLE B-VI

EXAMPLE SO<sub>2</sub> CALCULATIONS

1. VOLUME OF DRY GAS SAMPLE THROUGH THE DRY GAS METER  
(AT STANDARD CONDITIONS)

$$VMSTD = VM * \frac{530}{TM} * \frac{PM}{29.92}$$

$$= 17.71 * \frac{VM * PM}{TM}$$

$$= 17.71 * \frac{2.073 * 30.05}{520.00} = 2.1220 \text{ CU.FT.}$$

ST

2. CONCENTRATION OF SULFUR DIOXIDE AT STANDARD CONDITIONS

$$CSO_2 = 0.0000705 * \frac{(VT - VTB) * N * (VSOLN/VA)}{VMSTD}$$

$$= 0.0000705 * \frac{(7.80 - .80) * .00960}{2.1220} * \frac{*(100.0 / 10.0)}{}$$

$$= .00002233 \text{ LB/CF}$$

## APPENDIX C

### OPERATION RESULTS

This section is to be prepared by EPA.

## APPENDIX D

### FIELD DATA

This section presents the actual field data from the testing.

FIELD MOISTURE DETERMINATION

Location Stark

Comments:

Test No. 1

Date Dec. 14, 1971

Operator IET

By Absorption:

Barometric Pressure 29.97 in Hg

Clock Time	Meter (Ft <sup>3</sup> )	Flow Meter Setting (CFH)	Meter Temperature, T <sub>m</sub>
10:41	<sup>Initial</sup> 126.06	.75	76 <sup>58</sup> <sub>59</sub>
10:51	<sup>Final</sup> 129.80		
	--		

Tube No.	Weight, grams		
	Final	Initial	Difference

(W) = weight of moisture collected = 17 gm

% Moisture by Volume =  $100 \cdot W$

$$\left( \frac{375 \cdot P_B \cdot V_m}{T_m + 460} \right) + W$$

% Moisture by Volume = 17.5%

By Wet and Dry Bulb Temperatures:

Wet Bulb Temp. \_\_\_\_\_ °F % Moisture From Psychometric Chart

Dry Bulb Temp. \_\_\_\_\_ °F

## VELOCITY TRAVERSE FIELD DATA

Plant Chesron

Test No.: 1

Location Stack

Date Dec. 14, 1971

Operator ET

## Meter All

(1) ΔP, in. H<sub>2</sub>O Average \_\_\_\_\_

(2)  $\Delta P$ , in.  $H_2O$  Average \_\_\_\_\_

### Comments:

PRELIMINARY DATA  
EMISSION TEST

Project \_\_\_\_\_ Sample Date Dec. 14, 1971  
Test Team FT B.S. B.C. Test No. 1

A. Moisture Content

1. Wet/Dry Bulb Method

$$T_s \text{ (dry)} = \underline{\hspace{2cm}}^{\circ}\text{F}, T_s \text{ (wet)} = \underline{\hspace{2cm}}^{\circ}\text{F}$$

Moisture content =                  % by volume

2. Condenser Method

$$V_m = \underline{3.74} \text{ cu. ft. } T_m = \underline{60}^{\circ}\text{F } V_c = \underline{17} \text{ ml.}$$

$$p_m = p(\text{atmo}) = \underline{29.97} \text{ in. of Hg}$$

$$\text{Moisture content} = \frac{1}{1 + 375 \frac{P_m V_m}{(T_m + 460) V_c}} = \underline{17.5} \% \text{ by vol.}$$

3.74

(See Test       )

B. Velocity Profile ( $\Delta p$  = velocity pressure, in.  $H_2O$ )

Measuring instrument (convert to s-shaped)

8.5  
2170

$$\Delta p: \text{max.} = \underline{595}, \text{min.} = \underline{425}, \text{avg.} = \underline{510}.$$

See Test       .

C. Temperature Profile ( $T_s$ )

Measuring instrument Minimite - thermocouple

$$T_s (\text{°F}): \text{max.} = \underline{742}, \text{min.} = \underline{732}, \text{avg.} = \underline{737}$$

See Test       .

D. Nomograph Settings

$$\Delta H_{\text{ref.}} = 1.84 \text{ in. of } H_2O, T_m = \underline{60}^{\circ}\text{F}$$

$$\% H_2O = \underline{18.0}, P_s/P_m = \underline{1.0}$$

$$C = \underline{.80}, \Delta p = \text{values from G above}$$

$$T_s = \underline{737}^{\circ}\text{F}, D = \underline{.250} \text{ in.}$$

Plant Chesron

Date Dec 14, 1971

Sampling location Stack

STACK DATA FOR NOMOGRAPH:

1. Meter  $\Delta H$  1.84 in  $H_2O$

2. Avg. meter tempt (ambient + 20°) 80 °F

3. Moisture (volume) 17.5 %

4. Avg. static press.  $\pm$  \_\_\_\_\_ in.  $H_2O \times 0.073 =$  \_\_\_\_\_ in. Hg.

5. Bar. press sampling point 29.97 in. Hg  $+ \frac{5.5}{4.2}$  (static press in. Hg) =  
in. Hg.

6. Bar press of meter 29.97 in. Hg.

7.  $P_s/P_m = \frac{5.}{6.} \frac{\text{in. Hg}}{\text{in. Hg}} = \frac{1.0}{}$

8. Avg. stack temperature 737 °F.

9. Avg. stack velocity ( $\Delta P$ ) .510 in  $H_2O$ . MAX. VELOCITY .810

C factor (1) .80 (2)

10. Probe Tip size .250

SAMPLE DATA  
EMISSION TESTProject \_\_\_\_\_ Sample Data ~~Stacks~~  
Test Team ET B.S. B.C. Test NO. 1

Point No.	RAC Filter No.	Sample Time Min.	Start Time	Pitot in. H <sub>2</sub> O	Probe in. H <sub>2</sub> O	Vacuum in. Hg	Meter ft <sup>3</sup>	Meter Temp. °F		Stack Temp. °F	S. Gel Temp. °F	Probe Temp. °F	Comments
								Left	Right				
1	1051	4:00	3:05	.325	.493	3.5	130.09 31.40	59	59	720			
2			3:09	.365	.550	3.5	132.82	63	59	725		150	
3			3:13	.390	.580	4.0	134.48	74	60	730			
4			3:17	.430 <sup>b.480</sup> .440	.665	4.0	136.23	76	61	734			
5			3:21	.455 <sup>a.465</sup> .455	.680	4.0	138.00	82	62	732			
6			3:25	.470 <sup>b.480</sup> .465 <sup>b.480</sup>	.708	4.0	139.83	85	65	733		165	
7			3:29	.450 <sup>b.480</sup> .450	.679	4.5	141.63	89	66	734	65		
8			3:33	.465 <sup>b.480</sup> .465	.700	4.5	143.47	91	68	737			
9			3:37	.480 <sup>b.490</sup> .480	.723	4.5	145.33	92	70	737			
10			3:41	.495 <sup>b.500</sup> .495 <sup>b.500</sup>	.734	5.0	147.22	93	71	733	68		
11			3:45	.555 <sup>b.560</sup> .555 <sup>b.560</sup>	.923	5.5	149.14	94	73	730		166	
12			3:49	.600 <sup>b.610</sup> .600 <sup>b.610</sup>	.988	6.0	151.24	95	75	731			
13			3:53	.675	1.000	7.5	153.27	96	75	723	70		
14			3:57	.710	1.050	8.0	155.44	98	76	724			
15			4:01	.730	1.090	9.5	157.66	100	77	726		245	
16			4:05	.760	1.140	10.0	159.89	102	77	726	70		
17			4:09	.810	1.200	10.5	162.13	103	78	727		259	
18			4:13	.760	1.140	10.5	164.41	104	79	725			
19			4:17	.770	1.145	11.0	166.72	104	79	725			
20			4:21	.740	1.100	10.0	168.94	106	80	724			
		Stopper	4:25										

II : SAMPLE DATA  
EMISSION TESTProject ET B.S. B.C. Sample Data Stack  
Test Team 1

Pt No.	Point No.	RAC Filter No.	Sample Time Min.	Start Time	Pitot in. H <sub>2</sub> O	Probe in. H <sub>2</sub> O	Vacuum in. Hg	Meter ft <sup>3</sup>	Meter Temp. °F	Stack Left °F	S. Gel Temp. °F	Probe Temp. °F	Comment
1	1051	4:00	6:08	.460	.690	11.0	168.94	170.54	62	62	757		
2			6:12	.490	.730	13.5	172.29	69	63	772			reset monog.
3			6:16	.520	.755	15.0	174.12	78	64	774			770
4			6:20	.550	.790	14.5	176.00	86	65	783	15	152	
5			6:24	.575	.830	14.5	177.90	93	67	778			
6			6:28	.565	.820	14.0	179.78	98	69	768			
7			6:32	.470	.675	13.0	181.54	102	70	753	62		
8			6:36	.475	.684	14.0	183.54	104	72	747			reset monog.
9			6:40	.440	.660	13.5	185.34	107	74	744			740
10			6:44	.480	.716	14.0	187.18	108	76	758		158	
11			6:48	.450	.675	14.0	188.91	110	78	753	63		
12			6:52	.540	.805	14.5	190.75	111	80	748			
13			6:56	.550	.815	14.5	192.65	112	81	746			
14			7:00	.550	.815	15.0	194.60	114	82	742	65		
15			7:04	.540	.805	15.0	196.54	114	84	734			
16			7:08	.580	.870	15.0	198.60	116	85	728			
17			7:12	.570	.850	14.5	200.51	117	85	725		217	
18			7:16	.580	.870	14.5	202.57	117	87	723	65		
19			7:20	.540	.805	13.5	204.54	117	88	719			
20	↓	↓	7:24	.580	.870	14.0	206.58	117	88	735			
	at		7:28				180.09						
							Static pressure .50						

## PARTICULATE CLEANUP SHEET

Date: 12/14/71

Run number: 1

Operator: E.T. R.C. RS.

Sample box number: 8

Plant: Std. oil of CA.

Location of sample port: STACK

Barometric pressure: 29.97

Ambient temperature: 57 - 50

Impinger H<sub>2</sub>O

Volume after sampling 692 ml

Container No. 2

155

Impinger prefilled with 200 ml

Extra No. \_\_\_\_\_

Ether-chloroform extraction

of impinger water 0.22579 mg

Volume collected 492 ml

Impinger water residue, 04317 mg

## Impingers and back half of filter, acetone wash:

Container No. 3 - 153

Extra No. \_\_\_\_\_

Weight results, 16772 mg

## Dry probe and cyclone catch:

Container No. \_\_\_\_\_

Extra No. \_\_\_\_\_

Weight results \_\_\_\_\_ mg

## Probe, cyclone, flask, and front half of filter, acetone wash:

Container No. 1 - 154

Extra No. \_\_\_\_\_

Weight results, 09353 mg

## Filter Papers and Dry Filter Particulate

Filter number Container no.

1051 TEST 1

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

Container number: 1. 2. 3. 4.

Filter number Container no.

acetone

Blank - 0.0010

Filter particulate

weight, 13432 mg

Total particulate weight

,66453 mg

## Silica Gel

Weight after test: 615

Weight before test: 590

Moisture weight collected: 25

Container number:

Moisture total 517 gm

24.50 H<sub>2</sub>O

Sample number: \_\_\_\_\_

Analyze for: \_\_\_\_\_

Method determination: \_\_\_\_\_

Comments: at @ 6:30 PM O, analysis went out of whack. Running about 0.1% instead of 1%. Particulate material was this to brown instead of white to gray.

PRELIMINARY DATA  
EMISSION TEST

Project \_\_\_\_\_ Sample Date \_\_\_\_\_  
Test Team \_\_\_\_\_ Test No. \_\_\_\_\_

E. Orsat Data

1. Field Run: CO \_\_\_\_\_, CO<sub>2</sub> \_\_\_\_\_, O<sub>2</sub> \_\_\_\_\_
2. Lab Run: CO \_\_\_\_\_, CO<sub>2</sub> \_\_\_\_\_, O<sub>2</sub> \_\_\_\_\_  
(lab calculations using bulbs)

F. Stack Pressure

Measuring instrument \_\_\_\_\_

Inches H<sub>2</sub>O \_\_\_\_\_ + (\_\_\_\_) - (\_\_\_\_)

(See Test \_\_\_\_\_)

G. Probe Tip Diameter \_\_\_\_\_ Inches.

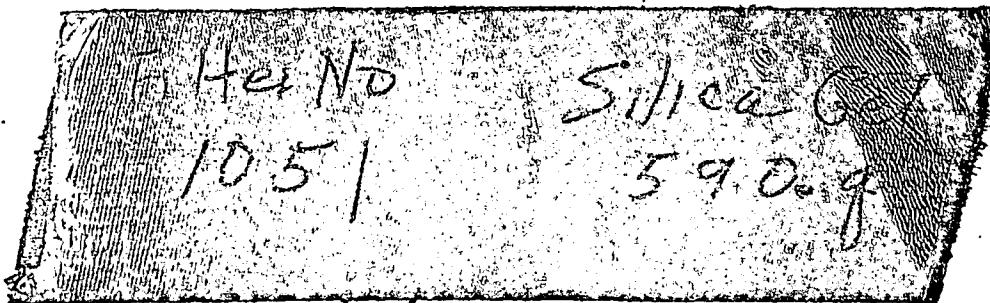
H. Define Sample Train

1. Impingers

	<u>Normal</u>	<u>Initial</u>	<u>Final</u>	<u>Difference</u>
No. 1 (tip)	150 ml.	100	360	260
No. 2	150 ml.	100	320	220
No. 3	Dry	0	12	12
No. 4	Silica Gel	540	615	75

2. Probe Length

3. Special:



## OPACITY DATA

**Location** F.D. off - FCA. E/S.

Date 12/14/71

Run #1

**Reader** R.P. Khan

**Comments:**

Comments: AT NO TIME DID  
STACK PLUME REACH  
ON RING LE MAN CHAM-  
BERING Model 110  
Smoke Inspection Guide  
S.N. 294 Cal. on 12/2/71

FIELD MOISTURE DETERMINATION

Location Feedline Duct Comments:

Test #1

Date DEC 14 1971

Operator K

By Absorption:

Barometric Pressure 29.97

Clock Time	Meter (Ft <sup>3</sup> )	Flow Meter Setting (CFH)	Meter Temperature, T <sub>m</sub>
0:00	1.657	.100/95 SEC	66°F
0:10	2.390		65°F
0:20	2.988		64°F

Tube No.	Weight, grams		
	Final	Initial	Difference

(W) = weight of moisture collected = 0

$$\% \text{ Moisture by Volume} = \frac{100 \cdot W}{\left( \frac{375 \cdot P_B \cdot V_m}{T_m + 460} \right) + W}$$

% Moisture by Volume =                 

By Wet and Dry Bulb Temperatures:

Wet Bulb Temp.                  °F      % Moisture From Psychometric Chart

Dry Bulb Temp.                  °F

GAS SAMPLING FIELD DATA

Material Sampled for  $\text{CO}, \text{CO}_2 + \text{O}_2$  (ORSAT)

Date Dec 14, 1971

Plant Standard Oil Location FEED LINE DUCT

Bar. Pressure 29.97 "Hg Stack Temperature        °F

Ambient Temp. 57 °F Stack Dimensions DUCT

Run No. 1

Power Stat Setting       

Filter Used: Yes        No X

Operator K

INTEGRATED, ORSAT

CLOCK TIME	METER (FT. <sup>3</sup> )	FLOW METER SETTING (CFH)	METER TEMPERATURE IN
3:45	7.120	2.0	68 °F
4:09	8.910	2.0	68 °F
4:33	9.678	2.0	63 °F
4:55	10.331	2.0	60 °F

Impingers with        ml of       

Impingers with        ml of       

Total number of Impingers       

Sample Bottle No.       

Impinger Bucket No.       

Meter Box No.

ORSAT FIELD DATA

Location FEED LINE Comments:

Date DEC 14, 1971

Time 6:00 pm - 7:00pm

Operator Kelso - Flippin

Duct to  
39 Boiler  
12-14-71

Test	(CO <sub>2</sub> ) Reading 1	(O <sub>2</sub> ) Reading 2	(CO) Reading 3
1	<u>10.2</u> <u>-0.8</u> <u>10.2%</u>	<u>11.4</u> <u>-10.2</u> <u>1.2%</u>	<u>19.8</u> <u>-11.4</u> <u>8.4%</u>
OPERATOR	<u>9.2</u> <u>-0.0</u> <u>9.2%</u>	<u>10.1</u> <u>-9.2</u> <u>0.9%</u>	<u>18.5</u> <u>-10.1</u> <u>8.4%</u>
TRAINING	<u>9.4</u> <u>-0.0</u> <u>9.4%</u>	<u>10.6</u> <u>-9.4</u> <u>1.2%</u>	<u>18.9</u> <u>-10.6</u> <u>8.4%</u>

FIELD MOISTURE DETERMINATION

Location S. Stch

Comments:

Test No. 2

Date Dec. 15, 1971

Operator ET

By Absorption:

Barometric Pressure 30.05

Clock Time	Meter (Ft <sup>3</sup> )	Flow Meter Setting (CFH)	Meter Temperature, T <sub>m</sub>
10:08	<sup>Initial</sup> 206.55	.75	63 64 79 66
10:20	<sup>Final</sup> 212.21		

Tube No.	Weight, grams		
	Final	Initial	Difference

(W) = weight of moisture collected = 27.5 ml

% Moisture by Volume = 100 · W

$$\left( \frac{375 \cdot P_B \cdot V_m}{T_m + 460} \right) + W$$

% Moisture by Volume = 19.2

By Wet and Dry Bulb Temperatures:

Wet Bulb Temp. \_\_\_\_\_ °F % Moisture From Psychometric Chart

Dry Bulb Temp. \_\_\_\_\_ °F \_\_\_\_\_

PRELIMINARY DATA  
EMISSION TEST

Project \_\_\_\_\_ Sample Date Dec 15, 1971  
Test Team ET B.S. B.C. Test No. 2  
Hm

A. Moisture Content

1. Wet/Dry Bulb Method

$T_s$  (dry) = \_\_\_\_\_ °F,  $T_s$  (wet) = \_\_\_\_\_ °F  
Moisture content = \_\_\_\_\_ % by volume

2. Condenser Method

$V_m$  = 76.46 cu. ft.  $T_m$  = 85 °F  $V_c$  = 517 ml.  
 $p_m$  = p(atmo) = 30.05 in. of Hg

$$\text{Moisture content} = \frac{1}{1 + 375 \frac{P_m V_m}{(T_m + 460) V_c}} = \underline{24.4} \% \text{ by vol.}$$

*calculated from test*

(See Test \_\_\_\_\_) No. 1

B. Velocity Profile ( $\Delta p$  = velocity pressure, in.  $H_2O$ )

Measuring instrument (convert to s-shaped)

$\Delta p$ : max. = \_\_\_\_\_, min. = \_\_\_\_\_, avg. = .510.  
See Test 1.

C. Temperature Profile ( $T_s$ )

Measuring instrument \_\_\_\_\_  
 $T_s$  (°F): max. = \_\_\_\_\_, min. = \_\_\_\_\_, avg. = 740  
See Test 1.

D. Nomograph Settings

$\Delta H_{ref.}$  = 1.84 in. of  $H_2O$ ,  $T_m$  = 85 °F  
 $\% H_2O$  = 25.0,  $P_s/P_m$  = 1  
 $C$  = .72,  $\Delta p$  = values from G above  
 $T_s$  = 740 °F, D = .250 in.

Plant Standard Oil of California

Date Dec 15, 1971

Sampling location Stack

STACK DATA FOR NOMOGRAPH:

1. Meter AH \_\_\_\_\_ in H<sub>2</sub>O

2. Avg. meter tempt (ambient + 20°) 85 °F

3. Moisture (volume) 24.4 %

4. Avg. static press. ~~0.5~~ in. H<sub>2</sub>O X .073 = ~~.0365~~ in. Hg.

5. Bar. press sampling point 30.05 in. Hg ~~-.0365~~ (static press in. Hg) = 30.0135 in. Hg.

6. Bar press of meter 30.05 in. Hg.

$$7. P_s/P_m = \frac{5.}{6.} \frac{30.0135 \text{ in. Hg}}{30.05 \text{ in. Hg}} = .099$$

8. Avg. stack temperature 740 °F.

9. Avg. stack velocity ( $\Delta P$ ) .510 in H<sub>2</sub>O. MAX. VELOCITY .78

C factor (1) .72 (2)

10. Probe Tip size .250

SAMPLE DATA  
EMISSION TESTProject                  Sample Data SEED  
Test Team ET BS. B.C. Test NO. 2

P. t No.	Point No.	RAC Filter No.	Sample Time Min.	Start Time	Pitot in. H <sub>2</sub> O	Probe in. H <sub>2</sub> O	Vacuum in. Hg	Meter ft <sup>3</sup>	Meter Temp. °F		Stack Temp. °F	S. Gel Temp. °F	Probe Temp. °F	Comment
									Left	Right				
1	1	1052	6:00	10:55	.175	.250	2.0	212.75 214.44	68	69	—			
2	1			11:03	.200	.281	2.0	216.13	74	70	708	←	stopped clock memo say 2	
3				11:09	.245	.350	2.5	218.05	78	71	717		reset monograph	
4				11:15	.285	.404	3.0	220.14	85	72	716	16	110	
5				11:21	.290	.410	3.0	222.24	87	74	706		133	
6				11:27	.280	.396	3.0	224.29	85	75	711	-58		
7				11:33	.280	.396	3.0	226.32	82	76	715		140	
8				11:39	.490	.692	3.5	228.72	82	75	722			
9				11:45	.550	.768	4.0	231.47	84	75	716	60		
10				11:51	.545	.765	4.0	234.23	85	75	722			
11				11:57	.490	.692	4.0	236.90	84	74	732		reset monograph at 730°	
12				12:03	.475	.664	4.0	239.50	82	74	731	60	154	
13				12:09	.460	.647	4.0	242.06	81	72	742			
14				12:15	.450	.642	4½	244.60	80	72	741		163	
15				12:21	.460	.647	6	247.22	81	72	742			
16				12:27	.450	.642	7	249.02	81	72	735			
17				12:33	.460	.647	8	252.35	80	70	732			
18				12:39	.476	.675	9	254.79	81	70	735	60	191	
19				12:45	.490	.695	9½	257.44	82	70	730			
20	↓	↓	↓	12:51	.490	.695	10	260.06	84	71	725			
		stopped	12:57											

SAMPLE DATA  
EMISSION TESTProject                    Sample Data STACK  
Test Team FT, BC, BS Test NO. 2

Point No.	Point No.	RAC Filter No.	Sample Time Min.	Start Time	Pitot in. H <sub>2</sub> O	Probe in. H <sub>2</sub> O	Vacuum in. Hg	Meter ft <sup>3</sup>	Meter Temp. °F		Stack Temp. °F	S. Gel Temp. °F	Probe Temp. °F	Comments
									Left	Right				
1	1	1052	6:50	2:58	.270	.378	6.0	260.07 261.94	59	58	710			
2	1			3:04	.370	.511	8.5	264.07	67	59	713	reset 10710°		
3	1			3:10	.410	.575	10.5	266.15	71	60	726		62	
4	1			3:16	.430	.600	13.0	268.88	74	62	723			
5	1			3:22	.450	.630	15.0	271.35	78	63	726		70	
6	1			3:28	.450	.630	16.5	273.84	79	65	727			
7	1			3:34	.460	.640	18.0	276.33	80	66	730		74	
8	1			3:40	.440	.613	19.5	278.80	80	68	733	reset normal at 730		
9	1			3:46	.455	.630	23.0	281.23	82	68	731		85	
10	1053			3:52 5:06	.490	.675	3.0	283.89	64	68	748	← changed filter new value		
11	1			5:12	.585	.80	4.2	286.63	79	69	751		105	
12	1			5:18	.60	.825	4.5	289.55	88	71	752			
13	1			5:24	.74-.76	1.02	5.0	292.66	95	79	752		110	
14	1			5:30	.78	1.07	5.1	295.76	96	75	753			
15	1			5:36	.76 75-.77	1.04	5.1	298.91	102	77	749			
16	1			5:42	.75	1.02	5.5	302.09	104	79	747			
17	1			5:48	.72	.98	5.5	305.23	105	80	743			
18	1			5:54	.71	.97	5.5	308.36	107	83	738			
19	1			6:00	.7	.96	5.5	311.49	106	85	740		155	
20	1			6:06	.69	.945	5.6	314.68	106	86	738			
			5:59 PM	6:12										

## PARTICULATE CLEANUP SHEET

EL SEGUNDO

Date: Dec 15, 1971

Run number: 2

Operator: E.T. Q.S. H.M.

Sample box number: 7

Plant: STANDARD oil of CAL

Location of sample port: STACK

Barometric pressure: 30.05

Ambient temperature: 55

Impinger H<sub>2</sub>O

Volume after sampling 1020 ml

Impinger prefilled with 400 ml

Volume collected 620 ml

Container No. 160

Extra No. 161

Ether-chloroform extraction  
of impinger water 11248 mg

Impinger water residue 30373 mg

Impingers and back half of filter, acetone wash:

Container No. 158

Extra No. Weight results 0.0990 mg

Dry probe and cyclone catch:

Container No. \_\_\_\_\_

Extra No. Weight results \_\_\_\_\_ mg

Probe, cyclone, flask, and front half of filter, acetone wash:

Container No. 159

Extra No. Weight results 0.8803 mg

## Filter Papers and Dry Filter Particulate

Filter number Container no.

1052 Test 2

1053 Test 2

Filter number Container no.

Wt Part 08275

04191

Aet Bl. -00182

Filter particulate weight 0.12466 mg

Total particulate weight

0.63880 mg

## Silica Gel

Weight after test: 629

Weight before test: 604

Moisture weight collected: 25

Container number: 1. 2. 3. 4.

Moisture total 645 gm

Sample number: \_\_\_\_\_

Analyze for: \_\_\_\_\_

Method determination: \_\_\_\_\_

Comments: \_\_\_\_\_

PRELIMINARY DATA  
EMISSION TEST

Project \_\_\_\_\_ Sample Date 12/15/71  
Test Team \_\_\_\_\_ Test No. 2

E. Orsat Data

1. Field Run: CO \_\_\_\_\_, CO<sub>2</sub> \_\_\_\_\_, O<sub>2</sub> \_\_\_\_\_

2. Lab Run: CO 4 ppm, CO<sub>2</sub> \_\_\_\_\_, O<sub>2</sub> \_\_\_\_\_ NDIR  
~~(lab calculations using bulbs)~~

F. Stack Pressure

Measuring instrument \_\_\_\_\_

Inches H<sub>2</sub>O \_\_\_\_\_ + (\_\_\_\_) - (\_\_\_\_)

(See Test \_\_\_\_\_)

G. Probe Tip Diameter \_\_\_\_\_ Inches.

H. Define Sample Train

1. Impingers

	<u>Normal</u>	<u>Initial</u>	<u>Final</u>	<u>Difference</u>
No. 1 (tip)	150 ml.	<u>100</u> $\varnothing$ 100	<u>350</u> $\varnothing$ 302	452
No. 2	150 ml.	<u>100</u> $\varnothing$ 100	<u>120</u> $\varnothing$ 126	146
No. 3	Dry	0	<u>22</u>	22
No. 4	Silica Gel	604	629	25

2. Probe Length

3. Special:

IMPINGERS #1 + #2 WERE REPLACED DUE TO EXCESS  
MOISTURE ACCUMULATION DURING TEST.



Filter #  
1052 and  
1053  
used on  
Test 2

ORSAT FIELD DATA

Location STACK  
Date DEC 15, 1971  
Time 6:15 PM  
Operator SHUTTS & FLIPPEN

Comments:

Test	(CO <sub>2</sub> ) Reading 1	(O <sub>2</sub> ) Reading 2	(CO) Reading 3
Test #2	7.5 <u>-0.0</u> 7.5%	19.9 <u>-7.5</u> 72.4%	WOULD NOT ZERO <u>-19.9</u> NO READING
Test #2	6.4 <u>-0.0</u> 6.4%	18.8 <u>-6.4</u> 72.4%	18.8 <u>-18.8</u> 0.0%
Test #2	NDIR		4 ppm

OXIDES OF NITROGEN FIELD DATA

Date 12-15-71

Plant Std. Oil of Calif.

Sample Collected By Ishita

Run No. 2 + 1

Power Stat Setting \_\_\_\_\_

<u>Field Data</u>	<u>1-N1</u> #1	<u>2-N1</u> #2	<u>2-N2</u> #2	<u>2-N3</u> #2	<u>2-N4</u> #2
-------------------	-------------------	-------------------	-------------------	-------------------	-------------------

Clock time	17:25 Q 12-14-71	1130 12-15-71	1215 12-15-71	1455 12-15	1715 12-15
Flask number	2	6	12	11	8
Volume of flask less correction (liter)	2.092	2.116	2.076	2.056	2.083
Pressure before sampling in Hg. P. Bar = 30.0	<u>3.3"</u> 26.7 Hg	<u>3.2"</u> 26.8 Hg	<u>2.9"</u> 27.1 Hg	<u>2.9"</u> 27.1	<u>2.9"</u> 27.1
Pressure after sampling in Hg.	0"	.1" +	.1" -	.1" +	.1" +
Flask temperature, °F AT SAMPLE	62°F	64°F	60°F	70°F	64°F
FLASK TEMP OF AT LAB	64°F	61°F	64°F	64°F	64°F
Remarks:	Bar Press 29.99				
Flask #2 Probe inlet	15"				
" #6 " "	15.5"				
" #12 " "	15.5"				
Analysis mg	.40	.43	.43	.38	.45
NCAP-35 (12/67)					
			68		

GAS SAMPLING FIELD DATA

Material Sampled for  $SO_2$

Date 12-15-71

Plant STD OIL Location El Segundo

Bar. Pressure 30.05 "Hg Stack Temperature 730 °F

Ambient Temp. 55 °F Stack Dimensions 13'10" ID

Run No. 2

Power Stat Setting \_\_\_\_\_

Filter Used: Yes No X Glasswool

Operator Shultz

CLOCK TIME	METER (Ft. <sup>3</sup> )	FLOW METER SETTING (CFH)	METER TEMPERATURE IN
1520	5.165	N/A	56
1525:00	5.390		57
1531:45	5.620		58
1536:00	5.769		59
1545:00	6.122		60
1555:00	6.544		61
1605:00	6.830		63°
1620:00	7.238		64°

1 Bubbler Impingers with 15 ml of 80% IPA (DISCARD)

2 Impingers with 15 EA. ml of 3% H<sub>2</sub>O<sub>2</sub>

Total number of Impingers 2

Sample Bottle No. 147

Analyses Impinger bucket No.  $4.7376 \times 10^{-5}$  lbs

Meter Box No. Vs

Test Started at 10<sup>51</sup> AM

OPACITY DATA

**Location** STD. OIL OF CA.

**Comments:**

Date 12/15/71

Run it 2

Reader E.P. J. Had

FIELD MOISTURE DETERMINATION

Location FEED LINE

Comments:

Test NO. ONE 2

Date DEC 15, 1971

Operator Kelso

By Absorption:

Barometric Pressure 30.05

Clock Time	Meter (Ft <sup>3</sup> )	Flow Meter Setting (CFH)	Meter Temperature, T <sub>m</sub>
10:30	12.663	2.58	72°F
10:45	13.247	2.46	76°F
11:00	13.892	2.64	74°F
2:15	21.284	2.64	73°F.

Tube No.	Weight, grams		
	Final	Initial	Difference
SILICA GEL IN IMPINGER	102.3 g	96.8 g	5.5 g

(W) = weight of moisture collected = 5.5 g

% Moisture by Volume = 100 · W

$$\left( \frac{375 \cdot P_B \cdot V_m}{T_m + 460} \right) + W$$

% Moisture by Volume = 2.98 %

By Wet and Dry Bulb Temperatures:

Wet Bulb Temp. \_\_\_\_\_ °F % Moisture From Psychometric Chart

Dry Bulb Temp. \_\_\_\_\_ °F \_\_\_\_\_

GAS SAMPLING FIELD DATA

Material Sampled for CO, CO<sub>2</sub>, O<sub>2</sub>

Date DEC 15, 1971

Plant EL SEGUNDO, CALIF. Location FEED LINE

Bar. Pressure 30.05 "Hg Stack Temperature \_\_\_\_\_ °F

Ambient Temp. 60 °F Stack Dimensions \_\_\_\_\_

Run No. 2

Power Stat Setting \_\_\_\_\_

Filter Used: Yes NO X

Operator KELSO

CLOCK TIME	METER (Ft. <sup>3</sup> )	FLOW METER SETTING (CFH)	METER TEMPERATURE IN
2:45 PM	21.347	2.00	68°F
3:00	21.810	1.92	67°F
3:15	22.242	1.44	65°F
3:45	23.061	1.92	73°F
4:00 PM	23.540	2.00	74°F

Impingers with \_\_\_\_\_ ml of \_\_\_\_\_

Impingers with \_\_\_\_\_ ml of \_\_\_\_\_

Total number of Impingers \_\_\_\_\_

Sample Bottle No. \_\_\_\_\_

Impinger Bucket No. \_\_\_\_\_

Meter Box No. \_\_\_\_\_

ORSAT FIELD DATA

Location FEED LINE  
Date DEC 15, 1971  
Time 5:00 PM  
Operator KELSO ; FLIPPIN

Comments:

Test	(CO <sub>2</sub> ) Reading 1	(O <sub>2</sub> ) Reading 2	(CO) Reading 3
F1,pp: #2 from Duct	11.0 <u>-0.0</u> 11.0 %	13.0 <u>-11.0</u> 2.0 %	21.0 <u>-13.0</u> 8.0 %
Kelso #2 from Duct	10.6 <u>-0.0</u> 10.6 %	12.6 <u>-10.6</u> 2.0 %	20.0 <u>-12.6</u> 8.2 %

Location Stack

Comments:

Test 3Date Dec, 16, 1971Operator ET

By Absorption:

Barometric Pressure 30.38

Clock Time	Meter (Ft <sup>3</sup> )	Flow Meter Setting (CFH)	Meter Temperature, T <sub>m</sub>
9:27	Initial 314.59	.50 (avg)	85
	Final 370.00		
	--		

Tube No.	Weight, grams		
	Final	Initial	Difference

(W) = weight of moisture collected = 296.5 ml

$$\% \text{ Moisture by Volume} = \frac{100 \cdot W}{\left( \frac{375 \cdot P_B \cdot V_m}{T_m + 460} \right) + W}$$

% Moisture by Volume = 20%

By Wet and Dry Bulb Temperatures:

Wet Bulb Temp. \_\_\_\_\_ °F % Moisture From Psychometric Chart

Dry Bulb Temp. \_\_\_\_\_ °F \_\_\_\_\_

Plant Standard Oil of California Date Dec. 16, 1971

Sampling location Stack

STACK DATA FOR NOMOGRAPH:

1. Meter  $\Delta H$  \_\_\_\_\_ in  $H_2O$

2. Avg. meter tempt (ambient + 20°) 85 °F

3. Moisture (volume) 24.4 %

4. Avg. static press. + \_\_\_\_\_ in.  $H_2O \times 0.073 = +$  in. Hg.

5. Bar. press sampling point 30.39 in. Hg + .5 in. H<sub>2</sub>O (static press in. Hg) =  
in. Hg.

6. Bar press of meter 30.38 in. Hg.

7.  $P_s/P_m = \frac{5}{6} = \frac{\text{in. Hg}}{\text{in. Hg}} = 1.0$

8. Avg. stack temperature 735 °F.

9. Avg. stack velocity ( $\Delta P$ ) .480 in  $H_2O$ . MAX. VELOCITY

C factor (1) .72 (2)

10. Probe Tip size .250

I I. SAMPLE DATA  
EMISSION TEST

Project 3585-C6 Sample Data stacks  
Test Team ET.B.S.B.C Test NO. 3

Prt No.	Point No.	RAC Filter No.	Sample Time Min.	Start Time	Pitot in. H <sub>2</sub> O	Probe in. H <sub>2</sub> O	Vacuum in. Hg	Meter ft <sup>3</sup>	Meter		Stack Temp. °F	S. Gel Temp. °F	Probe Temp. °F	Commer
									Left	Temp. °F Right				
1	1054	3:00	9:27	.25	.352	3.2	314.59				64	64	700	
2	1		9:30	.33	.462	3.2	316.52	66	63	703			Reset to 720	
3			9:33	.37	.519	3.2	317.72	72	65	723				
4			9:36	.42	.59	3.8	318.92	76	64	718			90	
5			9:39	.45	.634	3.8	320.15	80	66	716			63	
6			9:42	.44	.612	4.0	321.40	84	66	716			85	
7			9:45	.445	.630	4.0	322.66	87	68	717				
8			9:48	.445	.630	4.0	323.96	90	69	718			83	
9			9:51	.45	.634	4.0	325.20	94	70	720			63	
10			9:54	.46	.642	4.0	326.48	95	72	721				
11			9:57	.57	.790	4.5	327.85	98	74	723				
12			10:00	.59	.815	5.0	329.26	99	75	722			98	
13			10:03	.61	.840	5.0	330.75	102	77	720			64	
14			10:06	.67	.925	5.2	332.23	105	78	725				
15			10:09	.69	.945	5.5	333.90	107	80	723				
16			10:12	.71	.980	5.8	335.45	110	80	725				
17			10:15	.75	1.03	6.0	337.10	112	82	726			65	
18			10:18	.75	1.03	6.0	338.70	114	84	721				
19			10:21	.72	985	6.0	340.31	116	85	718			133	
20	↓	↓	10:24	.67	.925	5.5	341.85	119	86	718			65	
			10:27				76							

I.I. SAMPLE DATA  
EMISSION TESTProject \_\_\_\_\_  
Test Team E.T.B.S. B.C. Test NO. 3  
H.A.M.

P. t No.	Point No.	RAC Filter No.	Sample Time Min.	Start Time	Pitot in. H <sub>2</sub> O	Probe in. H <sub>2</sub> O	Vacuum in. Hg	Meter ft <sup>3</sup>	Meter Temp. °F		Stack Temp. °F	S. Gel Temp. °F	Probe Temp. °F	Commen
									Left	Right				
V	1	1054	3:00	11:01	.30	.427	1.1	341.85			78	78	700	
	2	1		11:04	.47	.655	1.5	344.18	82	81	716			
	3			11:07	.5	.700	1.7	345.56	86	79	728			
	4			11:10	.55	.760	1.5	347.12	92	79	732			
	5			11:13	.57	.785	1.5	348.45	98	80	738			
	6			11:16	.58	.800	1.5	349.91	102	80	734			
	7			11:19	.56	.775	1.5	351.38	106	81	738			
	8			11:22	.57	.785	1.5	352.84	110	82	734			
	9			11:25	.550	.760	1.5	354.38	111	84	738			
	10			11:28	.530	.732	4.2	355.79	112	84	737	65		
	11			11:31	.480	.673	4.0	357.15	112	85	733			
	12			11:34	.490	.688	4.2	358.50	114	87	732			
	13			11:37	.530	.735	4.5	359.92	115	86	731			
	14			11:40	.58	.800	5	361.28	116	88	733	65		
	15			11:43	.56	.775	5	362.73	117	89	726			
	16			11:46	.57	.785	5	364.17	118	89	725			
	17			11:49	.63	.870	5.3	365.66	119	90	725			
	18			11:52	.59	.820	5.2	367.15	120	91	721			
	19			11:55	.57	.785	5	368.59	122	91	729			
	20	↓	↓	11:58	.52	.728	5	370.00	121	92	>20	65		
				12:01										
							77							

## PARTICULATE CLEANUP SHEET

Date: 12/16/71Run number: 3Operator: E.T. R.S.H.M.Sample box number: 7Plant: STD. OIL OF CA. EL SEGONDOLocation of sample port: STACKBarometric pressure: 30.38Ambient temperature: 62Impinger H<sub>2</sub>OVolume after sampling 483 mlContainer No. 166Impinger prefilled with 200 ml

Extra No. \_\_\_\_\_

Volume collected 283 mlEther-chloroform extraction  
of impinger water .01554 mgImpinger water residue .02436 mgImpingers and back half of  
filter, acetone wash:Container No. 164

Extra No. \_\_\_\_\_

Weight results .00772 mg

Dry probe and cyclone catch:

Container No. \_\_\_\_\_

Extra No. \_\_\_\_\_

Weight results \_\_\_\_\_ mg

Probe, cyclone, flask, and  
front half of filter,  
acetone wash:Container No. 165

Extra No. \_\_\_\_\_

Weight results .05962 mg

## Filter Papers and Dry Filter Particulate

Filter number Container no. Filter number Container no.

1054 Test 3

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

Filter particulate  
weight .04980 mg

Total particulate weight

mg

## Silica Gel

Weight after test: 619.5Weight before test: 606Moisture weight collected: 13.5Container number: 1. 2. 3. 4.Moisture total 296.5 gm

Sample number: \_\_\_\_\_

Analyze for: \_\_\_\_\_

Method determination: \_\_\_\_\_

Comments: \_\_\_\_\_

PRELIMINARY DATA  
EMISSION TEST

Project \_\_\_\_\_  
Test Team \_\_\_\_\_

Sample Date 12/16/71

Test No. 3

E. Orsat Data

1. Field Run: CO \_\_\_\_\_, CO<sub>2</sub> \_\_\_\_\_, O<sub>2</sub> \_\_\_\_\_

2. Lab Run: CO 7, CO<sub>2</sub> \_\_\_\_\_, O<sub>2</sub> \_\_\_\_\_ NDIR  
(lab calculations using bulbs)

F. Stack Pressure

Measuring instrument \_\_\_\_\_

Inches H<sub>2</sub>O \_\_\_\_\_ + (\_\_\_\_) - (\_\_\_\_)

(See Test \_\_\_\_\_)

G. Probe Tip Diameter \_\_\_\_\_ Inches.

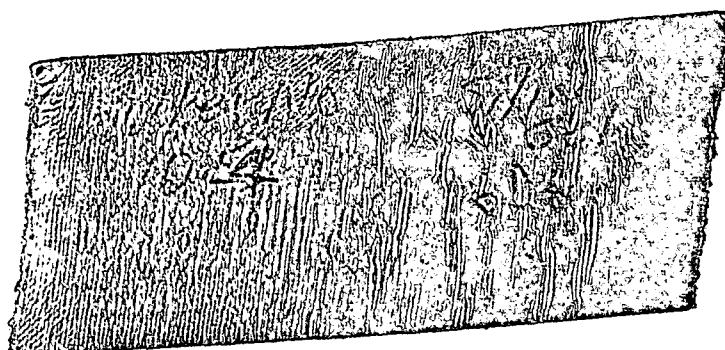
H. Define Sample Train

1. Impingers

	<u>Normal</u>	<u>Initial</u>	<u>Final</u>	<u>Difference</u>
No. 1 (tip)	150 ml.	100	315	215.
No. 2	150 ml.	100	160	60
No. 3	Dry	0	8	8
No. 4	Silica Gel	606	619.5	13.5

2. Probe Length

3. Special:



ORSAT FIELD DATA

Location FEED LINE AND STACK Comments:

Date DEC 16, 1971

Time 2:00 PM

Operator KELSO

Test	(CO <sub>2</sub> ) Reading 1	(O <sub>2</sub> ) Reading 2	(CO) Reading 3
Kelso Run # 3 FEED LINE	11.8 -0.0 <u>11.8%</u>	12.0 -11.3 <u>0.7%</u>	20.2 12.0 <u>8.2%</u>
Flippin Run # 3 Feed Line	11.0 -0 <u>11.0%</u>	12.6 -11.0 <u>1.6%</u>	21.0 -12.6 <u>8.4%</u>
Flippin Run # 3 Stack Sample	10.30 -0 <u>10.2%</u>	17.6 -10.2 <u>7.4%</u>	17.6 -17.6 <u>0%</u>

OXIDES OF NITROGEN FIELD DATA

Date 12-16-71

Plant STD OIL El Segundo

Sample Collected By Shuttle

Run No. 3

Power Stat Setting Max

Field Data

3-N1    3-N2    3-N3

Clock time	1020	1110	1420		
Flask number	3	9	10		
Volume of flask less correction (liter)	2.084	2.088	2.094		
Pressure before sampling in Hg.	30.3 27.5 2.8	30.3 27.8 2.5	30.3 27.1 3.2	12/16	
Pressure after sampling in Hg.	.5—	.75—	.5—	12/17	
Flask temperature, °F	78	72	69	12/16	
Flask Lab Temp, °F	64	64	64	12/17	

Remarks:

Barometric  
when  
Lab Sampling  
bottled.

Press  
30.4 12/17

Analysis mg.    0.53    0.61    0.51

NCAP-35 (12/67)

GAS SAMPLING FIELD DATA

Material Sampled for SO<sub>2</sub>

1084

Date 12-16-71

Plant STD AL

Location EL SEGUNDO

Bar. Pressure 30.36

"Hg

Stack Temperature \_\_\_\_\_ °F

Ambient Temp. 65

°F

Stack Dimensions \_\_\_\_\_

Run No. 3

Power Stat Setting \_\_\_\_\_

Filter Used: Yes    No   

Operator SHUTTS

CLOCK TIME	METER (Ft. <sup>3</sup> )	FLOW METER SETTING (CFH)	METER TEMPERATURE IN
1150	7,944		65°
1155	8.033		66
1200	8.170		67
1205	8.323		67
1210	8.457		68
1215	8.616		69
1220	8.700		68
1225	8.760		67

Bubbler

Impingers with 15 ml of 80% IPA

Impingers with \_\_\_\_\_ ml of \_\_\_\_\_

Total number of Impingers \_\_\_\_\_

Sample Bottle No. 3-81

Impinger Bucket No. \_\_\_\_\_

Meter Box No. \_\_\_\_\_

GAS SAMPLING FIELD DATA

Material Sampled for SO<sub>2</sub> 2074  
Date \_\_\_\_\_  
Plant \_\_\_\_\_ Location \_\_\_\_\_  
Bar. Pressure \_\_\_\_\_ "Hg Stack Temperature \_\_\_\_\_ °F  
Ambient Temp. \_\_\_\_\_ °F Stack Dimensions \_\_\_\_\_  
Run No. \_\_\_\_\_  
Power Stat Setting \_\_\_\_\_  
Filter Used: Yes    No     
Operator \_\_\_\_\_

CLOCK TIME	METER (Ft. <sup>3</sup> )	FLOW METER SETTING (CFH)	METER TEMPERATURE IN
11230	8.837		66
1233	.880		66
1236	.912		65
1240	.935		64
1245	.996		64
1250	9.037		64
1255	.080		63
1300	.127		64

Impingers with \_\_\_\_\_ ml of \_\_\_\_\_

Impingers with \_\_\_\_\_ ml of \_\_\_\_\_

Total number of Impingers \_\_\_\_\_

Sample Bottle No. \_\_\_\_\_

Impinger Bucket No. \_\_\_\_\_

Meter Box No. \_\_\_\_\_

GAS SAMPLING FIELD DATA

Material Sampled for 50z 3g4

Date \_\_\_\_\_

Plant \_\_\_\_\_ Location \_\_\_\_\_

Bar. Pressure \_\_\_\_\_ "Hg Stack Temperature \_\_\_\_\_ °F

Ambient Temp. \_\_\_\_\_ °F Stack Dimensions \_\_\_\_\_

Run No. \_\_\_\_\_

Power Stat Setting \_\_\_\_\_

Filter Used: Yes    No   

Operator \_\_\_\_\_

CLOCK TIME	METER (Ft. <sup>3</sup> )	FLOW METER SETTING (CFH)	METER TEMPERATURE IN
1305	9.165		64
1310	.221		64
1315	.256		64
1320	.315		64
1325	.344		64
1330	.405		64
1335	.440		63
/			

Impingers with \_\_\_\_\_ ml of \_\_\_\_\_

Impingers with \_\_\_\_\_ ml of \_\_\_\_\_

Total number of Impingers \_\_\_\_\_

Sample Bottle No. \_\_\_\_\_

Impinger Bucket No. \_\_\_\_\_

Meter Box No. \_\_\_\_\_

GAS SAMPLING FIELD DATA

Material Sampled for  $SO_2$  4/4

Date \_\_\_\_\_

Plant \_\_\_\_\_ Location \_\_\_\_\_

Bar. Pressure \_\_\_\_\_ "Hg Stack Temperature \_\_\_\_\_  $^{\circ}$ F

Ambient Temp. \_\_\_\_\_  $^{\circ}$ F Stack Dimensions \_\_\_\_\_

Run No. \_\_\_\_\_

Power Stat Setting \_\_\_\_\_

Filter Used: Yes    No   

Operator \_\_\_\_\_

CLOCK TIME	METER (Ft. <sup>3</sup> )	FLOW METER SETTING (CFH)	METER TEMPERATURE IN
1340	.495		63
1345	.534		63
1350	.576		63
Final	.535		63
2			
	→ No pump, Vacuum in train at shut off		

1 Impingers with 15 ml of 80% IPA (D150A)

2 Impingers with 15 ml of 5% H<sub>2</sub>O<sub>2</sub>

Total number of Impingers 4

Sample Bottle No. 149

Impinger Bucket No.  $9.20448 \times 10^{-5}$  lbs

Meter Box No. V/S

## OPACITY DATA

Location Stack 39 Boiler St/oil Comments:  
Date 12/16/71  
Run 39 4  
Reader E.D. Kea

GAS SAMPLING FIELD DATA

Material Sampled for CO, CO<sub>2</sub>, O<sub>2</sub>

Date DEC 16, 1971

FEED LINE

Plant STANDEO OIL, CALIF Location EL SEGUNDO, CALIF

Bar. Pressure 30.40 "Hg Stack Temperature                  °F

Ambient Temp. 65 °F Stack Dimensions                 

Run No. 3

Power Stat Setting                 

Filter Used: Yes        No X

Operator KELSO

CLOCK TIME	METER (Ft. <sup>3</sup> )	FLOW METER SETTING (CFH)	METER TEMPERATURE IN
10:00AM	23.542	1.80	72°F
10:15	23.987	1.70	76°F
10:30	24.392	1.80	79°F
10:45	24.805	1.80	78°F
11:15	25.636	1.86	84°F
11:20	25.778	1.80	84°F

Impingers with                  ml of                 

Impingers with                  ml of                 

Total number of Impingers                 

Sample Bottle No.                 

Impinger Bucket No.                 

Meter Box No.

Location FEED LINE

Comments:

Test #3 + #4Date DEC 16, 1971Operator KELSO

By Absorption:

Barometric Pressure 30.40

Clock Time	Meter (Ft <sup>3</sup> )	Flow Meter Setting (CFH)	Meter Temperature, T <sub>m</sub>
10:00 AM	23.542	1.80	72°F
10:15 AM	23.987	1.70	76°F
10:30 AM	24.392	1.80	79°F
10:45 AM	24.805	1.80	78°F
3:00 PM	32.442	1.80	79°F

Tube No.	Weight, grams		
	Final	Initial	Difference
SILICA GEL IN IMPLINGER	101.97	97.68	4.29

(W) = weight of moisture collected = 4.29 grams% Moisture by Volume = 100 · W

$$\frac{(375 \cdot P \cdot V_m)}{T_m + 460} + W$$

% Moisture by Volume = 2.2 %

By Wet and Dry Bulb Temperatures:

Wet Bulb Temp. \_\_\_\_\_ °F % Moisture From Psychometric Chart

Dry Bulb Temp. \_\_\_\_\_ °F \_\_\_\_\_

SAMPLE DATA  
EMISSION TESTProject ET BC. B.S Sample Data Stack  
Test Team HM Test NO. 4

Part No.	Point	RAC Filter No.	Sample Time Min.	Start Time	Pitot in. H <sub>2</sub> O	Probe in. H <sub>2</sub> O	Vacuum in. Hg	Meter ft <sup>3</sup>	Meter	Stack Temp. °F	S. Gel Temp. °F	Probe Temp. °F	Comments
									Temp. °F		°F	°F	
1	1055	3:00	3:45	.340	.478	3	370.35 271.46		62	62	700°		
2			3:48	.50	.692	3.6	372.71	64	62	723			
3			3:51	.57	.790	5	374.06	70	63	728			
4			3:54	.59	.820	4.1	375.47	74	62	733			
5			3:57	.58	.810	4.2	376.88	78	63	728			
6			4:00	.62	.850	4.2	378.29	82	64	735			
7			4:03	.61	.840	4.1	379.71	85	65	734			
8			4:06	.63	.87	4.1	381.16	87	66	734			
9			4:09	.59	.82	4.1	382.59	70	67	736	64		
10			4:12	.56	.78	4.1	383.97	90	68	731			
11			4:15	.54	.752	4.0	385.33	90	69	733			
12			4:18	.51	.712	4.0	386.67	91	70	732			
13			4:21	.55	.760	4.0	388.03	91	72	735	65		
14			4:24	.57	.790	4.3	389.43	93	73	739			
15			4:27	.62	.850	4.5	390.87	94	74	736			
16			4:30	.59	.820	4.5	392.30	94	75	733			
17			4:33	.61	.840	4.7	393.75	95	76	735			
18			4:36	.570	.790	4.5	395.18	96	76	734			
19			4:39	.600	.830	4.9	396.62	98	77	730			
20	↓	↓	4:42	.560	.780	4.8	398.02	98	78	730			
			4:45										

I. SAMPLE DATA  
EMISSION TESTProject                  Sample Data Stack  
Test Team FT BC BS Test No. 4

P. t. No.	Point No.	RAC Filter No.	Sample Time Min.	Start Time	Pitot in. H <sub>2</sub> O	Probe in. H <sub>2</sub> O	Vacuum in. Hg	Meter ft <sup>3</sup>	Meter	Stack Temp. °F	S. Gel	Probe	Commens
									Temp. Left		Temp. °F	Temp. °F	
1	1	1055	3:00	5:32	.240	.342	3.0	399.03	64	66	700		
								399.01					
1	2			5:35	.350	.490	3.5	400.07	68	67	707		
1	3			5:38	.380	.530	3.5	401.21	72	66	731		
1	4			5:41	.420	.580	4.0	402.41	75	68	735		
1	5			5:44	.440	.625	4.0	403.65	80	68	738		
1	6			5:47	.450	.630	4.0	404.91	82	70	738	65	
1	7			5:50	.430	.605	4.2	406.16	84	70	736		
1	8			5:53	.42	.585	4.2	407.39	85	70	737		
1	9			5:56	.455	.641	4.8	408.63	86	70	737		
1	10			5:59	.49	.685	5.2	410.10	88	72	741	Reset to 740	
1	11			6:02	.56	.755	8.0	411.43	90	72	744		
1	12			6:05	.62	.831	9.5	412.84	92	74	741	65	
1	13			6:08	.67	.845	12.2	414.26	93	74	743		
1	14			6:11	.69	.930	15	415.76	96	75	742		
1	15			6:14	.73	.980	17.5	417.30	98	75	741		
1	16			6:17	.77	1.03	19.0	418.87	100	76	739		
1	17			6:20	.75	.995	20.0	420.45	102	77	738		
1	18			6:23	.73	.98	21.0	422.04	103	78	739		
1	19			6:26	.74	.985	21.1	423.60	102	78	737		
1	20			6:29	.74	.985	13.0	425.18	104	80	731		
1		Stopped	6:32										
		aq											

## PARTICULATE CLEANUP SHEET

Date: 12/16/67Run number: 4Operator: E.T. RS RHMSample box number: 8Plant: Std oil of CA. El SEGONDOLocation of sample port: STACKBarometric pressure: 30.38Ambient temperature: 57Impinger H<sub>2</sub>OVolume after sampling 588 mlContainer No. 171Impinger prefilled with 200 ml

Extra No. \_\_\_\_\_

Volume collected 388 mlEther-chloroform extraction  
of impinger water .09094 mgImpinger water residue .29809 mgImpingers and back half of  
filter, acetone wash:Container No. 169

Extra No. \_\_\_\_\_

Weight results .01858 mg

Dry probe and cyclone catch:

Container No. \_\_\_\_\_

Extra No. \_\_\_\_\_

Weight results \_\_\_\_\_ mg

Probe, cyclone, flask, and  
front half of filter,  
acetone wash:Container No. 170

Extra No. \_\_\_\_\_

Weight results .13136 mg

## Filter Papers and Dry Filter Particulate

Filter number Container no. Filter number Container no.

1055 Test 4

\_\_\_\_\_

Filter particulate  
weight .09749 mg

Total particulate weight

mg

## Silica Gel

Weight after test: 611

\_\_\_\_\_

Weight before test: 595

\_\_\_\_\_

Moisture weight collected: 16

\_\_\_\_\_

Moisture total 404 gmContainer number: 1. 2. 3. 4.

\_\_\_\_\_

Sample number: \_\_\_\_\_

Analyze for: \_\_\_\_\_

Method determination: \_\_\_\_\_

Comments: \_\_\_\_\_

PRELIMINARY DATA  
EMISSION TEST

Project \_\_\_\_\_ Sample Date 12/16/71  
Test Team \_\_\_\_\_ Test No. 4

E. Orsat Data

1. Field Run: CO \_\_\_\_\_, CO<sub>2</sub> \_\_\_\_\_, O<sub>2</sub> \_\_\_\_\_

2. Lab Run: CO 12, CO<sub>2</sub> \_\_\_\_\_, O<sub>2</sub> \_\_\_\_\_ NDIR  
(lab calculations using bulbs)

F. Stack Pressure

Measuring instrument \_\_\_\_\_

Inches H<sub>2</sub>O \_\_\_\_\_ + (\_\_\_\_) - (\_\_\_\_)

(See Test \_\_\_\_\_)

G. Probe Tip Diameter \_\_\_\_\_ Inches.

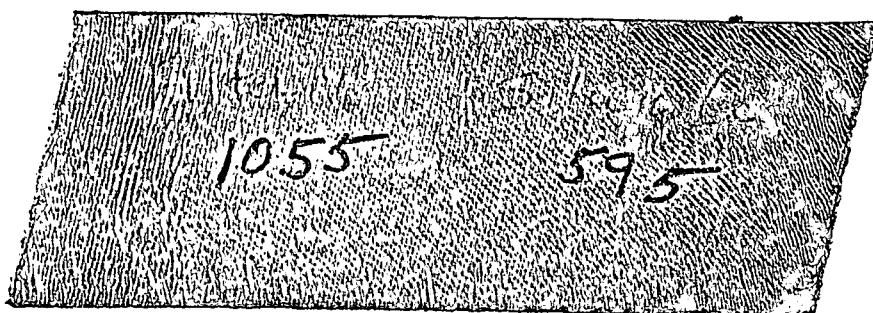
H. Define Sample Train

1. Impingers

	Normal	Initial	Final	Difference
No. 1	150 ml.	100	352	252
(tip) No. 2	150 ml.	100	202	102
No. 3	Dry	0	34	34
No. 4	Silica Gel	595	611	16
				404

2. Probe Length

3. Special:



GAS SAMPLING FIELD DATA

Material Sampled for SO<sub>2</sub> 10/2  
Date 12-16-71  
Plant STD oil Location El Segundo  
Bar. Pressure 30.4 "Hg Stack Temperature \_\_\_\_\_ °F  
Ambient Temp. 55° °F Stack Dimensions \_\_\_\_\_  
Run No. 4  
Power Stat Setting Max  
Filter Used: Yes    No     
Operator Shuttle

CLOCK TIME	METER (Ft. <sup>3</sup> )	FLOW METER SETTING (CFH)	METER TEMPERATURE IN
1818	10,735		57
23	757		58
28	800		57
33	828		56
38	853		55
43	902		55
48	938		55

Impingers with \_\_\_\_\_ ml of \_\_\_\_\_  
Impingers with \_\_\_\_\_ ml of \_\_\_\_\_  
Total number of Impingers \_\_\_\_\_  
Sample Bottle No. 4-51  
Impinger Bucket No. \_\_\_\_\_  
Meter Box No. \_\_\_\_\_

GAS SAMPLING FIELD DATA

Material Sampled for SO<sub>2</sub> 20/2  
Date \_\_\_\_\_  
Plant \_\_\_\_\_ Location \_\_\_\_\_  
Bar. Pressure \_\_\_\_\_ "Hg Stack Temperature \_\_\_\_\_ °F  
Ambient Temp. \_\_\_\_\_ °F Stack Dimensions \_\_\_\_\_  
Run No. 4  
Power Stat Setting \_\_\_\_\_  
Filter Used: Yes    No     
Operator WHS

CLOCK TIME	METER (Ft. <sup>3</sup> )	FLOW METER SETTING (CFH)	METER TEMPERATURE IN
1853	11.004		55
58	073		56
1203	150		57
08	236		57
13	323		56
18	408		56
final	416		56

1 Impingers with 15 ml of 80% TPA (DISCAE)

2 Impingers with 15 ml of 3% H<sub>2</sub>O<sub>2</sub>

Total number of Impingers 7

Sample Bottle No. 151

Impinger Bucket No.  $4.33152 \times 10^{-5}$  lbs

Meter Box No. V5

OXIDES OF NITROGEN FIELD DATA

Date 12-16-71

Plant std Oil

Sample Collected By Shatto

Run No. 4

Power Stat Setting 7112

Field Data

4-N1    4-N2

Clock time	1745	1925		
Flask number	8	2		
Volume of flask less correction (liter)	2.083	2.092	12/16	
Pressure before sampling in Hg.	30.4 27.6 2.8	30.4 27.2 2.2	12/16	
Pressure after sampling in Hg.	-1 +	.75 -	12/17	
Flask temperature, °F	66	12	12/16	
Flask Lab Temp °F	66	66	12/17	
Remarks:	33.3 5.10 27.6	33.4 5.4 28.2	B.T 30.4	
Analysis mg.	0.55	0.51		

GAS SAMPLING FIELD DATA

Material Sampled for CO, CO<sub>2</sub>, O<sub>2</sub>

Date DEC 16, 1971

Plant Standard Oil, Calif. Location FEED LINE

Bar. Pressure 30.40 "Hg Stack Temperature                    °F

Ambient Temp. 60 °F Stack Dimensions                   

Run No. 4

Power Stat Setting                   

Filter Used: Yes        No X

Operator KELSO

CLOCK TIME	METER (Ft. <sup>3</sup> )	FLOW METER SETTING (CFH)	METER TEMPERATURE IN
3:30 PM	32.442	1.90	76°F
4:00 PM	33.321	1.90	74°F
4:30 PM	34.308	1.80	72°F
4:45 PM	34.712	1.80	72°F

Impingers with                    ml of                   

Impingers with                    ml of                   

Total number of Impingers                   

Sample Bottle No.                   

Impinger Bucket No.                   

Meter Box No.

ORSAT FIELD DATA

Location STANDARD OIL, CAYF Comments:  
 Date DEC 16, 1971  
 Time 5:30 PM  
 Operator KELSO ; FLIPPIN

	Test	(CO <sub>2</sub> ) Reading 1	(O <sub>2</sub> ) Reading 2	(CO) Reading 3
FLIPPIN	FEED LINE	12.0	13.2	21.4
	TEST #4	-0.0 <u>12.0 %</u>	-12.0 <u>1.2 %</u>	-13.2 <u>8.2 %</u>
KELSO	FEED LINE	10.6	11.6	19.5
	TEST #4	-0.0 <u>10.6 %</u>	-10.6 <u>1.0 %</u>	-11.6 <u>7.9 %</u>
KELSO	FEED LINE	10.8	11.9	20.2
	TEST #4	-0.0 <u>10.8 %</u>	-10.8 <u>1.1 %</u>	-11.9 <u>8.3 %</u>
KELSO	FEED LINE	11.0	12.1	20.1
	TEST #4	-0.0 <u>11.0 %</u>	-11.0 <u>1.1 %</u>	-12.1 <u>8.0 %</u>
KELSO	STACK	13.0	16.4	16.4
	TEST #4	-0.0 <u>13.0 %</u>	-13.0 <u>3.4 %</u>	-16.4 <u>0.0 %</u>
KELSO	STACK	13.2	17.2	17.2
	TEST #4	-0.0 <u>13.2 %</u>	-13.2 <u>4.0 %</u>	-17.2 <u>0.0 %</u>
KELSO	STACK	12.7	16.3	16.3
	TEST #4	-0.0 <u>12.7 %</u>	-12.7 <u>3.6 %</u>	-16.3 <u>0.0 %</u>
Flippin	Stack test #4	13.2 -0 <u>13.2 %</u>	17.2 -13.2 <u>4.0 %</u>	17.2 -17.2 <u>0.0 %</u>

APPENDIX E

STANDARD SAMPLING PROCEDURES

The sampling procedures are those specified in the attached  
Federal Register of 17 August 1971.

METHOD 1—SAMPLE AND VELOCITY TRAVERSSES  
STATIC SOUR

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

New Source Performance Standards. 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 a rectangular cross section, determine an equivalent diameter from the following equation:

$$\text{equivalent diameter} = 2 \left[ \frac{(\text{length})(\text{width})}{\text{length} + \text{width}} \right]$$

equation 1-1

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

NUMBER OF DUCT DIAMETERS UPSTREAM\*  
(DISTANCE A)

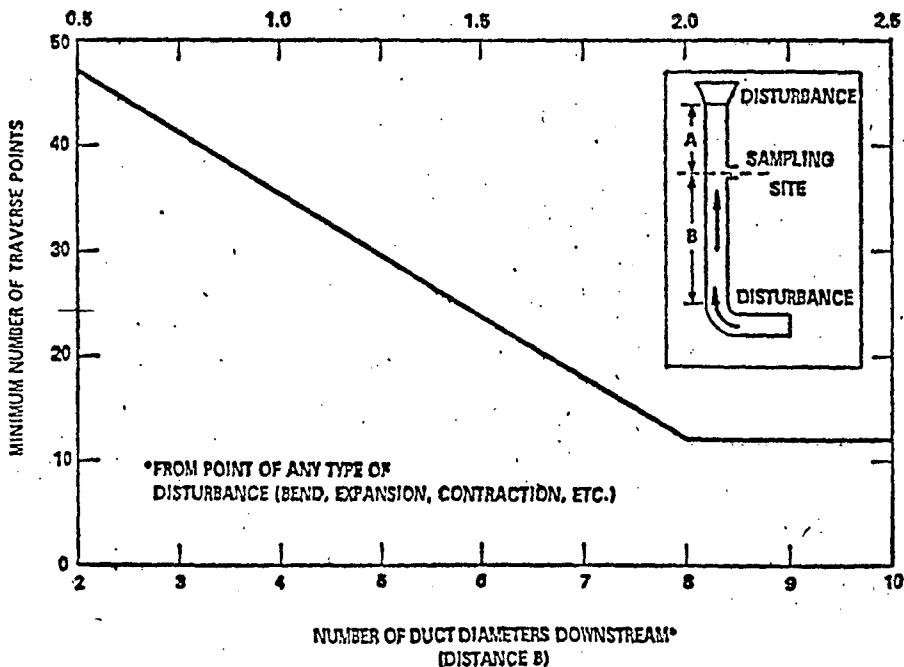


Figure 1-1. Minimum number of traverse points.

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 1-2 to determine the minimum number of traverse points.

2.1.4 To use Figure 1-2 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 four, 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 two perpendicular diameters according to Figure 1-2 and Table 1-1.

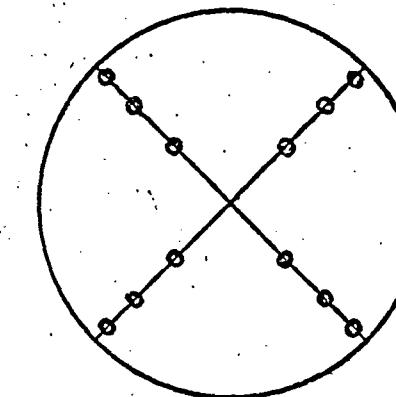


Figure 1-2. Cross section of circular stack showing location of traverse points on perpendicular diameters.

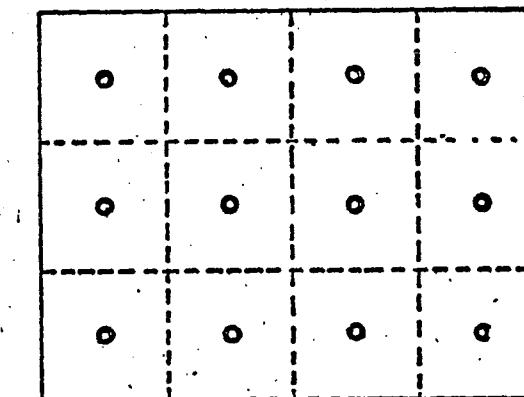


Figure 1-3. Cross section of rectangular stack divided into 12 equal areas, with traverse points at centroid of each area.

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									
	6	8	10	12	14	16	18	20	22	24
1	4.4	3.3	2.5	2.1	1.8	1.6	1.4	1.3	1.1	1.1
2	14.7	10.5	8.2	6.7	5.7	4.9	4.4	3.9	3.5	3.2
3	29.5	19.4	14.6	11.8	9.9	8.5	7.5	6.7	6.0	5.5
4	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	75.0	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	

100

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, 1957.

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

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

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

#### METHOD 2—DETERMINATION OF STACK GAS VELOCITY (TYPE S PITOT TUBE)

##### 1. Principle and applicability.

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

1.2 Applicability. This method should be applied only when specified by the test procedures for determining compliance with New Source Performance Standards. Being a directional instrument, a pitot tube should

not be used in the case of nondirectional flow.

##### 2. Apparatus.

2.1 Pitot tube—Type S (Figure 2-1), or equivalent.

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

2.3. Temperature gauge—Thermocouples, bimetallic thermometers, liquid filled systems, or equivalent, to measure stack temperature to within 1.5 percent 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 at the traverse points specified by Method 1.

3.2 Measure the temperature of the stack gas. If the total temperature variation with time is less than 50° F., a point measurement will suffice. Otherwise, conduct a temperature traverse.

3.3 Measure the static pressure in the stack.

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

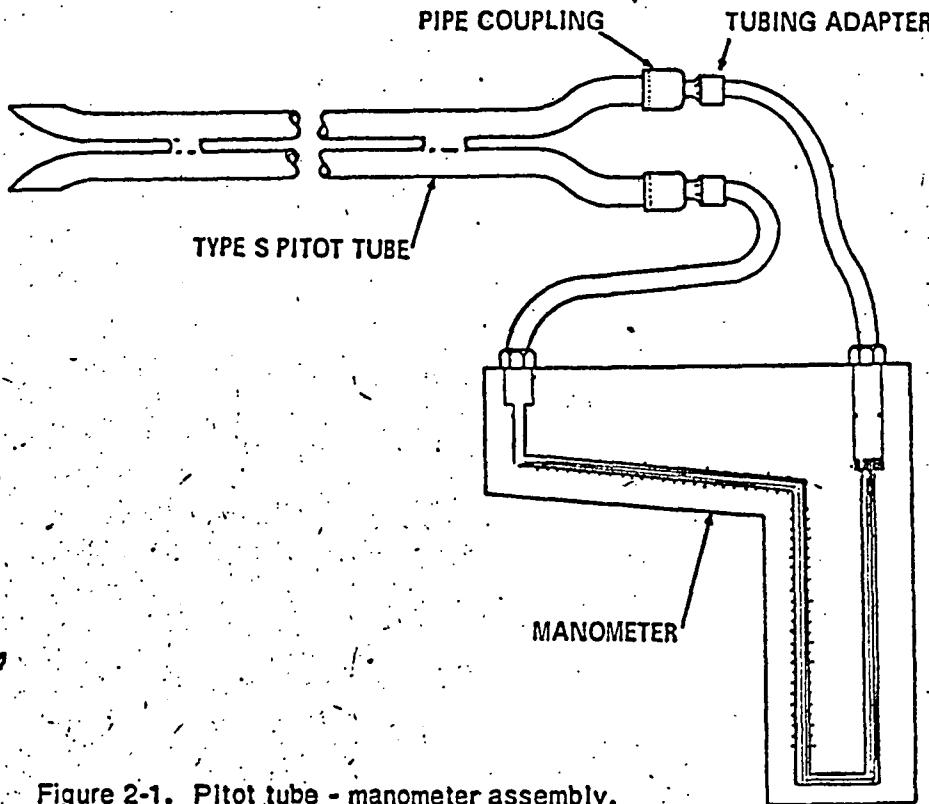


Figure 2-1. Pitot tube - manometer assembly.

a standard type pitot tube with known coefficient. The velocity of the flowing gas stream should be within the normal working range.

## PROPOSED RULE MAKING

15711

**4.2 Calculate the pitot tube coefficient using Equation 2-1.**

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

where:

$C_{P_{\text{test}}}$ =Pitot tube coefficient of Type S pitot tube.

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

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

$\Delta P_{\text{test}}$ =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.

$$V_s = K_p C_p \sqrt{\frac{T_s \Delta p}{P_m}} \quad \text{equation 2-2}$$

where:

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

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

$C_p$ =Pitot tube coefficient, dimensionless.

$T_s$ =Absolute stack gas temperature, °R.

$\Delta p$ =Velocity head of stack gas, in  $H_2O$  (see fig. 2-2).

$P_m$ =Absolute stack gas pressure, in Hg.

$M_s$ =Molecular weight of stack gas, lb./lb.-mole.

PLANT \_\_\_\_\_

DATE \_\_\_\_\_

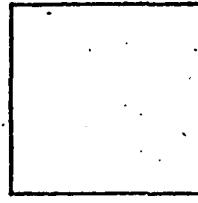
RUN NO. \_\_\_\_\_

STACK DIAMETER, in. \_\_\_\_\_

BAROMETRIC PRESSURE, in. Hg. \_\_\_\_\_

STATIC PRESSURE IN STACK ( $P_g$ ), in. Hg. \_\_\_\_\_

OPERATORS \_\_\_\_\_



SCHEMATIC OF STACK  
CROSS SECTION

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

Figure 2-2. Velocity traverse data.

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.

### 6. References.

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

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

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

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

Vennard, J. K. Elementary Fluid Mechanics. John Wiley and Sons, Inc., New York, 1947.

### ~~METHOD 3—GAS ANALYSIS FOR CARBON DIOXIDE EXCESS AIR AND PYREX 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 New Source Performance Standards.

#### 2. Apparatus.

##### 2.1 Grab sample (Figure 3-1).

2.1.1 Probe—Stainless steel or Pyrex 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.

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

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

2.2.2 Air-cooled condenser—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 c.f.m.

2.2.6 Flexible bag—T Tedlar, 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. Place the probe in the stack at a sampling point and purge the sampling line.

<sup>1</sup> Trade name.

## PROPOSED RULE MAKING

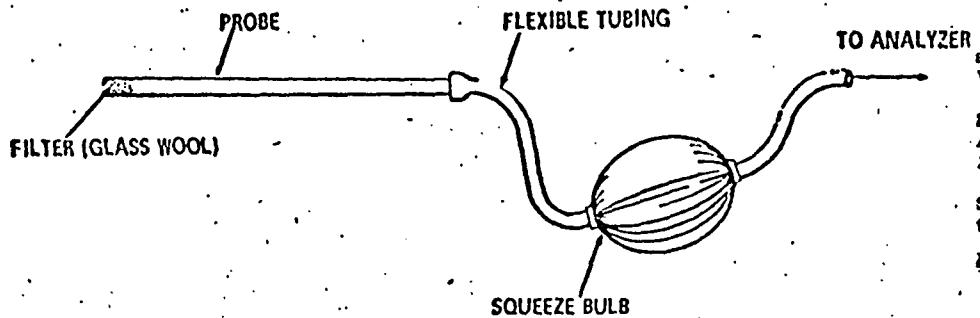


Figure 3-1. Grab-sampling train.

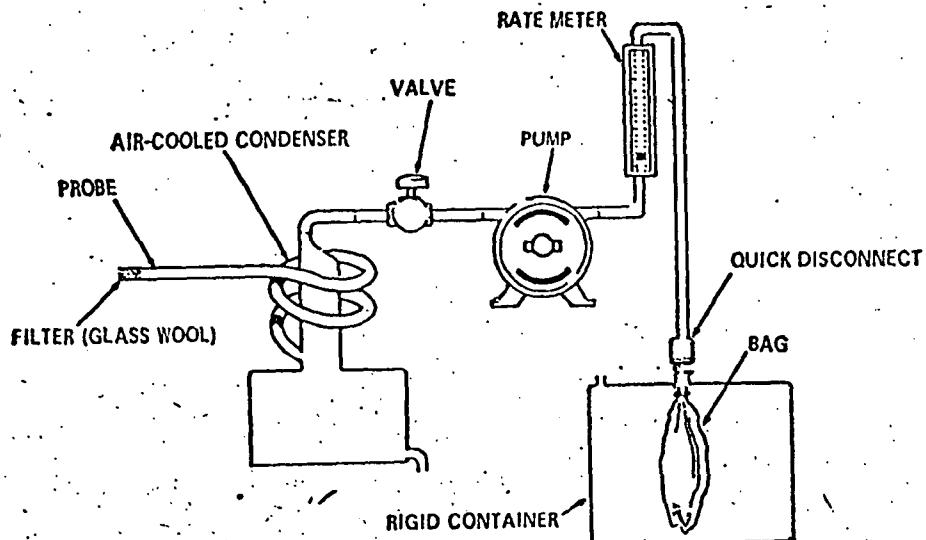


Figure 3-2. Integrated gas - sampling train.

## 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 gas velocity.

## 3.3 Analysis.

3.3.1 Determine the CO<sub>2</sub>, O<sub>2</sub>, and CO concentrations as soon as possible. Make as many passes as are necessary to give constant readings. If more than 10 passes are necessary, replace the absorbing solution.

3.3.2 For integrated sampling, repeat the analysis until three consecutive runs 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 result to the nearest 0.1 percent CO<sub>2</sub>.

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

$$\% EA =$$

$$\frac{(\% O_2) - 0.5(\% CO)}{0.264(\% N_2) - (\% O_2) + 0.5(\% CO)} \times 100$$

equation 3-1

where:

%EA=Percent excess air.  
 %O<sub>2</sub>=Percent oxygen by volume, dry basis.  
 %N<sub>2</sub>=Percent nitrogen by volume, dry basis.  
 %CO=Percent carbon monoxide by volume, dry basis.  
 0.264=Ratio of oxygen to nitrogen in air by volume.

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

$$M_d = 0.44(\% CO_2) + 0.32(\% O_2) + 0.28(\% N_2 + \% CO)$$

Equation 3-2

where:

M<sub>d</sub>=Dry molecular weight, lb./lb.-mole.  
 %CO<sub>2</sub>=Percent carbon dioxide by volume, dry basis.  
 %O<sub>2</sub>=Percent oxygen by volume, dry basis.  
 %N<sub>2</sub>=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 divided by 100.

## 5. References

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

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

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

METHOD 4—DETERMINATION OF MOISTURE IN STACK GAS<sup>1</sup>

## 1. Principle and applicability.

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

1.2 Applicability. This method is applicable for the determination of moisture in stack gas only when specified by test procedures for determining compliance with New Source Performance Standards. This method does not apply when liquid droplets are present in the gas stream.<sup>2</sup>

Other methods such as drying tubes, wet bulb-dry bulb techniques, and volumetric condensation techniques may be used subject to the approval of the Administrator.

## 2. Apparatus.

2.1 Probe—Stainless steel or Pyrex<sup>1</sup> glass sufficiently heated to prevent condensation and equipped with a filter to remove particulate matter.

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

2.3 Ice bath container—to condense moisture in impingers.

2.4 Silica gel tube—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 percent of the total sample volume.

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

2.9 Balance—Capable of measuring to the nearest 0.1 g.

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

2.11 Pilot 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 about 5 ml. distilled water in each impinger and weigh the impinger and contents to the nearest 0.1 g. 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 percent 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 not to exceed 0.075 c.f.m. Continue sampling until the dry gas meter registers 1 cu. ft. or until visible liquid droplets are carried over from the first impinger to the second. Record temperature, pressure, and dry gas meter reading as required by Figure 4-2.

3.3 After collecting the sample, weigh the impingers and their contents again to the nearest 0.1 g.

<sup>1</sup> Trade name.

<sup>2</sup> If liquid droplets are present in the gas stream, assume the stream to be saturated, determine the average stack gas temperature (Method 1), and use a psychrometric chart to obtain an approximation of the moisture percentage.

**4. Calculations.****4.1 Volume of water collected.**

$$V_{w0} = \frac{(W_f - W_i) RT_{std}}{P_{std} M_w}$$

$$(1.0474 \frac{\text{ft}^3}{\text{g.}})(W_f - W_i)$$

equation 4-1

where:

 $V_{w0}$  = Volume of water vapor collected (standard conditions), cu. ft. $W_f$  = Final weight of impingers and contents, g. $W_i$  = Initial weight of impingers and contents, g. $R$  = Ideal gas constant, 21.83-in. Hg-cu. ft./lb. mole-°R. $T_{std}$  = Absolute temperature at standard conditions, 530° R. $P_{std}$  = Pressure at standard conditions, 29.92 in. Hg. $M_w$  = Molecular weight of water, 18 lb./lb. mole.**4.2 Gas volume.**

$$V_{m0} = V_m \left( \frac{P_m}{P_{std}} \right) \left( \frac{T_{std}}{T_m} \right) = \\ (17.71 \frac{\text{°R}}{\text{in. Hg}}) \frac{V_m P_m}{T_m}$$

equation 4-2

where:

 $V_m$  = 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, in. Hg. $P_{std}$  = Pressure at standard conditions, 29.92-in. Hg. $T_{std}$  = Absolute temperature at standard conditions, 530° R. $T_m$  = Absolute temperature at meter (°F.+460), °R.**4.3 Moisture content.**

$$B_{w0} = \frac{V_{w0}}{V_{w0} + V_{m0}} + B_{wm} = \frac{V_{w0}}{V_{w0} + V_m} + (0.025)$$

equation 4-3

where:

 $B_{w0}$  = Proportion by volume of water vapor in the gas stream, dimensionless. $V_{w0}$  = Volume of water vapor collected (standard conditions), cu. ft. $V_m$  = 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. 899-Ap-40, 1967.

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

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

**METHOD 5—DETERMINATION OF PARTICULATE EMISSIONS FROM STATIONARY SOURCES****1. Principle and applicability.**

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

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

**2. Apparatus.**

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

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

2.1.2 Probe—Pyrex glass with a heating system capable of maintaining a gas temperature of 250° F. at the exit end during sampling. When temperature or length limitations are encountered, 316 stainless steel, or equivalent, may be used, as approved by the Administrator.

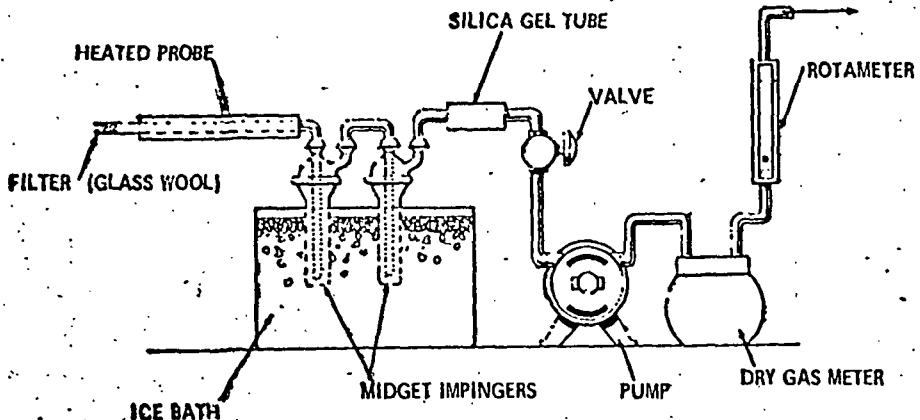


Figure 4-1. Moisture-sampling train.

LOCATION	COMMENTS
TEST	
DATE	
OPERATOR	
BAROMETRIC PRESSURE	

CLOCK TIME	GAS VOLUME THROUGH METER, ( $V_m$ ). $\text{ft}^3$	ROTAMETER SETTING, $\text{ft}^3/\text{min}$	METER TEMPERATURE, °F

Figure 4-2. Field moisture determination.

## PROPOSED RULE MAKING

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

2.1.4 Filter holder—Pyrex<sup>1</sup> glass with heating system capable of maintaining any temperature to a maximum of 225° F.

2.1.5 Impingers—Four impingers connected in series with glass ball joint fittings. The first, third, and fourth impingers are of the Greenburg-Smith design, modified by re-

placing the tip with a  $\frac{1}{2}$ -inch ID glass tube extending to  $\frac{1}{2}$ -inch from the bottom of the flask. The second impinger is of the Greenburg-Smith design with the standard tip.

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

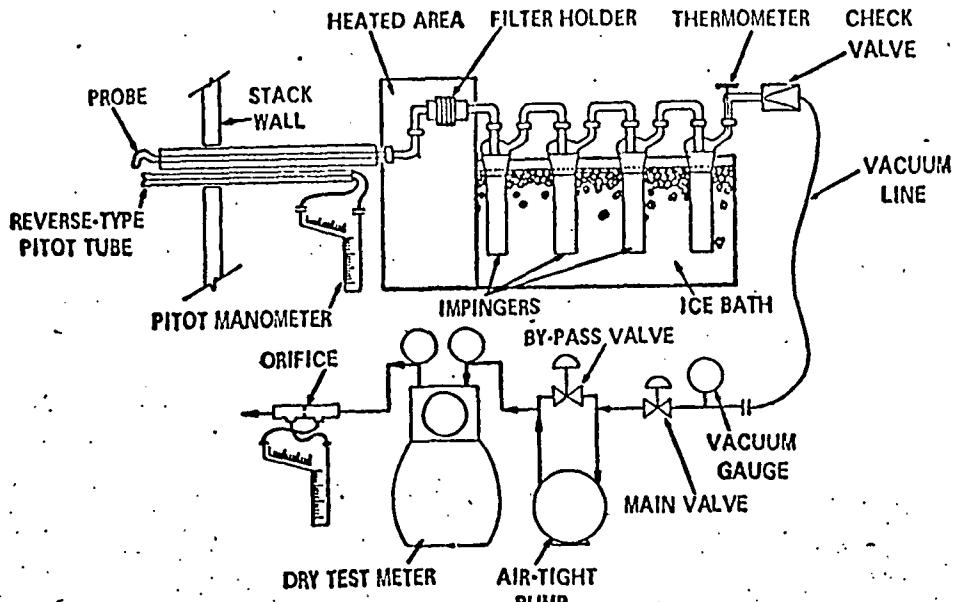


Figure 5-1. Particulate-sampling train.

2.1.7 Barometer—to measure atmospheric pressure to  $\pm 0.1$  in. 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  $\pm 0.1$  mg.

2.3.4 Beakers—250 ml.

2.3.5 Separatory funnels—500 ml. and 1,000 ml.

2.3.6 Trip balance—300 g. capacity, to measure to  $\pm 0.05$  g.

2.3.7 Graduated cylinder—25 ml.

3. Reagents.

3.1 Sampling

3.1.1 Filters—Glass fiber, MSA 1106 BH, or equivalent, numbered for identification and preweighed.

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

3.1.3 Water—Deionized, distilled.

3.1.4 Crushed ice.

3.2 Sample recovery

3.2.1 Water—Deionized, distilled.

3.2.2 Acetone—Reagent grade.

3.3 Analysis

3.3.1 Water—Deionized, distilled.

3.3.2 Chloroform—Reagent grade.

3.3.3 Ethyl ether—Reagent grade.

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

4. Procedure.

4.1 Sampling.

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

4.1.2 Preparation of collection train. Weigh to the nearest gram approximately 200 g. of silica gel. Label a filter of proper diameter, desiccate<sup>2</sup> for at least 24 hours and weigh to the nearest 0.5 mg. in a room where the relative humidity is less than 50 percent. 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. Save a portion of the water for use as a blank in the sample analysis. Set up the train without the probe as in Figure 5-1. Leak check the sampling train at the sampling site by plugging the inlet to the filter holder and pulling a 15-in. Hg vacuum. A leakage rate not in excess of 0.02 c.f.m. at a vacuum of 15-in. Hg is acceptable. Attach the probe and adjust the heater to provide a gas temperature of about 250° F. at the probe outlet. Turn on the filter heating system. Place crushed ice around the impingers. Add more ice during the run to keep the temperature of the gases leaving the last impinger at 70° F. or less.

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. 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.

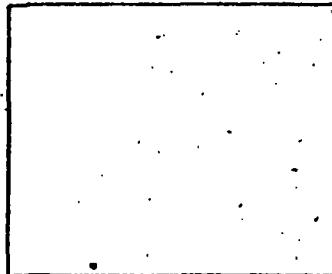
<sup>1</sup>Dry using Drierite<sup>1</sup> at 70°  $\pm$  10° F.

<sup>2</sup>Trade name.

## **PROPOSED RULE MAKING**

15715

**PLANT** \_\_\_\_\_  
**LOCATION** \_\_\_\_\_  
**OPERATOR** \_\_\_\_\_  
**DATE** \_\_\_\_\_  
**RUN NO.** \_\_\_\_\_  
**SAMPLE BOX NO.** \_\_\_\_\_  
**METER BOX NO.** \_\_\_\_\_  
**METER  $\Delta H_6$**  \_\_\_\_\_  
**C FACTOR** \_\_\_\_\_



## **SCHEMATIC OF STACK CROSS SECTION**

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

**Figure 5-2.** Particulate field data.

**4.2 Sample recovery.** Exercise care in moving the collection train from the test site to the sample recovery area to minimize the loss of collected sample or the gain of extraneous particulate matter. Set aside portions of the water and acetone used in the sample recovery as blanks for analysis. Place the samples in containers as follows:

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

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

Container No. 3 Measure the volume of water from the first three impingers and place the water in this container. Place water

rinsings of all sample-exposed surfaces between the filter and fourth impinger in this container prior to sealing.

Container No. 4. Transfer the silica gel from the fourth impinger to the original container and seal. Use a rubber policeman as an aid in removing silica gel from the impinger.

Container No. 5. Thoroughly rinse all sample-exposed surfaces between the filter and fourth impinger with acetone, place the washings in this container, and seal.

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

Container No. 1. Transfer the filter and any loose particulate matter from the sample container to a tared glass weighing dish, des-

sicate, and dry to a constant weight. Report results to the nearest 0.5 mg.

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

Container No. 3. Extract organic particulate from the Impinger solution with three 25 ml. portions of chloroform. Complete the extraction with three 25 ml. portions of ethyl ether. Combine the ether and chloroform extracts, transfer to a tared beaker and evaporate at 70° F. until no solvent remains. Desiccate, dry to a constant weight, and report the results to the nearest 0.5 mg.

Container No. 4. Weigh the spent silica gel and report to the nearest gram.

Evaporate the remaining H<sub>2</sub>O portion at 212°F. Desiccate the residue, dry to constant weight, and report the results to the nearest 0.5 mg.

## PROPOSED RULE MAKING

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

CONTAINER NUMBER	WEIGHT OF PARTICULATE COLLECTED, mg.		
	FINAL WEIGHT	TARE WEIGHT	WEIGHT GAIN
1			
2			
3a*			
3b**			
5			
TOTAL	X	X	X

\*3a - ORGANIC EXTRACT FRACTION.

\*\*3b - RESIDUAL WATER FRACTION.

	VOLUME OF LIQUID WATER COLLECTED	
	IMPIINGER 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.

Container No. 5. Transfer the acetone washings to a tared beaker and evaporate to dryness at ambient temperature and pressure. Desiccate, dry to a constant weight, and report the results to the nearest 0.5 mg.

## 5. Calibration.

Use standard methods and equipment approved by the Administrator to calibrate the orifice meter, pitot tube, dry gas meter, and probe heater.

## 6. Calculations.

## 6.1 Sample concentration method.

6.1.1 Average dry gas meter temperature. See data sheet (Figure 5-2).

6.1.2 Dry gas volume. Correct the sample

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

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

equation 5-1

where:

$V_{m,\text{std}}$  = 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.

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

$T_m$  = Average dry gas meter temperature, °R.

$P_{\text{bar}}$  = Barometric pressure at the orifice meter, in. Hg.

$\Delta H$  = Pressure drop across the orifice meter, in. Hg.

13.6 = Specific gravity of mercury.

$P_{\text{std}}$  = Absolute pressure at standard conditions, 29.92 in. Hg.

## 6.1.3 Volume of Water vapor.

$$V_{w,\text{std}} = V_i \left( \frac{\rho_{H_2}O}{M_{H_2}O} \right) \left( \frac{RT_{\text{std}}}{P_{\text{std}}} \right) = \\ (0.0474 \frac{\text{cu. ft.}}{\text{ml.}}) V_i$$

equation 5-2

where:

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

$V_i$  = Total volume of liquid collected in impingers and silica gel (see Figure 5-3), ml.

$\rho_{H_2}O$  = Density of water, 1 g./ml.

$M_{H_2}O$  = Molecular weight of water, 18 lb./lb. mole.

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

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

$P_{\text{std}}$  = Absolute pressure at standard conditions, 29.92 in. Hg.

## 6.1.4 Total gas volume.

$$V_{\text{total}} = V_{m,\text{std}} + V_{w,\text{std}}$$

equation 5-3

where:

$V_{\text{total}}$  = Total volume of gas sample (standard conditions), cu. ft.

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

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

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

## 6.1.6 Concentration.

$$c' = \left( 0.0154 \frac{\text{gr.}}{\text{mg.}} \right) \left( \frac{M_n}{V_{\text{total}}} \right)$$

equation 5-4

where:

$c'$  = Concentration of particulate matter in stack gas (Sample Concentration Method), gr./s.c.f.

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

$V_{\text{total}}$  = Total volume of gas sample (standard conditions), cu. ft.

## 6.2 Ratio of area method.

6.2.1 Stack gas velocity. Collect the necessary data as detailed in Method 2. Correct the

stack gas velocity to standard conditions (29.92 in. Hg, 53° R.) as follows:

$$V_{std} = V_s \left( \frac{P_s}{P_{std}} \right) \left( \frac{T_{std}}{T_s} \right)$$

$$(17.71 \text{ in. Hg}) \left( \frac{V_s}{T_s} \right) \quad \text{equation 5-5}$$

where:

$V_{std}$  = Stack gas velocity at standard conditions, ft./sec.

$$c_s = \frac{M_s A_s}{Q_s} = \frac{\theta}{A_s V_{std}} = \left( 2.57 \times 10^{-4} \frac{\text{gr. = min.}}{\text{mg. = sec.}} \right) \left( \frac{M_s}{\theta V_{std} A_s} \right) \quad \text{equation 5-6}$$

where:

$c_s$  = Concentration of particulate matter in the stack gas (Ratio of Area Method), gr./s.c.f.

$M_s$  = Particulate mass flow rate through the stack (standard conditions), mass/time.

$Q_s$  = Volumetric flow rate of gas stream through the stack (standard conditions), volume/time.

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

$$\left( 1.667 \frac{\text{min.}}{\text{sec.}} \right) \left[ \left( 0.00267 \frac{\text{in. Hg-cu. ft.}}{\text{ml. }^{\circ}\text{R.}} \right) V_{std} + \frac{V_s}{T_s} \left( P_{bar} + \frac{\Delta H}{13.6} \right) \right] T_s \quad \text{equation 5-7}$$

where:

$I$  = Percent of isokinetic sampling.

$C_s$  = Concentration of particulate matter in the stack gas (Ratio of Area Method), gr./s.c.f.

$C_s'$  = Concentration of particulate matter in the stack gas (Sample Concentration Method), gr./s.c.f.

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

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

$R$  = Ideal gas constant, 21.83 in. Hg-cu.

ft./lb. mole- $^{\circ}$ R.

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

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

$T_s$  = Absolute average dry gas meter temperature (see Figure 5-2),  $^{\circ}$ R.

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

$\Delta H$  = Average pressure drop across the orifice (see Figure 5-2), in  $H_2O$ .

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

$V_{std}$  = Stack gas velocity calculated by Method 2, Equation 2-2, ft./sec.

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

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

$T_{std}$  = Absolute temperature at standard conditions, 53° R.

$T_s$  = Absolute stack gas temperature (average),  $^{\circ}$ R.

### 6.2.2 Concentration.

$c_s'$  = Concentration of particulate matter in the stack gas (Sample Concentration Method), gr./s.c.f.

### 7. References.

Addendum to Specifications for Incinerator Testing at Federal Facilities. PHS, NCAPO. 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, 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, NCAPO. 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, and the acid mist including sulfur trioxide is separated from the sulfur dioxide. The sulfur dioxide fraction is measured by the barium-thorin titration method.

#### 1.2 Applicability. This method is applicable

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

#### 2. Apparatus.

2.1 Sampling. See Figure 6-1

2.1.1 Probe—Pyrex glass, approximately 5-6 mm. ID, with a heating system to prevent condensation and a filter 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 Pump—Leak-free, vacuum type.

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

2.1.8 Dry gas meter—Sufficiently accurate to measure the sample volume within 1 percent.

2.1.9 Pitot tube—Type S, or equivalent, necessary only if a sample traverse is required or if stack gas velocity varies with time.

#### 2.2 Sample recovery.

2.2.1 Glass wash bottles—Two.

2.2.2 Polyethylene storage bottles—to store impinger samples.

#### 2.3 Analysis.

1 Trade name.

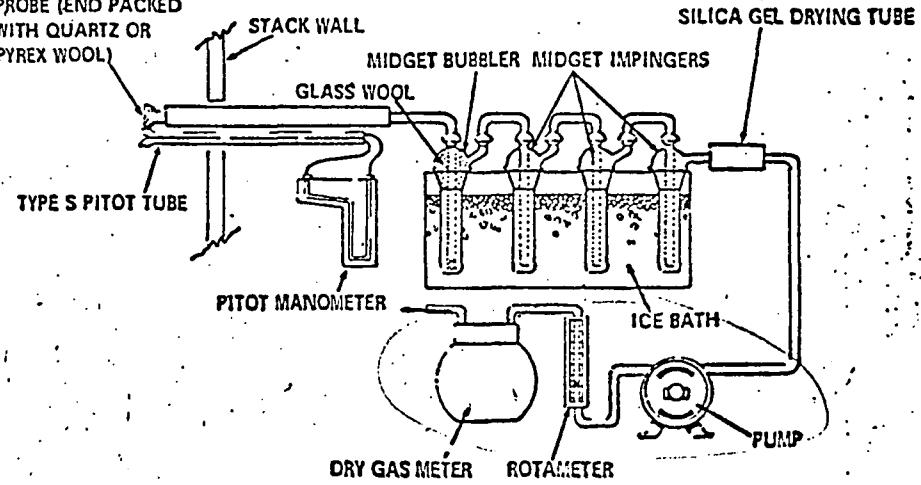


Figure 6-1.  $\text{SO}_2$  sampling train.

## PROPOSED RULE MAKING

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 percent—Mix 80 ml. of isopropanol with 20 ml. of distilled water.

3.1.3 Hydrogen peroxide, 3 percent—dilute 100 ml. of 30 percent hydrogen peroxide with 900 ml. of distilled water. Prepare fresh daily.

3.2 Sample recovery.

3.2.1 Water—Deionized, distilled.

3.2.2 Isopropanol, 80 percent.

3.3 Analysis.

3.3.1 Water—Deionized, distilled.

3.3.2 Isopropanol.

3.3.3 Thorin indicator—1-(o-nitrophenylazo)-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(ClO<sub>4</sub>)<sub>2</sub>·3H<sub>2</sub>O] in 200 ml. distilled water and dilute to 1 liter with isopropanol. Standardize with sulfuric acid.

3.3.5 Sulfuric acid standard (0.01*N*)—Purchase or standardize against a primary standard to  $\pm 0.0002N$ .

4. Procedure.

4.1 Sampling.

4.1.1 Preparation of collection train. Pour 15 ml. of 80 percent isopropanol into the midget bubbler and 15 ml. of 3 percent hydrogen peroxide to 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-in. Hg vacuum. A leakage rate not in excess of 1 percent 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 as velocity. Take readings at least every 5 minutes and when significant changes in stack conditions necessitate additional adjustments in flow rate. To begin sampling, position the nozzle with the tip pointing directly into the gas stream 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 the purging period. 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 to a 125-ml. erlenmeyer flask. Add 40 ml. of isopropanol and 2 to 4 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 approved by the Administrator to calibrate the orifice meter, pitot tube, dry gas meter, and probe heater.

5.2 Standardize the sulfuric acid with potassium acid phthalate as a primary standard. Standardize the barium perchlorate with 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 in. Hg) by using Equation 6-1.

$$V_{m_{std}} = V_m \left( \frac{T_{std}}{T_m} \right) \left( \frac{P_{bar}}{P_{std}} \right) = \\ (17.71 \frac{\text{°R}}{\text{in. Hg}}) \frac{V_m P_{bar}}{T_m} \quad \text{equation 6-1}$$

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, in. Hg.

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

6.2 Sulfur dioxide concentration.

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

where:

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

$7.05 \times 10^{-5}$ =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.

$V_{t_b}$ =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, 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.

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 SO<sub>x</sub> and SO<sub>2</sub> in Flue Gases. Journal of the Institute of Fuel 24:237-243, 1961.

Matty, R. E. and E. K. Diehl. Measuring Flue-Gas SO<sub>x</sub> and SO<sub>2</sub>. Power 101:94-97, November 1957.

Patterson, W. F. and J. A. Brink, Jr. New Equipment and Techniques for Sampling Chemical Process Gases. Paper presented at the 55th Annual Meeting of APCA. Chicago, Ill. May 20-24, 1962.

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 measured 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—Pyrex<sup>1</sup> 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<sup>1</sup> round bottom with short neck and 24/40 standard taper opening, protected against implosion or breakage.

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-in. 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-in. 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.

<sup>1</sup> Trade name.

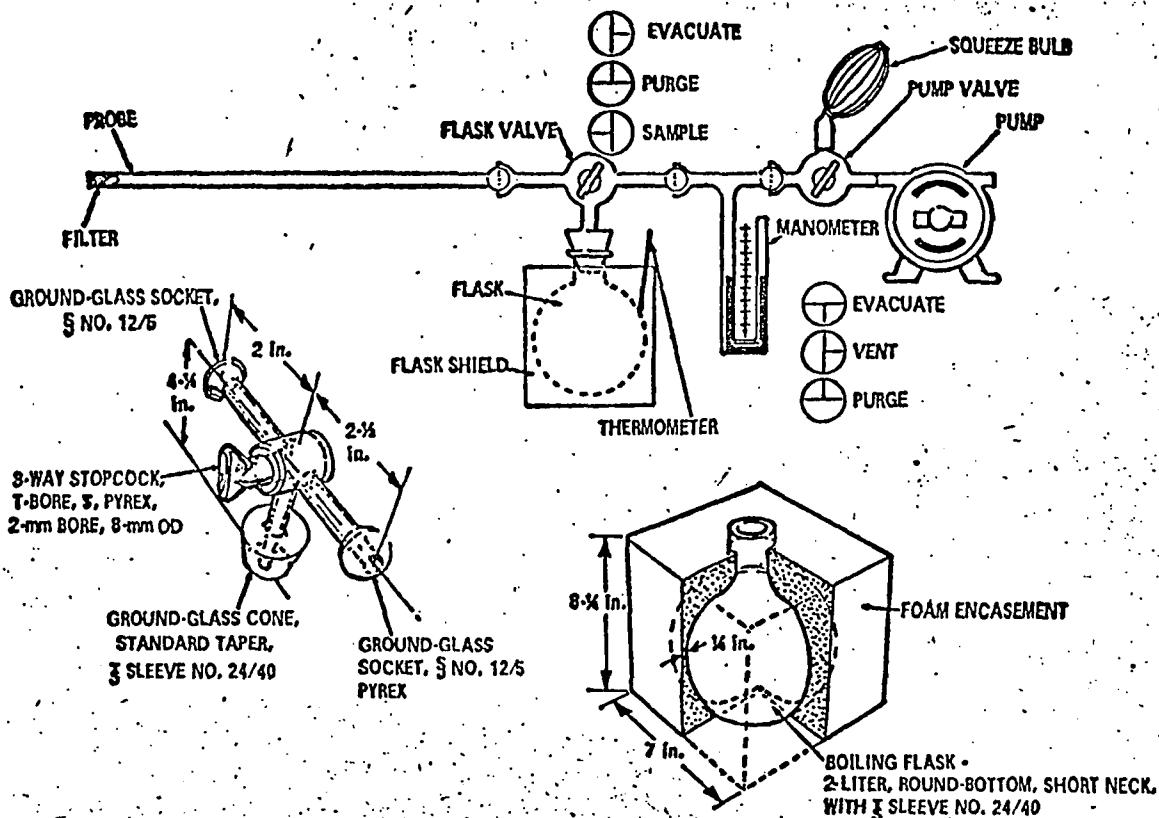


Figure 7-1. Sampling train, flask valve, and flask.

## 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 m $\mu$ .

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<sub>2</sub>SO<sub>4</sub> 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 18N 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<sub>3</sub>) 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  $\mu$ 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" positions. Evacuate the flask to at least 3-in. 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 1 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 sit for a minimum of 16 hours and then shake the contents for 2 minutes. Connect the flask to a mercury filled U-tube manometer, open the valve from the flask to the 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 water (approximately 10 ml.) and add to the same amount of rinse water as in the sample. For a blank use 25 ml. of absorbing solution and the solution in a container for shipment or in a 250-ml. beaker for analysis. 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 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. water and 4 drops of concentrated sulfuric acid. Heat the solution on a steam bath for 3 minutes with occasional stirring. Cool, add 20 ml. 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 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 m $\mu$  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  $\pm 10$

## APPENDIX F

### LABORATORY REPORT

This section presents the report on particulate analyses which were performed in the MRI Laboratory. The analytical data for the SO<sub>2</sub> analyses were presented in Table B-II.

## PARTICULATE ANALYSIS

RUN NO. 1Impinger H<sub>2</sub>O:

Volume after sampling	<u>692</u> ml	Ether-chloroform extraction	
Impinger prefilled with	<u>200</u> ml	of impinger water	<u>225.79</u> mg
Volume collected	<u>492</u> ml	Impinger water residue	<u>43.17</u> mg

Impingers and back half of filter, acetone wash:	Weight results	<u>167.72</u> mg
--	----------------	------------------

Dry probe and cyclone catch:	Weight results	<u>0</u> mg
------------------------------	----------------	-------------

Probe, cyclone, flask, and front half of filter, acetone wash:	Weight results	<u>93.53</u> mg
--	----------------	-----------------

## Filter Papers and Dry Filter Particulate

<u>Filter No.</u>	<u>Container No.</u>
-------------------	----------------------

<u>51</u>	<u>1051</u>
-----------	-------------

Filter particulate weight	<u>134.32</u> mg
Total particulate weight	<u>664.53</u> mg

## Silica gel (approx. 200 g) + container

Weight after test:	<u>615</u>
Weight before test:	<u>590</u>
Moisture weight collected:	<u>25</u>

Sample No. 1

Analyze for: Particulate weight.

Method determination: Specified in Federal Register.

Comments: Acetone blank of 1.10 mg should be subtracted from total particulate weight.

All other blanks were zero.

## PARTICULATE ANALYSIS

RUN NO. 2Impinger H<sub>2</sub>O:

Volume after sampling	<u>1,020</u> ml	Ether-chloroform extraction
Impinger prefilled with	<u>400</u> ml	of impinger water <u>112.48</u> mg
Volume collected	<u>620</u> ml	Impinger water residue <u>303.73</u> mg

Impingers and back half of filter, acetone wash: Weight results 9.90 mgDry probe and cyclone catch: Weight results 0 mgProbe, cyclone, flask, and front half of filter, acetone wash: Weight results 88.03 mg

## Filter Papers and Dry Filter Particulate

<u>Filter No.</u>	<u>Container No.</u>	
<u>52</u>	<u>1052</u>	
<u>53</u>	<u>1053</u>	Filter particulate weight <u>124.66</u> mg
		Total particulate weight <u>638.80</u> mg

## Silica gel (approx. 200 g) + container

Weight after test:	<u>629</u>
Weight before test:	<u>604</u>
Moisture weight collected:	<u>25</u>

Sample No. 2

Analyze for: Particulate weight.

Method determination: Specified in Federal Register.

Comments: Acetone blank of 1.82 mg should be subtracted from total particulate weight.

All other blanks were zero.

## PARTICULATE ANALYSIS

RUN NO. 3Impinger H<sub>2</sub>O:Volume after sampling 483 ml

Ether-chloroform extraction

Impinger prefilled with 200 mlof impinger water 15.54 mgVolume collected 283 mlImpinger water residue 24.36 mgImpingers and back half of filter, acetone wash: Weight results 7.72 mgDry probe and cyclone catch: Weight results 0 mgProbe, cyclone, flask, and front half of filter, acetone wash: Weight results 59.62 mg

## Filter Papers and Dry Filter Particulate

Filter No.Container No.541054Filter particulate weight 49.80 mgTotal particulate weight 157.04 mg

## Silica gel (approx. 200 g) + container

Weight after test: 619.5Weight before test: 606Moisture weight collected: 13.5Sample No. 3

Analyze for: Particulate weight.

Method determination: Specified in Federal Register.

Comments: All other blanks were zero.

## PARTICULATE ANALYSIS

RUN NO. 4Impinger H<sub>2</sub>O:

Volume after sampling	588	ml	Ether-chloroform extraction		
Impinger prefilled with	200	ml	of impinger water	90.94	mg
Volume collected	388	ml	Impinger water residue	288.09	mg

Impingers and back half of filter, acetone wash:	Weight results	11.58	mg
--	----------------	-------	----

Dry probe and cyclone catch:	Weight results	0	mg
------------------------------	----------------	---	----

Probe, cyclone, flask, and front half of filter, acetone wash:	Weight results	131.36	mg
--	----------------	--------	----

## Filter Papers and Dry Filter Particulate

<u>Filter No.</u>	<u>Container No.</u>
55	1055
_____	_____
_____	_____
_____	_____

Filter particulate weight	97.49	mg
Total particulate weight	619.46	mg

## Silica gel (approx. 200 g) + container

Weight after test:	611
Weight before test:	595
Moisture weight collected:	16

Sample No. 4Analyze for: Particulate weight.Method determination: Specified in Federal Register.Comments: All other blanks were zero.

APPENDIX G

TEST LOG

Table G-I presents the actual time during which each sampling was conducted.

TABLE G-I

SAMPLING LOG

<u>Run</u>	<u>Location</u>	<u>Pollutant</u>	<u>Date</u>	<u>Began</u>	<u>Ended</u>	<u>Elapsed Time (min)</u>
1	Stack (W)	Particulates	12/14/71	3:05 p.m.	4:25 p.m.	
1	Stack (N)	Particulates	12/14/71	6:08 p.m.	7:28 p.m.	
1-N1	Stack (N)	NO <sub>x</sub>	12/14/71	5:50 p.m.		-
1F-M	Feed line	Moisture	12/14/71	12:00 p.m.	12:20 p.m.	20
1F-C	Feed line	Integrated	12/14/71	3:45 p.m.	4:55 p.m.	70
2 <sup>a/</sup>	Stack (W)	Particulates	12/15/71	10:55 a.m.	12:57 p.m.	
2 <sup>a/</sup>	Stack (N)	Particulates	12/15/71	2:58 p.m.	3:52 p.m.	
				5:06 p.m.	6:12 p.m.	
2-N1	Stack (N)	NO <sub>x</sub>	12/15/71	11:30 a.m.		-
2-N2	Stack (N)	NO <sub>x</sub>	12/15/71	12:15 p.m.		-
2-N3	Stack (W)	NO <sub>x</sub>	12/15/71	2:55 p.m.		-
2-N4	Stack (W)	NO <sub>x</sub>	12/15/71	5:15 p.m.		-
2-S1	Stack (W)	SO <sub>2</sub>	12/15/71	3:20 p.m.	4:20 p.m.	60
2F-M	Feed line	Moisture	12/15/71	10:30 a.m.	2:15 p.m.	225
2F-C	Feed line	Integrated	12/15/71	2:45 p.m.	4:00 p.m.	75
3	Stack (N)	Particulates	12/16/71	9:27 a.m.	10:27 a.m.	
3	Stack (W)	Particulates	12/16/71	11:01 a.m.	12:01 p.m.	
3-N1	Stack (W)	NO <sub>x</sub>	12/16/71	10:20 a.m.		-
3-N2	Stack (N)	NO <sub>x</sub>	12/16/71	11:10 a.m.		-
3-N3	Stack (N)	NO <sub>x</sub>	12/16/71	2:20 p.m.		-
3-S1	Stack (N)	SO <sub>2</sub>	12/16/71	11:50 a.m.	1:50 p.m.	120
3F-M	Feed line	Moisture	12/16/71	10:00 a.m.	3:00 p.m.	
3F-C	Feed line	Integrated	12/16/71	10:00 a.m.	11:20 a.m.	80
4	Stack (N)	Particulates	12/16/71	3:45 p.m.	4:45 p.m.	
4	Stack (W)	Particulates	12/16/71	5:32 p.m.	6:32 p.m.	
4-N1	Stack (W)	NO <sub>x</sub>	12/16/71	5:45 p.m.		-
4-N2	Stack (W)	NO <sub>x</sub>	12/16/71	7:25 p.m.		-
4-S1	Stack (W)	SO <sub>2</sub>	12/16/71	6:18 p.m.	7:18 p.m.	60
4F-C	Feed line	Integrated	12/16/71	3:30 p.m.	4:45 p.m.	75

a/ A filter change was required during this traverse.

APPENDIX H

PROJECT PARTICIPANTS AND TITLES

<u>Name</u>	<u>Title</u>
Paul Constant	Program Manager
Pat Shea	Project Chief
Ed Trompeter	Testing Engineer (particulates)
Bob Conkling	Testing Engineer (particulates)
Bob Stultz	Engineering Technician (particulates)
Henry Maloney	Engineering Technician (particulates)
Bill Shutts	Testing Engineer (stack gases)
Gary Kelso	Testing Engineer (feed line gases)
Reid Flippin	Field Laboratory Technician
Fred Bergman	Analytical Chemist
Mike Hammons	Laboratory Technician
Terry Howard	Laboratory Technician
Chatten Cowherd	Consultant