RAMCON ENVIRONMENTAL CORPORATION

RAMCON BUILDING 223 SCOTT STREET MEMPHIS, TENNESSEE 38112 TELEPHONE 901 / 458-7000 800 / 458-4567

SOURCE SAMPLING
for
PARTICULATE EMISSIONS
R.F. KLINE, INC.
FREDERICK, MARYLAND
September 9 & 10, 1986

Ken Bruchey

Ken Bruchey
R.F. Kline, Inc.

Sumner Buck

G. Sumner Buck, III
President

Ken Allmendinger

Ken Allmendinger
Team Leader

RAMCON ENVIRONMENTAL CORPORATION

RAMCON BUILDING 223 SCOTT STREET MEMPHIS, TENNESSEE 38112 TELEPHONE 901 / 458-7000 800 / 458-4567

September 26, 1986

RECEIVED

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AIR MANAGEMENT
ADMINISTRATION

Mr. Ken Bruchey
R.F. Kline, Inc.
P.O. Box 665
Frederick, MD 21701

Subject: Particulate Emissions Test - Frederick, MD

Dear Mr. Bruchey:

Enclosed are four copies of our report on the particulate, SO_2 and SO_3 emissions test we conducted at your plant. Based on our test results, your plant does pass both EPA New Source Performance Standards for particulates and those set by the State of Maryland for particulates, SO_2 and SO_3. The plant is operating in compliance with State and Federal Standards.

You will need to sign the report covers and send two copies to:

Mr. Craig Holdefer
Maryland Air Mangement
Air Pollution Control
P.O. Box 13387
Baltimore, MD 21203

You will need to keep one copy of the report at the plant. We certainly have enjoyed working with you and look forward to serving you again in the future.

Sincerely,

Sumner

G. Sumner Buck, III
President

GSBIII:kr

Enclosures

TABLE OF CONTENTS

I. INTRODUCTION

On September 9 & 10, 1986, personnel from RAMCON Environmental Corporation (REC) conducted a source emissions test for particulates, SO_2, SO_3 and H_2SO_4 (combined) emissions compliance at R.F. Kline's H & B batch mix asphalt plant located in Frederick, Maryland. RAMCON personnel conducting the test were Ken Allmendinger, Team Leader and Shawn Greenwood. Kim Rea was responsible for the final particulate laboratory analysis including taring the beakers and filters and recording final data in the laboratory record books. John Biggs was responsible for the SO_2 and SO_3 analysis. Custody of the samples were limted to Mr. Biggs, Mr. Allmendinger and Ms. Rea.

The purpose of the test was to determine if the rate of particulate and sulfur emissions from the plant's baghouse and the total contaminants by weight (grain loading) are below the limits set by US EPA N.S.P.S. and the State of Maryland.

II. TEST RESULTS

Table I summarizes the test results. The grain loading limitation for EPA is specified in 39 FR 9314, March 8, 1974, 60.92 Standards for Particulate Matter (1), as amended. The allowable particulate emissions for the State of Maryland are the same as those set by EPA. The SO_2 and SO_3 allowable emissions for the State of Maryland are 500 ppm for SO_2 and 35 mg/m^3 for SO_3.

Mr. Craig Holdefer from Maryland's Office of Environmental Mangement observed the testing conducted by RAMCON.

TABLE I

SUMMARY OF TEST RESULTS
September 9 & 10, 1986

Test Run	Time	Grain Loading	SO_2 Emissions	SO_3 Emissions
1	08:49 to 10:05	0.0396 gr/DSCF	26.6 ppm	65.3 mg/m^3
2	10:45 to 12:00	0.0396 gr/DSCF	42.6 ppm	8.5 mg/m^3
3	07:32 to 08:47	0.0321 gr/DSCF	20.8 ppm	10.9 mg/m^3
	Average:	0.0371 gr/DSCF	30 ppm	28.2 mg/m^3

On the basis of these test results, the average grain loading of the three test runs was below the .04 gr/DSCF emissions limitation set by EPA and the State of Maryland. The average SO_2 and SO_3 emissions was also below the allowable limits set by the State of Maryland. . Therefore, the plant is operating in compliance with Federal and State Standards.

III. TEST PROCEDURES

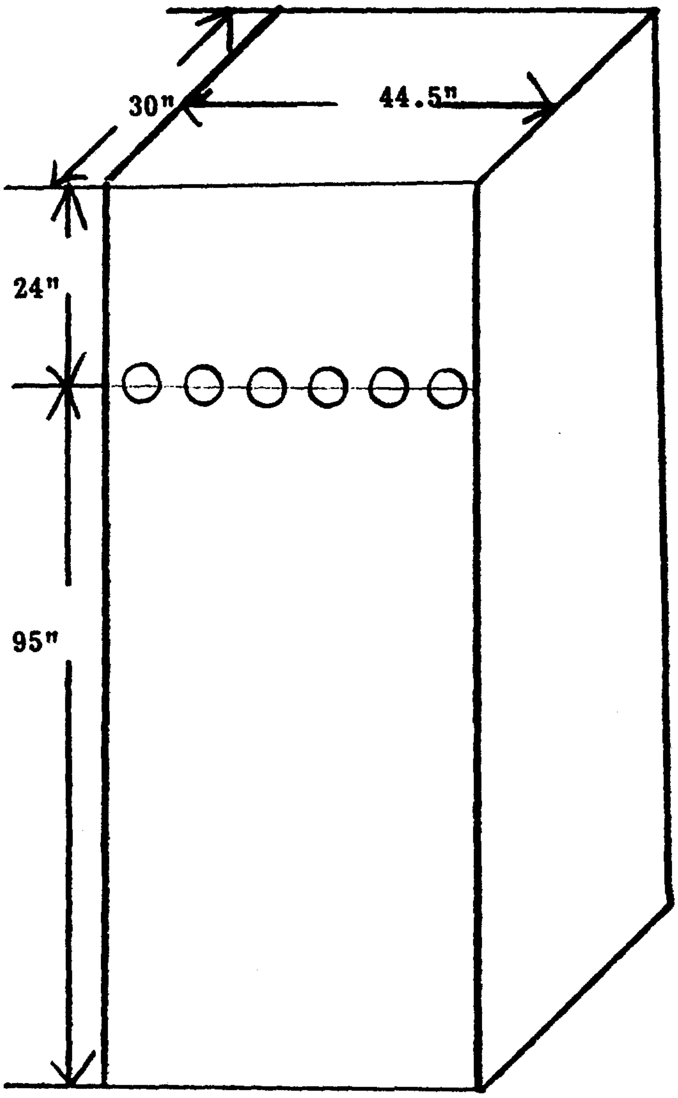
A. Method Used: The source sampling was conducted in accordance with requirements of the U.S. Environmental Protection Agency as set forth in 39 FR 9314, March 8, 1974, 60.93, as amended.

B. Problems Encountered: No problems were encountered that affected testing.

C. Sampling Site: The emissions test was conducted after a baghouse on a rectangular stack measuring 30" x 44.5" with an equivalent diameter of 35.8". Six sampling ports were placed 24" down (0.7 diameters upstream) from the top of the stack and 95" up (2.6 diameters downstream) from the last flow disturbance. Twenty four points were sampled, four through each port for three minutes each.

Points on a Diameter	Probe Mark
1	*9.8"
2	17.3"
3	24.8"
4	32.3"

* Measurements include a 6.0" standoff.



IV. THE SOURCE

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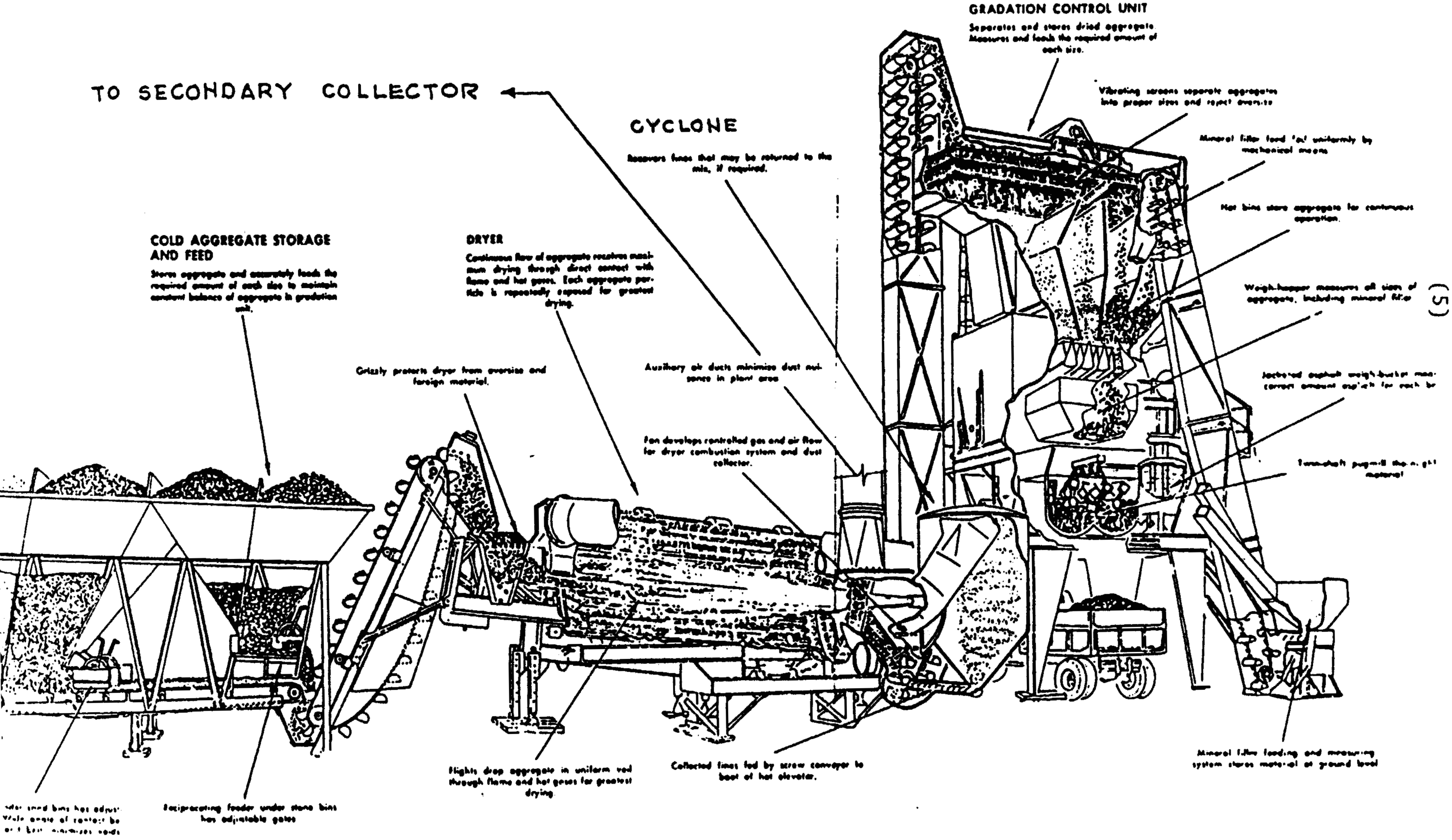
R.F. Kline, Inc. employs an H & B batch mix asphalt plant which is used to manufacture hot mix asphalt for road pavement. The process consists of blending prescribed portions of cold feed materials (sand, gravel, screenings, chips, etc.) uniformly and adding sufficient hot asphalt oil to bind the mixture together. After the hot asphalt mix is manufactured at the plant, it is transported to the location where it is to be applied. The hot asphalt mix is spread evenly over the surface with a paver and then compacted with a heavy roller to produce the final product.

The following is a general description of the plant's manufacturing process: The cold feed materials (aggregate) are dumped into four separate bins which in turn feed a common continuous conveyor. The aggregate is dispensed from the bins in accordance with the desired formulation onto the cold feed system conveyor to an inclined weigh conveyor then to a rotating drum for continuous mixing and drying at approximately 300°F. The dried aggregate is pulled by a bucket elevator to the top of a gradation control unit which separates and stores the aggregate by size. The required amount of each aggregate is dispensed into a weigh-hopper and from there, into a pugmill where the hot liquid asphalt is mixed thoroughly with the aggregate. The hot asphalt mix is then discharged from the storage silo through a slide gate into waiting dump trucks, which transport the material to a final destination for spreading. The rated capacity of the plant will vary with each aggregate mix and moisture content with a 5% surface moisture removal.

The drum dryer uses a burner fired with coal and propane to heat air to dry the aggregate. The air is drawn into the system via an exhaust fan. After passing through the burner and the mixing drum, the air passes through a baghouse. The baghouse is manufactured by H & B. The exhaust gasses are drawn through the baghouse and discharged to the atmosphere through the stack. The design pressure drop across the tube sheet is 1 - 6 inches of water. The particulate matter, which is removed by the baghouse is reinjected into the pugmill. The following sketch shows a typical batch mix asphalt plant.

Figure 4-1

ASPHALT BATCH MIX PLANT - AN EXPLODED VIEW



DATA SUMMARY

Plant

1. Manufacturer of plant H&B.

2. Designed maximum operating capacity 350 TPH @ ____ % moisture.

3. Actual operation rate 250-300 TPH @ ____ % moisture.

4. Startup date ____.

5. Type of fuel used in dryer Propane/Coal.

6. Quanity of fuel consumption Propane 3 gal/Ton; Coal 1 Ton coal/100 Ton Asphalt

Aggregate

7. Name/type of mix ST, SN, BC, BI.

8. Percent asphalt in mix 6,5 %.

9. Temperature of asphalt 330.

10. Sieve/Screening analysis: % Passing;

1"		3/8"		#	
3/4"		#		#	
1/2"		#		#200	

Baghouse

11. Manufacturer H&B.

12. No. of bags 756. Type of bags Nomex.

13. Air to cloth ratio 5:1. Designed ACFM ____.

14. Square feet of bags ____.

15. Type of cleaning; pulse jet ✓, reverse air ____,
plenum pulse ____, other ____.

16. Cleaning cycle time .4.

17. Interval between cleaning cycle 30 sec.

18. Pressure drop across baghouse 4 psi.

19. Pulse pressure on cleaning cycle 120 psi.

COMPANY NAME R.F. Kline, Inc. DATE Sept 9, 1986

PLANT DATA

(7)

COMPANY NAME Richard F. Kline, Inc.

COMPANY REP. HCB DATE Sept 9, 1986 Phone #(301)662-1789

DATA SOURCE

PLANT LOCATION Frederick, MD

PLANT MANUFACTURER PLANT MODEL NO. PLANT TYPE Batch

MIX SPECIFICATION NO. OIL SPECIFICATION NO.

TIME: START STOP A.T. °F R.H. %

RUN #1

RUN 2

TIME 24 HOUR	FUEL OIL ☐ NATURAL GAS ☐ PROPANE ☑ COAL	BURNER SETTING	AGGREGATE TPH	RECYCLE TPH	ASPHALT TPH	MIX TEMPERATURE °F	VENTURI ☐ Baghouse ☑ DIFFERENTIAL
[illegible]	70/30	5	212		2.7	330	4
8:50	"	5	309		3.2	330	4
9:05	"	5	290		1.8	332	4
9:20	"	5	223		1.0	332	4
9:35	"	5½	261		2.8	337	4
9:50	"	4½	265		3.5	332	4
10:05	"	5	311		3.7	327	4
10:45	"	4	230		2.7	328	4
11:00	"	4½	234		2.7	324	4
11:15	"	4½	241		2.7	330	4
11:30	"	4½	265		3.0	332	4
11:45	"	4	226		2.3	336	4
12:00	"	4	285		3.0	330	4

REMARKS:

PLANT DATA

COMPANY NAME Richard F. Kline, Inc

COMPANY REP. ____________ DATE Sept 10, 1986 Phone #(301) 293-1761

DATA SOURCE ____________

PLANT LOCATION Frederick, MD

PLANT MANUFACTURER H&B PLANT MODEL NO. ____________ PLANT TYPE Batch

MIX SPECIFICATION NO. ____________ OIL SPECIFICATION NO. ____________

TIME: START ______ STOP ______ A.T. ______ °F R.H. ______ %

TIME 24 HOUR	FUEL OIL ☐ NATURAL GAS ☐ PROPANE ☑ COAL ☑	BURNER SETTING	AGGREGATE TPH	RECYCLE TPH	ASPHALT	MIX TEMPERATURE °F	VENTURI ☐ Baghouse ☑ DIFFERENTIAL
7:38	70/30	3½	230	N/A	2.7	330	3½
7:53	"	4	240	"	2.7	330	4
8:09	"	5	255	"	3.6	335	4
8:24	"	5	265	"	3.3	340	4
8:39	"	4½	256	"	3.2	346	4
8:54	"	4½	241	"	3.0	327	4

REMARKS:

V. EQUIPMENT USED

V. EQUIPMENT USED

Equipment used on conducting the particulate emissions test was:

A. The Lear Siegler PM-100 stack sampler with appropriate auxillary equipment and glassware. The train was set up according to the schematic on the nex page.

B. An Airguide Instruments Model 211-B (uncorrected) aneroid barometer was used to check the barometric pressure.

C. Weston dial thermometers are used to check meter temperatures. An Analogic Model 2572 Digital Thermocouple is used for stack temperatures.

D. A Hays 621 Analyzer was used to measure the oxygen, carbon dioxide and carbon monoxide content of the stack gases. For non-combustion sources, A Bacharach Instrument Company Fyrite is used for the gas analysis.

E. Filters are mady by Schleicher and Schuell and are type 1-HV with a porosity of .03 microns.

F. The acetone is reagent grade or ACS grade with a residue of $\leq$ .001.

VI. LABORATORY PROCEDURES & RESULTS

LABORATORY PROCEDURES FOR PARTICULATE SAMPLING

I. Field Preparation

A. FILTERS: Fiberglass 4" sampling filters are prepared as follows:

Filters are removed from their box and numbered on the back side with a felt pen. The numbering system is continuous from job to job. The filters are placed in a dessicator to dry for at least 24 hours. Clean plastic petri dishes, also numbered, top and bottom, are placed in the dessicator with the filters. After dessication, the filters are removed one at a time and weighed on the Sartorius analytical balance, then placed in the correspondingly numbered petri dish. Weights are then recorded in the lab record book. Three filters are used for each complete particulate source emissions test and there should be several extra filters included as spares.

B. SILICA GEL: Silica Gel used for the test is prepared as follows:

Approximately 200 g of silica gel is placed in a wide mouth "Mason" type jar and dried in an oven (175°C for two hours). The open jars are removed and placed in a dessicator until cool (2 hours) and then tightly sealed. The jars are then numbered and weighed on the triple beam balance to the closest tenth of a gram, and this weight is recorded for each sealed jar. The number of silica gel jars used is the same as the number of filters. Silica gel should be indicating type, 6-16 mesh.

II. Post-Testing Lab Analysis

A. FILTERS: The filters are returned to the lab in their sealed glass filter holder which was used in field sampling. In the lab these holders are opened. The filter is placed in its petri dish with the lid off and returned to the dessicator for at least 24 hours. The top half of the filter holder is washed into the corresponding probe wash bottle and the bottom half of the filter holder is washed into the corresponding impinger catch bottle. (See II, C and D). After dessication, the filters are reweighed. The final weight is recorded in the lab record book. The filter pick up weight is calculated and recorded also. This procedure is repeated for all filters used in the field.

Alternately, the test team may opt to oven dry the filters at 220°F for two to three hours, weigh the sample, and use this weight as a final weight.

B. SILICA GEL: The sealed silica gel jars should be reweighed on the triple-beam balance and their weights recorded as shown on previous page.

C. PROBE RINSINGS: In all tests, a probe wash-out analysis will be necessary. These samples are returned in sealed Mason jars and consist of A.R. Acetone with an unknown solid content. Clean 250 ml beakers are used to make this analysis. These should be immaculately washed and rinsed with deionized water, then oven dried at 105°C for about one hour. The beakers should be moved to the dessicator to cool for ninety (90) minutes, then labeled with a pencil and weighed on the Sartorius analytical balance. Any variance from this procedure should be duplicated exactly when reweighing, as this procedure has been found to be quite sensitive. After preparing the necessary number of beakers (one for each probe wash and one blank) the Mason jars should be opened, poured into the beaker, and any material remaining on the jar walls rinsed with an acetone wash bottle into the beaker. The amount of liquid in the beaker should be noted on the analysis form. The acetone rinsings are evaporated on a warming plate. The liquid is kept swirled with an air sweep to prevent "bumping". When the acetone is evaporated the beakers are weighed as in Section II A.

D. IMPINGER CATCH: In some testing cases, the liquid collected in the impingers must be analyzed for solids content. This involves a similar procedure to the probe wash solids determination, except that the liquid is deionized water.

E. ACETONE: Conduct a blank analysis of acetone in the 1 gallon glass container. This acetone will be used in the field for rinsing the probe, nozzle, and top half of the filter holder. Performing such a blank analysis prior to testing will insure that the quality of the acetone to be used will not exceed the .001% residual purity standard.

SPECIAL NOTE

When sampling sources high in moisture content, (such as asphalt plants) the filter paper sometimes sticks to the filter holder. When removing the filter it may tear. In order to maintain control of any small pieces of filter paper which may be easily lost, they are washed with acetone into the probe washing. This makes the filter weight light (sometimes negative) and the probe wash correspondingly heavier. The net weight is the same and no particulate is lost. This laboratory procedure is taught by EPA in the Quality Assurance for Source Emissions Workshop at Research Triangle Park and is approved by EPA.

WEIGHING PROCEDURE - SARTORIUS ANALYTICAL BALANCE

The Sartorius balance is accurate to 0.1 mg and has a maximum capacity of 200 grams. The balance precision (standard deviation) is 0.05 mg. Before weighing an item, the balance should first be zeroed. This step should be taken before every series of weighings. To do this, the balance should have all weight adjustments at "zero" position. The beam arrest lever (on the lower left hand side toward the rear of the balance) is then slowly pressed downward to full release position. The lighted vernier scale on the front of the cabinet should align the "zero" with the mark on the cabinet. If it is not so aligned, the adjustment knob on the right hand side (near the rear of the cabinet) should be turned carefully until the marks align. Now return the beam arrest to horizontal arrest position. The balance is now "zeroed".

To weigh an item, it is first placed on the pan. And the sliding doors are closed to avoid air current disturbance. The weight adjustment knob on the right hand side must be at "zero". The beam arrest is then slowly turned upward. The lighted scale at the front of the cabinet will now indicate the weight of the item in grams. If the scale goes past the divided area, the item then exceeds 100 g weight (about 3-1/2 ounces) and it is necessary to arrest the balance (beam arrest lever) and move the lever for 100 g weight away from you. It is located on the left hand side of the cabinet near the front, and is the knob closest to the side of the cabinet. The balance will not weigh items greater than 200 grams in mass, and trying to do this might harm the balance. Remember -- this is a delicate precision instrument.

After the beam is arrested, in either weight range, the procedure is the same. When the weight of the item in grams is found, "dial in" that amount with the two knobs on the left hand side (near the 100 g lever) color coded yellow and green. As you dial the weight, the digits will appear on the front of the cabinet. When the proper amount is dialed, carefully move the arrest lever down with a slow, steady turn of the wrist. The lighted dial will appear, and the right hand side knob (front of cabinet) is turned to align the mark with the lower of the two lighted scale divisions which the mark appears between. When these marks are aligned, the two lighted digits along with the two indicated on the right hand window on the cabinet front are the fractional weight in grams (the decimal would appear before the lighted digits) and the whole number of grams weight is the amount "dialed in" on the left.

In general, be sure that the beam is in "arrest" position before placing weight on or taking weight off of the pan. Don't "dial in" weight unless the beam is arrested. The balance is sensitive to even a hand on the table near the balance, so be careful and painstaking in every movement while weighing.

LABORATORY PROCEDURES FOR SO_2

Pour the catch from impingers two and three into a 1000 ml volumetric flask. Bring the solution in the flask up to the required 1000 ml volume by mixing it with deionized distilled water, then mix thoroughly. Pipette a 10 ml aliquot of sample into a 250 ml Erlenmeyer flask. Add 40 ml of isopropanol, 2 to 4 drops of thorin indicator and titrate to a pink endpoint using 0.0100 N barium perchlorate. Repeat the titration with a second aliquot of sample and average the titration values. Replicate titrations must agree within 1 percent or 0.2 ml, whichever is greater.

Prepare the blanks by adding 2 to 4 drops of thorin indicator to 100 ml of 80 percent isopropanol. Titrate the blanks in the same manner as the samples.

LABORATORY PROCEDURES FOR H_2SO_4

Pour the contents of the first impinger into a 250 ml graduated cylinder and bring the volume up to 250 ml with 80% isopropanol. Transfer the contents to a storage container and add the filter. Shake the container to coat the isopropanol solution on the filter. If the filter tears, allow the fragments to settle before taking a sample. Pipette a 25 ml aliquot (100 ml aliquot is too large for these particular samples because of the strength of the solution) of this solution into a 250 ml Erlenmeyer flask, add 2 to 4 drops of thorin indicator and titrate to a pink endpoint using 0.0100 N barium perchlorate. Repeat the titration with a second aliquot and average the titration values.

Form REC#8

SAMPLE ANALYTICAL DATA FORM

Plant Location R.F. Kline
Relative humidity in lab 48 %
Sample Location asphalt plant stack
Density of Acetone (pa) .7853 mg/ml
Blank volume (V_a) 200 ml

Date/Time wt. blank 9-15-86 Gross wt. 98.2340 mg
Date/Time wt. blank 9-16-86 Gross wt. 98.2339 mg
Ave. Gross wt. 98.2340 mg
Tare wt. 98.2338 mg
Weight of blank (m_{ab}) .0002 mg

Acetone blank residue concentration (C_a) $(C_a) = (M_{ab}) / (V_a) (p_a)$ = (.0000013 mg/g)
Weight of residue in acetone wash: $W_a = C_a V_{aw} P_a$ = (.0000013)(200)(.7853) = (.0002)

		Run # 1	Run # 2	Run #3
Acetone rinse volume (V_{aw})	ml	200	200	200
Date/Time of wt 9-15-86 Gross wt	g	99.9432	97.4111	98.7291
Date/Time of wt 9-16-86 Gross wt	g	99.9431	97.4108	98.7290
Average Gross wt	g	99.9432	97.4110	98.7291
Tare wt	g	99.7972	97.2781	98.6106
Less acetone blank wt (W_a)	g	.0002	.0002	.0002
Wt of particulate in acetone rinse (m_a)	g	.1458	.1327	.1185

Filter Numbers	#	CM-1648	CM-1649	CM-1650
Date/Time of wt 9-15-86 Gross wt	g	.5264	.5380	.5293
Date/Time of wt 9-16-86 Gross wt	g	.5261	.5380	.5290
Average Gross wt	g	.5263	.5380	.5292
Tare wt	g	.5204	.5196	.5200

Weight of particulate on filters(s) (m_f)	g	.0059	.0184	.0092
Weight of particulate in acetone rinse	g	.1458	.1327	.1185
Total weight of particulate (m_n)	g	.1517	.1511	.1277

Note: In no case should a blank residue greater than 0.01 mg/g (or 0.001% of the blank weight) be subtracted from the sample weight.

Remarks

Signature of analyst Kim Rea Signature of reviewer

SO_2 ANALYSIS

(Method 8)

Plant Kline **Date** 4/22/86

Audit Samples

Audit Number								
	A	B	A	B	A	B	A	B
V_{soln} (ml)								
V_a (ml)								
N (N)								
V_t (ml)								
$V_{m(std)}$ (dscm)								
C_{SO_2} (mg/dscm)								

K_2 = 32.03 mg/meq

SO_2 Analysis for Impinger 2 & 3 Combined.

Run Number	1		2		3		Blank	
	A	B	A	B	A	B	A	B
V_{soln} (ml)	1000	1000	1000	1000	1000	1000		
V_a (ml)	10	10	10	10	10	10		
N (N)	0.0100	0.0100	0.0100	0.0100	0.0100	0.0100		
V_t (ml)	3.7	37	5.9	5.9	3.0	3.0		
$V_{m(std)}$ (dscf)								
C_{SO_2} (lb/dscf)								

K_3 = 7.061×10^{-5} lb/meq

Analysis performed by: John Biggs

Approved by: S Tuck

H_2SO_4 ANALYSIS

(Method 8)

Plant Kline **Date** 9/22/86

Audit Samples

Audit Number								
	A	B	A	B	A	B	A	B
V_{soln} (ml)								
V_a (ml)								
N (N)								
V_t (ml)								
$V_{m(std)}$ (dscm)								
C_{SO_2} (mg/dscm)								

K_2 = 32.03 mg/meq

O3 { H_2SO_4 **Analysis for Impinger** 1 ~~2 & 3 Combined.~~

Run Number	1		2		3		Blank	
	A	B	A	B	A	B	A	B
V_{soln} (ml)	250	250	250	250	250	250		
V_a (ml)	20	20						
N (N)	0.0100	0.0100	0.0100	0.0100	0.0100	0.0100		
V_t (ml)	17.8	17.8	2.3	2.3	3.1	3.1		
$V_{m(std)}$ (dscf)								
C_{SO_2} (lb/dscf)								

K_3 = ~~7.061 x 10^{-5} lb/meq~~

Analysis performed by: JRB

Approved by: ____________

VII. CALCULATIONS

NAME: R.F. KLINE, INC.

LOCATION: FREDERICK, MARYLAND

		date	9/09/86	9/09/86	9/10/
	SUMMARY OF TEST DATA		RUN # 1	RUN # 2	RUN #
	SAMPLING TRAIN DATA	start	08:49	10:45	07:3
		finish	10:05	12:00	08:47
1	Sampling time, minutes	θ	72	72	72
2	Sampling nozzle diameter, in.	Dn	.200	.200	.200
3	Sampling nozzle cross-sectional area, ft^2	An	.000219	.000218	.000218
4	Isokinetic variation	I	95	95	98
5	Sample gas volume - meter conditions, cf.	Vm	57.62	59.24	59.68
6	Average meter temperature, °R	Tm	540	557	539
7	Average oriface pressure drop, in.H_2O	ΔH	2.23	2.22	2.25
8	**Total particulate collected mg.**	**Mn**	**151.7**	**151.1**	**127.7**
	VELOCITY TRAVERSE DATA				
9	Stack area, ft^2	A	9.4	9.4	9.4
10	Absolute stack gas pressure, in. Hg.	Ps	31.02	31.02	31.00
11	Barometric pressure, in. Hg.	Pbar	31.02	31.02	31.00
12	Average absolute stack temperature, °R	Ts	681	680	679
13	Average $\sqrt{\text{velocity head}}$, (Cp= .84)	$\sqrt{\Delta P}$	1.47	1.48	1.49
14	Average stack gas velocity ft. / sec.	Vs	93	94	95
	STACK MOISTURE CONTENT				
15	Total water collected by train, ml.	Vlc	183.0	196.0	202.0
16	Moisture in stack gas, %	Bws	12.7	13.5	13.4
	EMISSIONS DATA:				
17	Stack gas flow rate, dscf/hr. (000's)	Qsd	2,213	2,213	2,235
18	Total particulate concentration, gr/dscf	Cs	.0396	.0396	.0321
19	Total particulate emissions lbs/hr	E	12.5	12.5	10.2
20	Total SO concentration, lbs/dscf	C'	.000004	.000007	.000003
21	Total SO_2 emissions lbs/hr	E'	9.80	15.67	7.73
	ORSAT DATA				
22	Percent CO2 by volume	CO2	3.0	3.0	2.8
23	Percent O2 by volume	O2	17.0	17.0	16.8
24	Percent CO by volume	CO	.0	.0	.0
25	Percent N2 by volume	N2	80.0	80.0	80.4

Dry Gas Volume :

$$V_{m(std)} = V_m \left[\frac{T_{(std)}}{T_m} \right] \left[\frac{P_{bar} + \frac{\Delta H}{13.6}}{P_{(std)}} \right] = 17.64 \ \frac{°R}{in.Hg.} \ Y \ V_m \left[\frac{P_{bar} + \frac{\Delta H}{13.6}}{T_m} \right]$$

Where:

$V_{m(std)}$ = Dry Gas Volume through meter at standard conditions, cu.ft.

V_m = Dry Gas Volume measured by meter, cu.ft.

P_{bar} = Barometric pressure at oriface meter, in. Hg.

P_{std} = Standard absolute pressure,(29.92 in. Hg.)

T_m = Absolute temperature at meter °R

T_{std} = Standard absolute temperature (528°R)

ΔH = Average pressure drop across oriface meter,in.H_2O

Y = Dry gas meter calibration factor

13.6 = Inches water per inches Hg.

Run # 1 $V_{m(std)} = 17.64 \ (1.01)(57.62) \left[\frac{(31.02) + \frac{2.23}{13.6}}{540} \right] = 59.02$ dsc

Run # 2 $V_{m(std)} = 17.64 \ (1.01)(59.24) \left[\frac{(31.02) + \frac{2.22}{13.6}}{557} \right] = 58.83$ dsc

Run # 3 $V_{m(std)} = 17.64 \ (1.01)(59.68) \left[\frac{(31.00) + \frac{2.25}{13.6}}{539} \right] = 61.20$ dsc

Total contaminants by weight: 'GRAIN LOADING'

Particulate concentration C_s' gr./dscf.

$$C_s' = \left[0.0154 \frac{gr}{mg} \right] \left[\frac{M_n}{V_{m(std)}} \right]$$

Where:

C_s' = Concentration of particulate matter in stack gas, dry basis, corrected to standard conditions, gr./dscf.

M_n = Total amount of particulate matter collected, mg.

$V_{m(std)}$ = Dry gas volume through meter at standard conditions, cu.ft.

Run # 1: $$C_s' = \left[0.0154 \frac{gr}{mg} \right] \left[\frac{151.7}{59.02} \right] = .0396 \text{ gr./dscf.}$$

Run # 2: $$C_s' = \left[0.0154 \frac{gr}{mg} \right] \left[\frac{151.1}{58.83} \right] = .0396 \text{ gr./dscf.}$$

Run # 3: $$C_s' = \left[0.0154 \frac{gr}{mg} \right] \left[\frac{127.7}{61.20} \right] = .0321 \text{ gr./dscf.}$$

Dry molecular weight:

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

Where:

M_d = Dry molecular weight, lb./lb.-mole.
$\%CO_2$ = Percent carbon dioxide by volume (dry basis).
$\%O_2$ = Percent oxygen by volume (dry basis).
$\%N_2$ = Percent nitrogen by volume (dry basis).
$\%CO$ = Percent carbon monoxide by volume (dry basis).
0.264 = Ratio of O_2 to N_2 in air, v/v.
0.28 = Molecular weight of N_2 or CO, divided by 100.
0.32 = Molecular weight of O_2 divided by 100.
0.44 = Molecular weight of CO_2 divided by 100.

Run # 1: $M_d = 0.44(\ 3.0\%\ ) + 0.32(17.0\%\ ) + 0.28(\ \ .0\% + 80.0\%\ ) =$ 29.2 lb./lb.-mol

Run # 2: $M_d = 0.44(\ 3.0\%\ ) + 0.32(17.0\%\ ) + 0.28(\ \ .0\% + 80.0\%\ ) =$ 29.2 lb./lb.-mol

Run # 3: $M_d = 0.44(\ 2.8\%\ ) + 0.32(16.8\%\ ) + 0.28(\ \ .0\% + 80.4\%\ ) =$ 29.1 lb./lb.-mol

Water vapor condensed :

$$V_{wc_{std}} = \left[V_f - V_i \right] \left[\frac{p_w \; R \; T_{(std)}}{M_w \quad P_{(std)}} \right] = 0.04707 \left[V_f - V_i \right]$$

$$V_{wsg_{std}} = \left[W_f - W_i \right] \left[\frac{R \quad T_{(std)}}{M_w \quad P_{(std)}} \right] = 0.04715 \left[W_f - W_i \right]$$

Where:

0.04707 = Conversion factor ft^3/ml.

0.04715 = Conversion factor ft^3/g.

$V_{wc_{std}}$ = Volume of water vapor condensed (standard conditions) scf.

$V_{wsg_{std}}$ = Volume of water vapor collected in silica gel (standard conditions)

V_f = Final volume of impinger contents, ml.

V_i = Initial volume of impinger contents

p = Density of water, (0.002201 lb/ml).

R = Ideal gas constant, 21.85 (in.Hg.)(cu.ft./lb.-mole)(°R)

M_w = Molecular weight of water vapor (18.0 lb/lb-mole).

T_{std} = Absolute temperature at standard conditions, 528°R.

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

Run # 1: $V_{wc(std)}$ = (0.04707) (175.0) = 8.2 cu.ft
$V_{wsg(std)}$ = (0.04715) (8.0) = .4 cu.ft

Run # 2: $V_{wc(std)}$ = (0.04707) (189.0) = 8.9 cu.ft
$V_{wsg(std)}$ = (0.04715) (7.0) = .3 cu.ft

Run # 3: $V_{wc(std)}$ = (0.04707) (193.0) = 9.1 cu.ft
$V_{wsg(std)}$ = (0.04715) (9.0) = .4 cu.ft

Moisture content of stack gases: $$B_{ws} = \frac{V_{wc_{std}} + V_{wsg_{std}}}{V_{wc_{std}} + V_{wsg_{std}} + V_{m\,std}} \times 100$$

Where:

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

V_m = Dry gas volume measured by dry gas meter,(dcf).

$V_{wc_{std}}$ = Volume of water vapor condensed corrected to standard conditions (scf).

$V_{wsg_{std}}$ = Volume of water vapor collected in silica gel corrected to standard conditions (scf).

Run # 1: $$B_{ws} = \frac{8.2 + .4}{8.2 + .4 + 59.02} \times 100 = 12.7\ \%$$

Run # 2: $$B_{ws} = \frac{8.9 + .3}{8.9 + .3 + 58.83} \times 100 = 13.5\ \%$$

Run # 3: $$B_{ws} = \frac{9.1 + .4}{9.1 + .4 + 61.20} \times 100 = 13.4\ \%$$

Molecular weight of stack gases: $M_s = M_d\ (1-B_{ws}) + 18\ (B_{ws})$.

Where:

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

M_d = Molecular weight of stack gas, dry basis, (lb./lb.-mole).

Run # 1: $M_s = 29.2\ (1- .127) + 18\ (.127) = 27.8$ (lb./lb.-mole).

Run # 2: $M_s = 29.2\ (1- .135) + 18\ (.135) = 27.7$ (lb./lb.-mole).

Run # 3: $M_s = 29.1\ (1- .134) + 18\ (.134) = 27.6$ (lb./lb.-mole).

Stack gas velocity:

$$V_s = K_p\, C_p \left[\sqrt{\Delta P} \right]_{avg.} \sqrt{\frac{T_{s(avg.)}}{P_s\ M_s}}$$

Where:

V_s = Average velocity of gas stream in stack, ft./sec.

K_p = 85.49 ft/sec $\left[(g/g\text{-mole})\text{-}(mm\ Hg) \,/\, (^\circ K)(\ mm\ H_2O \right]^{1/2}$

C_p = Pitot tube coefficient,(dimensionless).

ΔP = Velocity head of stack gas, in. H_2O.

P_{bar} = Barometric pressure at measurement site, (in.Hg).

P_g = Stack static pressure (in.Hg).

P_s = Absolute stack gas pressure, (in.Hg) = $P_{bar} + P_g$

P_{std} = Standard absolute pressure, (29.92 in.Hg).

t_s = Stack temperature, (°f).

T_s = Absolute stack temperature, (°R). = 460 + t_s.

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

Run # 1: $V = (85.49)(\ .84)(\ 1.47) \sqrt{\frac{681}{(31.02)(27.78)}}$ = 93.40 ft/se

Run # 2: $V = (85.49)(\ .84)(\ 1.48) \sqrt{\frac{680}{(31.02)(27.69)}}$ = 94.11 ft/se

Run # 3: $V = (85.49)(\ .84)(\ 1.49) \sqrt{\frac{679}{(31.00)(27.61)}}$ = 94.85 ft/se

Stack gas flow rate:

$$Q_{sd} = 3600 \begin{bmatrix} 1-B_{wc} \end{bmatrix} V_s \; A \begin{bmatrix} \frac{T_{std}}{T_{stk}} \end{bmatrix} \begin{bmatrix} \frac{P_s}{P_{std}} \end{bmatrix}$$

Where:

Q_{sd} = Dry volumetric stack gas flow rate corrected to standard conditions, (dscf/hr).

A = Cross sectional area of stack $(ft.)^2$.

3600 = Conversion factor, sec./hr.

t_s = Stack temperature (°f).

T_s = Absolute stack temperature, (°R).

T_{std} = Standard absolute temperature, (528 °R).

P_{bar} = Barometric pressure at measurement site, (in.Hg.).

P_g = Stack static pressure, (in.Hg.).

P_s = Absolute stack gas pressure, (in.Hg.); $= P_{bar} + P_g$

P_{std} = Standard absolute pressure, (29.92 in.Hg.)

Run # 1:

$$Q_{sd} = 3600\ (1-.127)\ (\ 93.40)\ (\ \ 9.4) \begin{bmatrix} \frac{528}{681} \end{bmatrix} \begin{bmatrix} \frac{31.02}{29.92} \end{bmatrix} = \quad 2213265 \text{ dscf/}$$

Run # 2:

$$Q_{sd} = 3600\ (1-.135)\ (\ 94.11)\ (\ \ 9.4) \begin{bmatrix} \frac{528}{680} \end{bmatrix} \begin{bmatrix} \frac{31.02}{29.92} \end{bmatrix} = \quad 2212903 \text{ dscf/}$$

Run # 3:

$$Q_{sd} = 3600\ (1-.134)\ (\ 94.85)\ (\ \ 9.4) \begin{bmatrix} \frac{528}{679} \end{bmatrix} \begin{bmatrix} \frac{31.00}{29.92} \end{bmatrix} = \quad 2234729 \text{ dscf/}$$

Emissions rate from stack:

$$E = \frac{(C_s)(Q_{sd})}{7000 \text{ gr./lb.}} = \text{lb. / hr.}$$

Where:

E = Emissions rate, lb./hr.

C = Concentration of particulate matter in stack gas, dry basis, corrected to standard conditions (gr/dscf).

Q = Dry volumetric stack gas flow rate corrected to standard conditions, (dscf/hr).

Run # 1: $$E = \frac{(.0396)(2213265)}{7000} = 12.5 \text{ lb. / hr.}$$

Run # 2: $$E = \frac{(.0396)(2212903)}{7000} = 12.5 \text{ lb. / hr.}$$

Run # 3: $$E = \frac{(.0321)(2234729)}{7000} = 10.2 \text{ lb. / hr.}$$

Isokinetic variation : $$I = 100\ T_s \left[\frac{0.002669\ V_{ic} + (V_m/T_m)(P_{bar} + \Delta H/13.6)}{60\quad O\quad V_s\quad P_s\quad A_n} \right]$$

Where:

I = Percent isokinetic sampling.

100 = Conversion to percent.

T_s = Absolute average stack gas temperature, °R.

0.002669 = Conversion factor, Hg - ft^3/ml - °R.

V_{ic} = Total volume of liquid collected in impingers and silica gel, m

T_m = Absolute average dry gas meter temperature, °R.

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

ΔH = Average pressure differential across the oriface meter, (in.H_2O

13.6 = Specific gravity of mercury.

60 = Conversion seconds to minutes

O = Total sampling time, minutes.

V_s = Stack gas velocity, ft./sec.

P_s = Absolute stack gas pressure, in.Hg.

A_n = Cross sectional area of nozzle, ft^2.

Run # 1:

$$I = 100 \times 681 \left[\frac{(0.002669)(183.0) + \frac{57.6}{540}\left[31.02 + \frac{2.23}{13.6}\right]}{60\ (72)\ (93.40)\ (31.02)\ (.000218)} \right] = 95\ \%$$

Run # 2:

$$I = 100 \times 680 \left[\frac{(0.002669)(196.0) + \frac{59.2}{557}\left[31.02 + \frac{2.22}{13.6}\right]}{60\ (72)\ (94.11)\ (31.02)\ (.000218)} \right] = 95\ \%$$

Run # 3:

$$I = 100 \times 679 \left[\frac{(0.002669)(202.0) + \frac{59.7}{539}\left[31.00 + \frac{2.25}{13.6}\right]}{60\ (72)\ (94.85)\ (31.00)\ (.000218)} \right] = 98\ \%$$

Sulfuric Acid Concentration (Including SO_3) Impinger 1

$$C_{H_2SO_4} = \frac{K_2 N \, (V_t - V_{tb}) \dfrac{(V_{soln})}{V_a}}{V_{m(std)}}$$

Where; H_2SO_4 = Sulfuric acid concentration (including SO_3), (g/dscm)

K_2 = 1.081×10^{-4} lbs/meq

N = Normality of barium perchlorate titrant, g equivalents/liter

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

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

V_{soln} = Total volume of solution in which the sulfuric acid sample is contained, ml.

$V_{m(std)}$ = Volume of gas sample measured by the dry gas meter corrected to standard conditions, dscm.

V_a = Volume of sample aliquot titrated (20 ml for H_2SO_4).

Run #1: $$C_{H_2SO_4} = .04904 \; \frac{.0100 \; (17.8 - .00) \; \dfrac{(250)}{20}}{(1.6712 \text{ m}^3)} = .06529 \text{ g/dscm or } 65.3 \text{ mg/m}^3$$

Run #2: $$C_{H_2SO_4} = .04904 \; \frac{.0100 \; (2.3 - .00) \; \dfrac{(250)}{20}}{(1.6659 \text{ m}^3)} = .00846 \text{ g/dscm or } 8.5 \text{ mg/m}^3$$

Run #3: $$C_{H_2SO_4} = .04904 \; \frac{.0100 \; (3.1 - .00) \; \dfrac{(250)}{20}}{(1.7329 \text{ m}^3)} = .01097 \text{ g/dscm or } 10.9 \text{ mg/m}^3$$

Sulfur Dioxide Concentration

$$CSO_2 = \frac{K_3 N\ (V_t - V_{tb})\ (\frac{V_{soln}}{V_a})}{V_{m(std)}}$$

Where; CSO_2 = Sulfur dioxide concentration, (lbs/dscf)

K_3 = 7.061×10^{-5} Lb/meq

N = Normality of barium perchlorate titrant, g equivalents/liter

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

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

V_{soln} = Total volume of solution in which the sulfuric acid or sulfur dioxide sample is contained, 250 ml or 1,000 ml respectively

$V_{m(std)}$ = Volume of gas sample measured by the dry gas meter corrected to standard conditions, dscf.

V_a = Volume of sample aliquot titrated (10 ml for SO_2)

Run # 1: $CSO_2 = 7.061 \times 10^{-5}\ \frac{[\ .0100000\ (\ 3.70-\ .00)\ \frac{(1000)}{10}]}{(\ 59.020\ )} = .0000044300$ lbs./dscf

Run # 2: $CSO_2 = 7.061 \times 10^{-5}\ \frac{[\ .0100000\ (\ 5.90-\ .00)\ \frac{(1000)}{10}]}{(\ 58.830\ )} = .0000070800$ lbs./dscf

Run # 3: $CSO_2 = 7.061 \times 10^{-5}\ \frac{[\ .0100000\ (\ 3.00-\ .00)\ \frac{(1000)}{10}]}{(\ 61.200\ )} = .0000034600$ lbs./dscf

Sulfur Dioxide Emissions

$$E = CSO_2 \times Q_{sd}$$

Where; E = Emissions of sulfur dioxide in pounds per hour

Q_{sd}= Stack gas flow rate (dscf/hr)

CSO_2= Sulfur dioxide concentration (lbs/dscf)

Run # 1: E = (.000004430 lbs/dscf) (2213265 dscf/hr) = 9.80 lbs/hr

Run # 2: E = (.000007080 lbs/dscf) (2212903 dscf/hr) = 15.67 lbs/hr

Run # 3: E = (.000003460 lbs/dscf) (2234729 dscf/hr) = 7.73 lbs/hr

Emissions of SO_2PPM (Parts Per Million)

$$E = CSO_2 \left| \frac{453.593\text{g}}{1 \text{ lb}} \right| \frac{\text{MOL SO}_2}{64\text{g SO}_2} \left| \frac{22.4 \text{ l}}{\text{MOL}} \right| \frac{293^\circ\text{K}}{273^\circ\text{K}} \left| \frac{\text{ft}^3}{28.317 \text{ l}} \right| 1{,}000{,}000$$

Where; CSO_2 = Concentration of SO_2 in lbs/dscf

453.593 = Conversion to grams

MOL SO_2 = Molar conversion for SO_2

22.4 l/MOL = Volumetric molar conversion @ 273°K

293°K/273°K = Temperature correction to std conditions

28.317 l = Conversion of liters to cubic feet

1,000,000 = Conversion to parts per million

Run # 1:

$$E = \frac{.0000044300 \text{ lbs}}{\text{dscf}} \left| \frac{453.593\text{g}}{1 \text{ lb}} \right| \frac{\text{MOL SO}_2}{64\text{g SO}_2} \left| \frac{22.4 \text{ l}}{\text{MOL}} \right| \frac{293^\circ\text{K}}{273^\circ\text{K}} \left| \frac{\text{ft}^3}{28.317 \text{ l}} \right| 1{,}000{,}000 \right| =$$

26.656 ppm

Run # 2:

$$E = \frac{.0000070800 \text{ lbs}}{\text{dscf}} \left| \frac{453.593\text{g}}{1 \text{ lb}} \right| \frac{\text{MOL SO}_2}{64\text{g SO}_2} \left| \frac{22.4 \text{ l}}{\text{MOL}} \right| \frac{293^\circ\text{K}}{273^\circ\text{K}} \left| \frac{\text{ft}^3}{28.317 \text{ l}} \right| 1{,}000{,}000 \right| =$$

42.602 ppm

Run # 3:

$$E = \frac{.0000034600 \text{ lbs}}{\text{dscf}} \left| \frac{453.593\text{g}}{1 \text{ lb}} \right| \frac{\text{MOL SO}_2}{64\text{g SO}_2} \left| \frac{22.4 \text{ l}}{\text{MOL}} \right| \frac{293^\circ\text{K}}{273^\circ\text{K}} \left| \frac{\text{ft}^3}{28.317 \text{ l}} \right| 1{,}000{,}000 \right| =$$

20.819 ppm

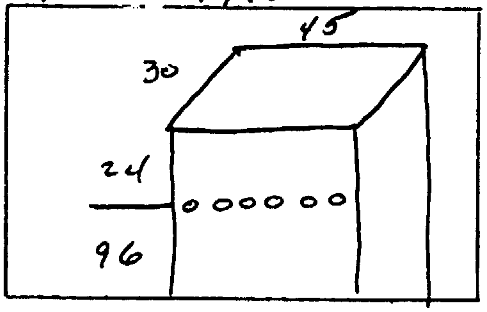
VIII. FIELD DATA

RAMCON ENVIRONMENTAL CORPORATION

Plant KLINE

Location Fredrick Md.
Operator K. Allmendinger
Date 9-9-86
Run No. 1
Sample Box No. 1
Meter Box No. 689836
Meter H @ 1.71
C Factor 1.0055
Pitot Tube Coefficient Cp .836

ΔP = .998



Schematic of Stack Cross Section

Ambient Temperature 53
Barometric Pressure 31.02
Assumed Moisture, % 15
Probe Length, m(ft) 4'

	IMPINGER VOLUME ml	SILICA GEL WEIGHT g
FINAL	475	487
INITIAL	300	479
DIFFERENCE	175	8

Nozzle Identification No. .0002182
Avg. Calibrated Nozzle Dia., (in.) .200/.204/.200
Probe Heater Setting 4.0
Leak Rate, m³/min. (cfm) ∠.01
Probe Liner Material 316 stainless
Static Pressure, mm Hg (in.Hg) .05
Filter No. CM-1646

TRAV. PT NO.	SAMPLING TIME (θ)min.	VACUUM in. Hg	STACK TEMP (Ts) °F	VELOCITY HEAD (Ps) in H20	PRESSURE DIFF. ORF. MTR in H20	GAS SAMPLE VOLUME ft³	GAS SAMPLE TEMP. AT DRY GAS METER °F		FILTER HOLDER TEMP °F	GAS TEMP LVG CONDENSER OR LAST IMPINGER °F
							Inlet	Outlet		
A 1	8:49:30 KA 8:52:30	6	215	2.2	2.2	~~[illegible]~~ 476.60	65	55	235	60
2	8:55	6	215	2.4	2.4	479.07	75	55	245	60
3	8:58	5	220	2.0	2.9	481.42	80	60	250	60
4	9:01:30	4	220	1.3	1.3	483.316	85	60	255	60
B) 1	9:02:15 9:05	6	220	2.7	2.7	485.93	85	60	260	60
2	9:08	6	220	2.2	2.2	488.35	90	60	265	60
3	9:11	5	225	2.0	2.0	490.63	90	60	265	60
4	9:14:15	5	225	2.1	2.1	492.986	95	60	260	60
C) 1	9:15:55 9:18	6	205	2.4	2.4	495.48	90	65	260	60
2	9:21	5	220	2.2	2.2	497.91	95	65	255	60
3	9:24	5	230	2.2	2.2	500.31	95	65	250	60
4	9:27:55	5	230	2.2	2.2	502.72	100	65	250	60
D) 1	9:28:30 9:31	6	210	2.5	2.5	505.30	95	65	245	60

00² ≈ 3.0 1 3.0

Form #REC-05

Form #REC-06

RAMCON emissions test log sheet, cont. DATE 9-5-86 LOCATION Frederick TEST NO. 1

TRAVERSE POINT	SAMPLING TIME θ (min)	VACUUM mm Hg (in. Hg)	STACK TEMP T_s (°F)	VELOCITY HEAD ΔP_s (in. H_2O)	ORFICE DIFF. PRESSURE ΔH (in. H_2O)	GAS VOLUME V_m (ft.^{3})	GAS SAMPLE TEMP. (°F) in	GAS SAMPLE TEMP. (°F) out	SAMPLE BOX TEMP. (°F)	IMPINGER TEMP (°F)
2	9:34	6	210	2.5	2.5	507.88	100	70	245	55
3	9:37	6	215	2.5	2.5	510.49	100	70	240	55
4	9:40:30	6	225	2.7	2.7	513.165	100	70	240	55
E) 1	9:41 / 9:44	7	220	3.0	3.0	515.96	100	70	245	55
2	9:47	4	225	1.6	1.6	518.09	100	70	250	55
3	9:50	4	230	1.6	1.6	520.21	100	70	250	55
4	9:53	4	230	1.6	1.6	522.324	100	70	255	55
F) 1	9:53:40 / 9:56	7	220	3.0	3.0	525.08	100	75	260	55
2	9:59	6	225	2.6	2.6	527.75	105	75	260	55
3	10:02	6	225	2.0	2..0	530.13	105	75	260	55
4	10:05:40	3	230	1.1	1.1	531.924	105	75	265	55

RAMCON ENVIRONMENTAL CORPORATION

Plant KLINE
Location Frederick Md
Operator K. Allmendinger
Date 9-9-86
Run No. 2
Sample Box No. 2
Meter Box No. 684836
Meter H @ 1.71
C Factor 1.0055
Pitot Tube Coefficient Cp .836

Ambient Temperature 68
Barometric Pressure 31.02
Assumed Moisture, % 15
Probe Length, m(ft) 4'
Nozzle Identification No. .0002182
Avg. Calibrated Nozzle Dia., (in.) .204/.204/.206
Probe Heater Setting 4.0
Leak Rate, m³/min. (cfm) ±.011
Probe Liner Material 316 Stainless
Static Pressure, mm Hg (in. Hg) .05
Filter No. CM-1649

	IMPINGER VOLUME, ml	SILICA GEL WEIGHT, g
FINAL	489	514
INITIAL	300	507
DIFFERENCE	189	7

Schematic of Stack Cross Section

TRAV. PT NO.	SAMPLING TIME (θ) min.	VACUUM in. Hg	STACK TEMP (Ts) °F	VELOCITY HEAD (Ps) in H20	PRESSURE DIFF. ORF. MTR in H20	GAS SAMPLE VOLUME ft³	GAS SAMPLE TEMP. AT DRY GAS METER °F Inlet	GAS SAMPLE TEMP. AT DRY GAS METER °F Outlet	FILTER HOLDER TEMP °F	GAS TEMP LVG CONDENSER OR LAST IMPINGER °F
A) 1	10:45:40 / 10:48	7	215	3.0	3.0	537.721 / 540.42	90	80	230	60
2	10:51	7	220	3.0	3.0	543.09	105	80	240	60
3	10:54	5	225	1.8	1.8	545.40	105	80	245	60
4	10:57:40	4	225	.97	.97	547.114	105	80	250	60
B) 1	10:58:25 / 11:01	7	220	3.1	3.1	549.91	105	80	255	60
2	11:04	4	220	1.7	1.7	552.12	110	80	260	60
3	11:07	4	225	1.7	1.7	554.22	110	80	265	55
4	11:10:25	5	225	2.3	2.3	556.73	110	80	270	55
C) 1	11:11:10 / 11:14	6	220	2.6	2.6	559.37	110	80	265	55
2	11:17	5	220	1.9	1.9	561.72	110	80	260	55
3	11:20	5	220	2.2	2.2	564.19	110	80	255	55
4	11:23:10	6	225	2.7	2.7	566.881	115	80	255	55
D) 1	11:23:45 / 11:26	6	215	2.4	2.4	569.49	110	85	250	55

CO2 = 3.0, 3.0
O2 - -

Form #REC-05

Form #REC-06

RAMCON emissions test log sheet, cont. DATE 9-5-86 LOCATION Frederick TEST NO. 2

TRAVERSE POINT	SAMPLING TIME θ (min)	VACUUM mm Hg (in. Hg)	STACK TEMP T_s (°F)	VELOCITY HEAD ΔP_s (in. H_2O)	ORFICE DIFF. PRESSURE ΔH (in. H_2O)	GAS VOLUME V_m (ft.^{3})	GAS SAMPLE TEMP. (°F)		SAMPLE BOX TEMP. (°F)	IMPINGER TEMP (°F)
							in	out		
2	11:29	5	215	2.1	2.1	571.96	115	85	250	55
3	11:32	5	225	2.1	2.1	574.42	115	85	245	55
4	11:35:45	5	230	2.0	2.0	576.81	115	85	240	55
E) 1	11:36:10 11:39	6	220	2.6	2.6	579.48	115	85	235	55
2	11:42	5	220	2.1	2.1	581.94	115	85	240	55
3	11:45:	5	225	1.8	1.8	584.24	115	85	245	55
4	11:48:10	5	225	2.2	2.2	586.695	115	85	250	55
F) 1	11:48:30 11:51	5	200	2.2	2.2	589.22	110	85	255	55
2	11:54	6	210	2.5	2.5	591.87	115	85	260	55
3	11:57	6	220	2.3	2.3	594.47	115	85	265	55
4	12:00:50	5	220	2.1	2.1	596.962	120	85	265	55

RAMCON ENVIRONMENTAL CORPORATION

Plant KLINE
Location Frederick Md
Operator K. Allmendinger
Date 9-10-86
Run No. 3
Sample Box No. 3
Meter Box No. 688836
Meter H @ 1.71
C Factor 1.0055
Pitot Tube Coefficient Cp .836

Ambient Temperature 60
Barometric Pressure 31.00
Assumed Moisture, % 15
Probe Length, m(ft) 4'
Nozzle Identification No. 0002182
Avg. Calibrated Nozzle Dia., (in.) .209/.209/.300
Probe Heater Setting 4.0
Leak Rate, m3/min. (cfm) +.014
Probe Liner Material 3/6 stainless
Static Pressure, mm Hg (in. Hg) .05
Filter No. CM-1650

	IMPINGER VOLUME, ml	SILICA GEL WEIGHT, g
FINAL	493	543
INITIAL	300	534
DIFFERENCE	193	9

Schematic of Stack Cross Section

TRAV. PT NO.	SAMPLING TIME (θ) min.	VACUUM in. Hg	STACK TEMP (Ts) °F	VELOCITY HEAD (Ps) in H20	PRESSURE DIFF. ORF. MTR in H20	GAS SAMPLE VOLUME ft3	GAS SAMPLE TEMP. AT DRY GAS METER °F Inlet	GAS SAMPLE TEMP. AT DRY GAS METER °F Outlet	FILTER HOLDER TEMP °F	GAS TEMP LVG CONDENSER OR LAST IMPINGER °F
A) 1	7:32:45 7:35	8	200	3.3	3.5	601.564 604.35	65	60	265	60
2	7:38	8	210	2.7	2.7	607.08	75	60	260	60
3	7:41	5	210	1.7	1.7	609.28	80	60	255	60
4	7:44:45	4	210	1.3	1.3	611.205	85	60	250	55
B) 1	7:45:15 7:48	8	200	3.0	3.0	614.00	85	60	245	55
2	7:51	5	210	1.8	1.8	616.27	90	60	240	55
3	7:54	5	215	1.8	1.8	618.54	90	60	250	55
4	7:57:15	6	215	2.2	2.2	621.008	90	60	250	55
C) 1	7:57:50 8:00	7	210	2.5	2.5	623.63	90	60	255	55
2	8:03	5	215	1.9	1.9	625.92	95	65	255	55
3	8:06	7	230	2.3	2.3	628.43	95	65	260	55
4	8:09:50	8	235	2.7	2.7	631.16	100	65	265	55
D) 1	8:10:20 8:13	7	220	2.3	2.3	633.72	95	65	265	55

CO^2 = 2.5 , 3.0

^{2} .

Form #REC-05

Form #REC-06

RAMCON emissions test log sheet, cont. DATE 9-10-86 LOCATION Frederick TEST NO. 3

TRAVERSE POINT	SAMPLING TIME θ (min)	VACUUM mm Hg (in. Hg)	STACK TEMP T_s (°F)	VELOCITY HEAD ΔP_s (in. H_2O)	ORFICE DIFF. PRESSURE ΔH (in. H_2O)	GAS VOLUME Vm (ft.^{3})	GAS SAMPLE TEMP. (°F) in	GAS SAMPLE TEMP. (°F) out	SAMPLE BOX TEMP. (°F)	IMPINGER TEMP (°F)
2	8:16	6	225	2.1	2.1	636.13	100	65	260	55
3	8:19	6	235	2.2	2.2	638.62	100	70	265	55
4	8:22:20	6	240	2.2	2.2	641.122	100	70	260	55
E) 1	8:22:50 8:25	7	205	2.4	2.4	643.72	100	70	260	55
2	8:28	6	225	2.2	2.2	646.22	100	70	255	55
3	8:31	5	240	1.8	1.8	648.46	100	70	250	55
4	8:34:50	6	240	2.1	2.1	650.87	100	70	250	55
F) 1	8:35:20 8:38	7	210	2.4	2.4	653.47	100	70	245	55
2	8:41	7	210	2.4	2.4	656.09	100	70	245	55
3	8:44	7	225	2.4	2.4	658.70	100	70	240	55
4	8:47:20	6	220	2.2	2.2	661.243	100	70	240	55

IX. CALIBRATIONS

METER BOX CALIBRATION DATA AND CALCULATION FORM

(English units)

Date 9-15-86 Meter box number 689836

Barometric pressure, P_b = 28.91 in. Hg Calibrated by

Orifice manometer setting (ΔH), in. H_2O	Gas volume		Temperature				Time (θ), min	Y_i	$\Delta H@_i$ in. H_2O
	Wet test meter (V_w), ft^3	Dry gas meter (V_d), ft^3	Wet test meter (t_w), °F	Dry gas meter Inlet (t_{d_i}), °F	Dry gas meter Outlet (t_{d_o}), °F	Dry gas meter Avg[a] (t_d), °F			
0.5	5	223.45 228.573	78	102 110	80 80	93	12:40	1.006	1.78
1.0	5	217.52 222.614	78	106 109	80 80	93.75	9:01	1.008	1.80
1.5	10	205.63 215.821	78	114 116	82 82	99.5	14:54	1.017	1.83
2.0	10								
3.0	10								
4.0	10								
							Avg	1.010	1.80

ΔH, in. H_2O	$\frac{\Delta H}{13.6}$	$Y_i = \frac{V_w P_b (t_d + 460)}{V_d \left(P_b + \frac{\Delta H}{13.6}\right)(t_w + 460)}$	$\Delta H@_i = \frac{0.0317 \Delta H}{P_b (t_d + 460)} \left[\frac{(t_w + 460)\theta}{V_w}\right]^2$
0.5	0.0368		
1.0	0.0737		
1.5	0.110		
2.0	0.147		
3.0	0.221		
4.0	0.294		

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[a] If there is only one thermometer on the dry gas meter, record the temperature under t_d.

METER BOX CALIBRATION DATA AND CALCULATION FORM

(English units)

Date 9-8-86　　Meter box number 685836

Barometric pressure, P_b = 29.655 in. Hg　　Calibrated by KH

Orifice manometer setting (ΔH), in. H_2O	Gas volume: Wet test meter (V_w), ft^3	Gas volume: Dry gas meter (V_d), ft^3	Temperature: Wet test meter (t_w), °F	Temperature: Dry gas meter: Inlet (t_{d_i}), °F	Temperature: Dry gas meter: Outlet (t_{d_o}), °F	Temperature: Dry gas meter: Avg[a] (t_d), °F	Time (θ), min	Y_i	$\Delta H@_i$ in. H_2O
0.5	10	134.99 140.182	75	104 110	88 88	98	12:27	1.0016	1.6998
1.0	10	128.74 133.927	76	110 112	86 88	99	8:52	1.0047	1.7225
1.5	10	116.04 126.345	75	112 112	86 86	99	14:26	1.0102	1.7095
2.0	10								
3.0	10								
4.0	10								
							Avg	1.0055	1.7106

ΔH, in. H_2O	$\frac{\Delta H}{13.6}$	$Y_i = \frac{V_w P_b (t_d + 460)}{V_d (P_b + \frac{\Delta H}{13.6}) (t + 460)}$	$\Delta H@_i = \frac{0.0317 \Delta H}{P_b (t_d + 460)} \left[\frac{(t_w + 460)\theta}{V_w}\right]^2$
0.5	0.0368	$\frac{5 \cdot 29.655 (558)}{5.192 \cdot 29.7286 \cdot 535}$ 1.0016	$\frac{.0317 \cdot .5}{29.655 \cdot \cancel{460} 558} \left[\frac{535 \cdot 12.45}{5}\right]^2$ 1.6998
1.0	0.0737	$\frac{5 \cdot 29.655 \cdot 559}{5.187 \cdot 29.7285 \cdot 535}$ 1.0047	$\frac{.0317 \cdot 1.0}{29.655 \; 559} \left[\frac{535 \cdot 8.87}{5}\right]^2$ 1.7225
1.5	0.110	$\frac{10 \cdot 29.655 \cdot 559}{10.305 \cdot 29.7653 \cdot 535}$ 1.0102	$\frac{.0317 \cdot 1.5}{29.655 \cdot 559} \left[\frac{535 \cdot 14.43}{10}\right]$ 1.7095
2.0	0.147		
3.0	0.221		
4.0	0.294		

[a] If there is only one thermometer on the dry gas meter, record the temperature under t_d.

STACK TEMPERATURE SENSOR CALIBRATION DATA FORM

Date 5-19-86 Thermocouple number Hot box

Ambient temperature 23 °C Barometric pressure 30.12 in. Hg

Calibrator LA Reference: mercury-in-glass ✓

other

Reference point number	Source[a] (specify)	Reference thermometer temperature, °C	Thermocouple potentiometer temperature, °C	Temperature difference,[b] %
A	Boiling water	100 °C	100 °C	0%
B	Ambient	23 °C	22.8 °C	< .1%
	9-9-86	53 °F	53 °F	0%

[a] Type of calibration system used.

[b] $\left[\frac{(\text{ref temp, °C} + 273) - (\text{test thermom temp, °C} + 273)}{\text{ref temp, °C} + 273}\right] 100 \le 1.5\%.$

STACK TEMPERATURE SENSOR CALIBRATION DATA FORM

Date 5-19-86 Thermocouple number inlet/outlet

Ambient temperature 23.9 °C Barometric pressure 30.12 in. Hg

Calibrator Reference: mercury-in-glass ✓

other

Reference point number	Source[a] (specify)	Reference thermometer temperature, °C	Thermocouple potentiometer temperature, °C	Temperature difference,[b] %
A	inlet Ambient	75 °F	75 °F	0 0%
B	outlet Ambient	75 °F	75 °F	0 0%
C	Ambient 9-9-86	53 °F	53 °F	0%

[a] Type of calibration system used.

[b] $\left[\frac{(\text{ref temp, °C} + 273) - (\text{test thermom temp, °C} + 273)}{\text{ref temp, °C} + 273}\right] 100 \leq 1.5\%$.

RAMCON ENVIRONMENTAL CORPORATION

Lear Siegler Stack Sampler

Nozzle Diameter Calibration

Date ______________ Signature ______________

Nozzle No.	Average Diameter	Nozzle No.	Average Diameter
1		7	
2		8	
3		9	
4		10	
5		11	
6		12	

Pitot Tube Calibration (S Type)

Pitot Tube Identification No. 44 (4ft) Date 5-12-86

Calibrated by: C. Mitchell

"A" SIDE CALIBRATION

Run No.	Δp std cm H_2O (in. H_2O)	Δp (s) cm H_2O (in. H_2O)	$C_p(s)$	DEVIATION $C_p(s)-\bar{C}_p(A)$
1	0.91	1.30	0.837	0.001
2	0.77	1.10	0.837	0.001
3	0.73	1.05	0.834	-0.002
		$\bar{C}_p$ (SIDE A)	0.836	

"B" SIDE CALIBRATION

Run No.	Δp std cm H_2O (in. H_2O)	Δp(s) cm H_2O in. H_2O)	$C_p(s)$	DEVIATION $C_p(s)-\bar{C}_p(B)$
1	0.91	1.30	0.837	0.001
2	0.77	1.10	0.837	0.001
3	0.73	1.05	0.834	-0.002
		$\bar{C}_p$ (SIDE B)	0.836	

$$\text{AVERAGE DEVIATION} = \sigma(\text{A OR B}) = \frac{\sum_{1}^{3} \left| C_p(s) - \bar{C}_p(\text{A OR B}) \right|}{3} \leftarrow \text{MUST BE} \leq 0.01$$

$$\left| \bar{C}_p(\text{SIDE A}) - \bar{C}_p(\text{SIDE B}) \right| \leftarrow \text{MUST BE} \leq 0.01$$

$$C_p(s) = C_p(std) \sqrt{\frac{\Delta p\ std}{\Delta p_s}}$$

Form No. EED-17-1

RAMCON

Lear Siegler Stack Sampler

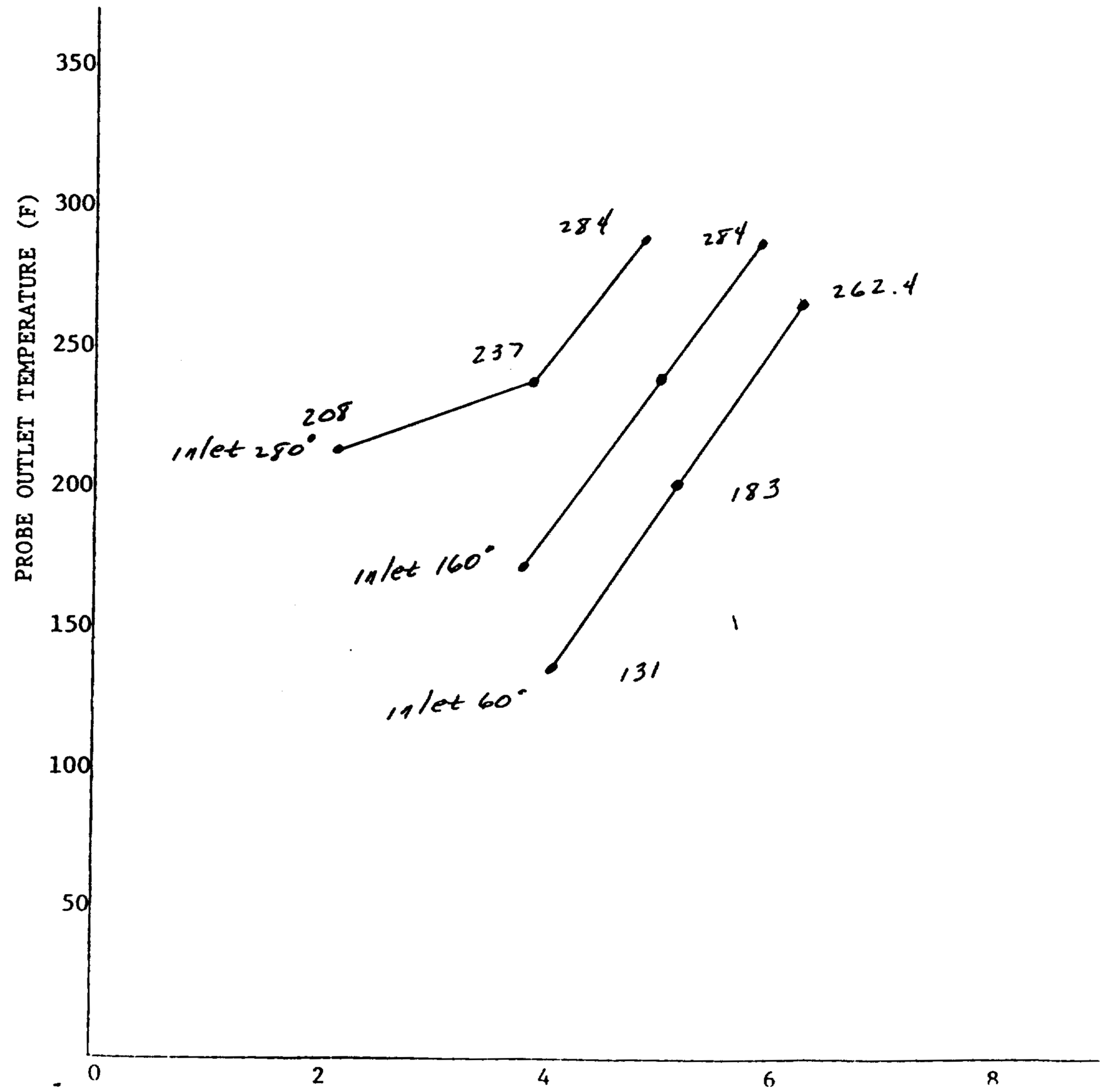
Heating Probe Calibration

Probe No. 44 Probe Length 4'

Date of Calibration 5-19-86 Signature K. B.

Name of Company to be tested ____________________

Note: 3 ft. probe - 5 min. warmup
6 ft. probe - 15 min. warmup
10 ft. probe - 30 min. warmup
Calibration flow rate = .75 CFM



STACK TEMPERATURE SENSOR CALIBRATION DATA FORM

Date 5-19-86 Thermocouple number 44

Ambient temperature 23.9 °C Barometric pressure 30.12 in. Hg

Calibrator Reference: mercury-in-glass ✓

other

Reference point number	Source[a] (specify)	Reference thermometer temperature, °C	Thermocouple potentiometer temperature, °C	Temperature difference,[b] %
A	ice water	32 °F	32 °F	0%
B	Boiling water	212 °F	212 °F	0%
C	Boiling oil	410.5 °F	411.2	< 3%
D	Ambient 9-9-86	53 °F	53 °F	0%

[a] Type of calibration system used.

[b] $$\left[\frac{(\text{ref temp, °C} + 273) - (\text{test thermom temp, °C} + 273)}{\text{ref temp, °C} + 273}\right] 100 \leq 1.5\%.$$

X. RAMCON PERSONNEL

RAMCON Environmental Stack Test Team

Sumner Buck - President

Sumner Buck is the President of RAMCON Environmental. He is a graduate of the EPA 450 "Source Sampling for Particulate Pollutants" course and the 474 "Continuous Emissions Monitoring" course all given at RTP. Mr. Buck is a qualified V.E. reader with current certification. Mr. Buck has personally sampled over 300 stacks including over 200 asphalt plants. He is 43 years old and a graduate of the University of Mississippi with graduate studies at Memphis State University and State Technical Institute of Memphis.

Ken Allmendinger - Team Leader

Ken Allmendinger has been employed with RAMCON for three years. He has sampled over 100 asphalt plants with extensive training in Methods 1 through 5. He is qualified as a team leader and has current certification as a V.E. reader.