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JUL 14 1987

Dept. of Environmental Quality
Southern District Office

RAMCON

ENVIRONMENTAL CORPORATION

RAMCON BUILDING

223 SCOTT STREET

MEMPHIS, TENNESSEE 38112

TELEPHONE 901 / 458-7000

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SOURCE SAMPLING
for
PARTICULATE EMISSIONS
BI-CO PAVING COMPANY
RAGLEY, LOUISIANA
June 23, 1987



David Waters
Bi-Co Paving Company



G. Sumner Buck, III
President



Ken Allmendinger
Team Leader

RAMCON

ENVIRONMENTAL CORPORATION

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223 SCOTT STREET

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July 6, 1987

Mr. David Waters
Bi-Co Paving Company
P.O. Box 650
Lake Charles, LA 70602

Re: Particulate Emissions Test - Ragley, Louisiana

Dear Mr. Waters:

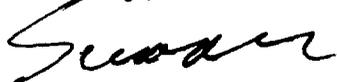
Enclosed are four copies of our report on the particulate emissions test we conducted at your plant. Based on our test results, your plant does pass both EPA New Source Performance Standards and those set by the State of Louisiana. The average grain loading of the three test runs is in compliance with Federal and State Standards.

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

Mr. William Coltrin
Louisiana D.E.Q.
Air Quality Division
P.O. Box 3047
Lake Charles, LA 70602

We certainly have enjoyed working with you and look forward to serving you again in the future.

Sincerely,



G. Sumner Buck, III
President

GSBIII:kr

Enclosures

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I. INTRODUCTION

On June 23, 1987, personnel from RAMCON Environmental Corporation (REC) conducted a source emissions test for particulate emissions compliance at Bi-Co Paving Company's Caterpillar drum mix asphalt plant located in Ragley, Louisiana. RAMCON personnel conducting the test were Ken Allmendinger, Team Leader and Allen Turner. 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. Custody of the samples was limited to Mr. Allmendinger and Ms. Rea.

The purpose of the test was to determine if the rate of particulate emissions from the plant's scrubber and the total contaminants by weight (grain loading) are below the limits set by EPA and the State of Louisiana.

II. TEST RESULTS

Table I summarizes the test results. The grain loading limitation for EPA is .04 gr/DSCF and is specified in 39 FR 9314, March 8, 1974, 60.92 Standards for Particulate Matter (1), as amended. The allowable emissions for the State of Louisiana are the same as those set by EPA.

Mr. William Coltrin of Louisiana's Department of Environmental Quality observed the testing conducted by RAMCON. Allen Turner conducted the opacity test (Reference Method 9) which ranged from 0% to 5% and therefore meets N.S.P.S. standards.

(2)

TABLE I

SUMMARY OF TEST RESULTS
June 23, 1987

<u>Test Run</u>	<u>Time</u>	<u>Grain Loading</u>	<u>Isokinetic Variation</u>	<u>Actual Emissions</u>
1	08:30 to 09:41	0.0277 gr/DSCF	110%	3.0 lbs/hr
2	10:50 to 12:35	0.0401 gr/DSCF	109%	4.3 lbs/hr
3	15:07 to 16:11	0.0349 gr/DSCF	108%	3.7 lbs/hr
	Average:	0.0342 gr/DSCF		3.7 lbs/hr

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 Louisiana. 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.

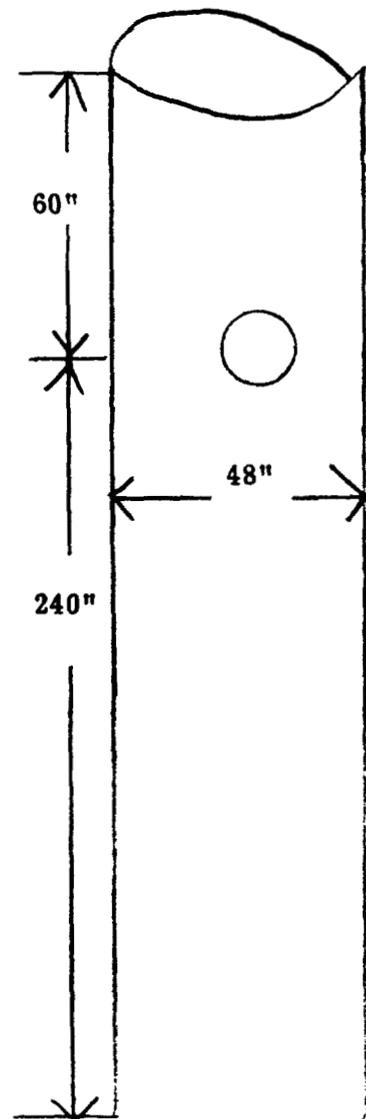
B. Problems Encountered: No problems were encountered that affected testing.

(3)

C. Sampling Site: The emissions test was conducted after a scrubber on a round stack with a diameter of 48". The sampling ports were placed 60" down (1.25 diameters upstream) from the top of the stack and 240" up (5.0 diameters downstream) from the last flow disturbance. Twenty four points were sampled, twelve through each traverse for 2.5 minutes each.

<u>Points on a Diameter</u>	<u>Probe Mark</u>
1	*6.0"
2	8.2"
3	13.7"
4	16.5"
5	17.0"
6	21.1"
7	36.0"
8	41.0"
9	45.0"
10	47.3"
11	49.8"
12	52.0"

*Measurements include a
5.0" standoff.



IV. THE SOURCE

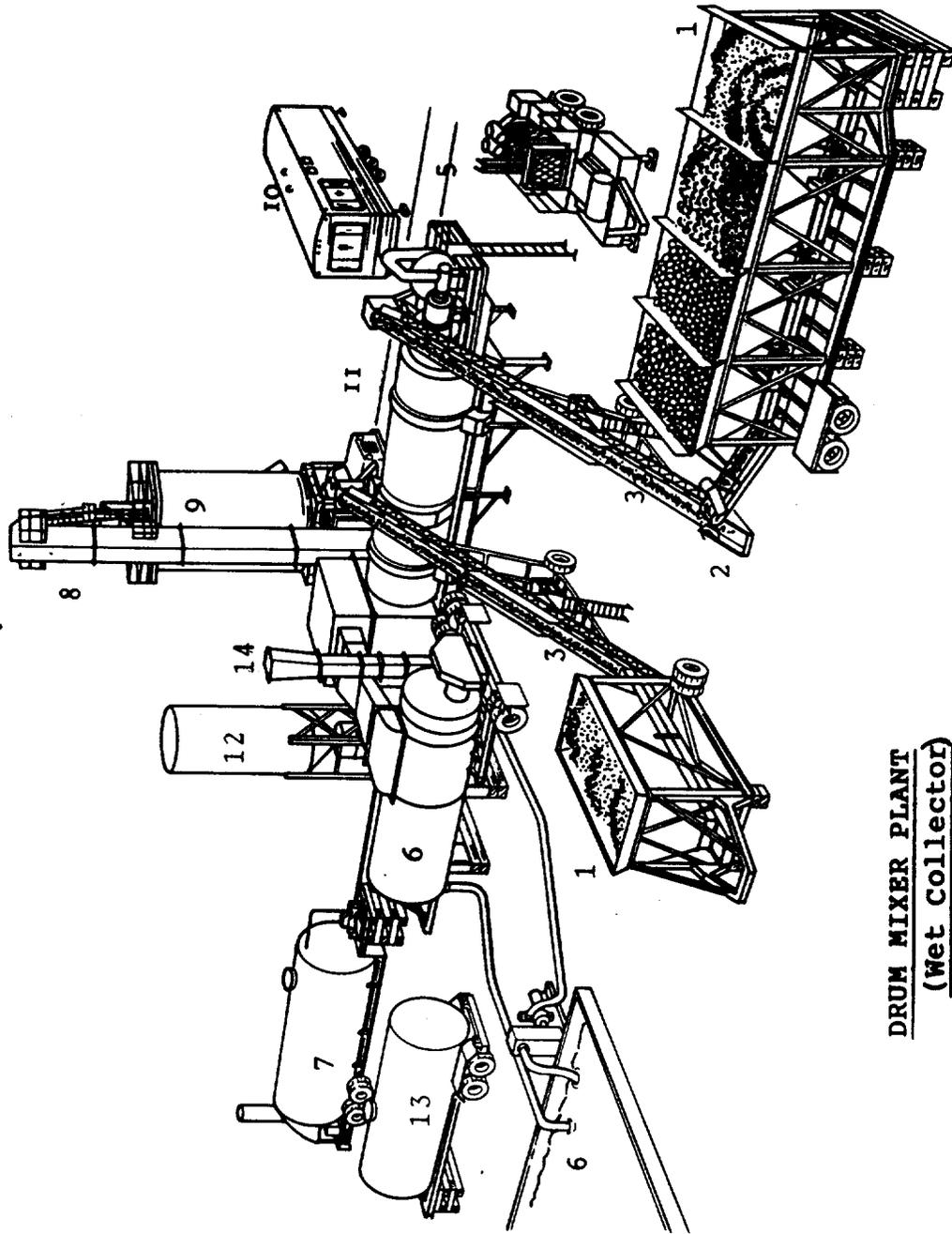


IV. THE SOURCE

Bi-Co Paving Company employs a Caterpillar drum 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 required amount of hot asphalt oil is then injected onto and mixed into the dried aggregate. The now newly formed hot asphalt mix is pulled to the top of a storage silo by conveyor. 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 mixer uses a burner fired with natural gas to heat air to dry the aggregate, and the motion of the rotating drum to blend the aggregate and hot asphalt oil thoroughly. 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 high efficiency scrubber. The scrubber was manufactured by Caterpillar. The exhaust gasses are drawn through the scrubber and discharged to the atmosphere through the stack. The design pressure drop across the venturi is in excess of 8 inches of water. The particulate matter, which is removed by the scrubber is fed into the scrubber pond where it drops out of suspension.



DRUM MIXER PLANT
(Wet Collector)

1. **Aggregate bins:** Virgin ⁽⁶⁾ and recycled aggregate is fed individually into each of the bins by type. It is metered onto a conveyor belt running under the bins to a shaker screen. The proportion of each aggregate type is determined by the job mix formula and pre-set to be metered out to meet these specifications.
2. **Preliminary oversize screen:** The aggregate is fed through a shaker screen where oversize rocks and foreign material is screened out of the mix.
3. **Weigh conveyor belt:** The aggregate is conveyed to the rotary drum dryer on a conveyor belt which weighs the material. The production rate is determined by this weight reading.
4. **Rotary drum dryer/mixer:** The aggregate is fed into the rotary drum dryer where it is tumbled by flighting into a veil in front of a gas flame which drives off the moisture. Further mixing is also accomplished in this drum. Hot liquid asphalt is injected approximately one-third of the way down the inclined drum where it is mixed with the aggregate.
5. **Burner:** The fuel fired burner is used to dry the rough aggregate and sand in the rotating drum as well as reheat recycled asphalt when it is part of the mix.
6. **Wet scrubbing system:** A system of cyclonic action, spray nozzles and a venturi removes 99% of particulates in the gas stream.
7. **Liquid asphalt storage:** The liquid asphalt is stored in this heated tank until it is needed in the mixer. The amount of asphalt content and its temperature are pre-set for each different type job.
8. **Conveyor to surge/storage bin:** The finished product of aggregate mixed with liquid asphalt is conveyed to a surge bin.
9. **Surge/storage bin:** The asphaltic cement is dumped into this surge bin and metered out to dump trucks which pull underneath the slide gate at the bottom of the bin.
10. **Control/operators house:** The entire plant operation is controlled from this operator's house.
11. **Truck loading scale:** As the trucks receive the asphalt from the storage/surge bin they are weighed on the loading scale which tells the plant operator the amount of asphalt that is being trucked on each individual load.
12. **Mineral filler system (when used).**
13. **Burner fuel storage (when used).**
14. **Stack.**

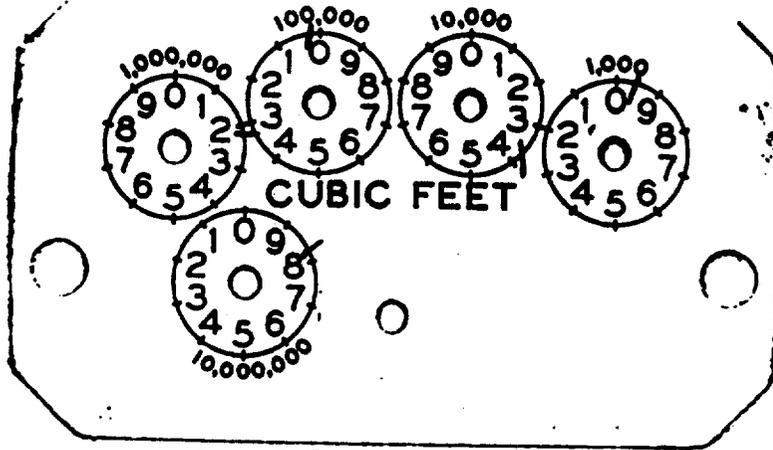
PLANT DATA⁽⁸⁾

COMPANY NAME R. Co Lumber Company
 COMPANY REP. D. N. Witt DATE 6-23-87 PHONE # 318-725-6175
 DATA SOURCE _____
 PLANT LOCATION RAGLEY, LOUISIANA
 PLANT MFG. CATERPILLAR PLANT MODEL # LVM-1400-107 PLANT TYPE DRUM MIXER
 MIX SPECIFICATION # 1-WEAR OIL SPECIFICATION # 30

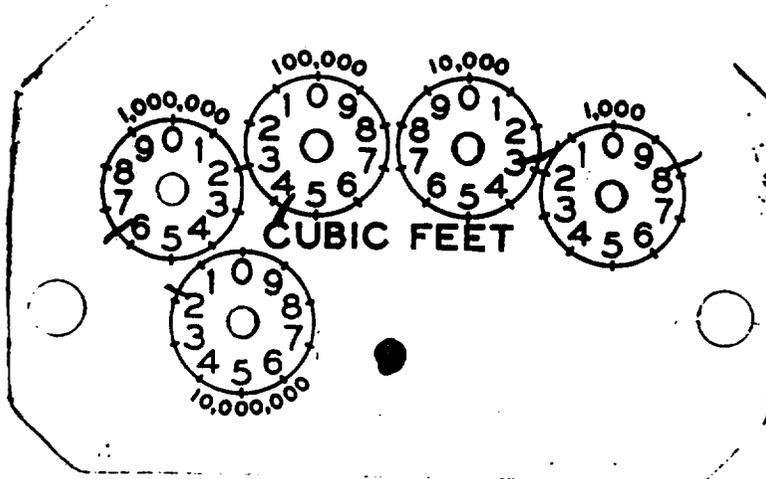
Time 24 Hour	Fuel Oil Nat. Gas <input checked="" type="checkbox"/> Propane <input type="checkbox"/> Coal <input type="checkbox"/>	Burner Setting	Aggregate TPH	Recycle TPH	Liquid Asphalt TPH	Mix Temp. OF	Venturi Baghouse Pressure Drop
							Inches Water
<i>START TEST #1</i> 8:33 AM		40	191	—	9.9	300	15.7
	Run 1	40	189	—	9.6	290	15.7
	111 ft ³	40	193	—	9.7	305	15.7
		45	196	9	10.2	310	15.7
		40	194	—	9.7	310	15.7
		40	198	—	9.8	300	15.7
		40	198	—	10.1	290	15.7
<i>STOP</i> 9:41 AM		45	192	—	9.4	300	15.7
			198	—	10.0	300	15.7
<i>START TEST #2</i> 10:50		40	198	—	10.0	300	15.7
	Run 2	45	197	—	10.2	300	15.7
	151 ft ³	45	197	—	10.6	275	15.7
		45	196	—	10.3	310	15.7
		45	193	—	10.3	305	15.7
		40	194	—	9.8	300	15.7
		40	192	—	9.7	300	15.7
<i>STOP</i> 12:35 PM		40	194	—	9.8	300	15.7
		40	192	—	9.8	300	15.7
<i>START TEST #3</i> 3:07 PM	Run 3	40	192	—	9.8	300	15.7
	94 ft ³	40	190	—	9.5	300	15.7
		40	192	—	9.7	300	15.7
		40	194	—	9.5	290	15.7
		40	196	—	10.0	300	15.7
		40	191	—	9.3	300	15.7
<i>Top</i> 4:11 PM		40	193	—	9.4	300	15.7

6/22/87

(9) 7-11-1111
Begin Test 1



$$82039 = 142.00$$

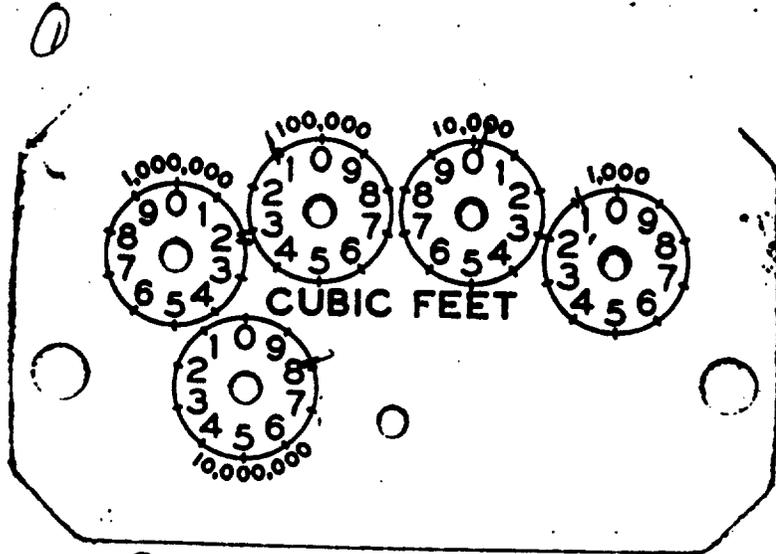


$$16428 = 141.00$$

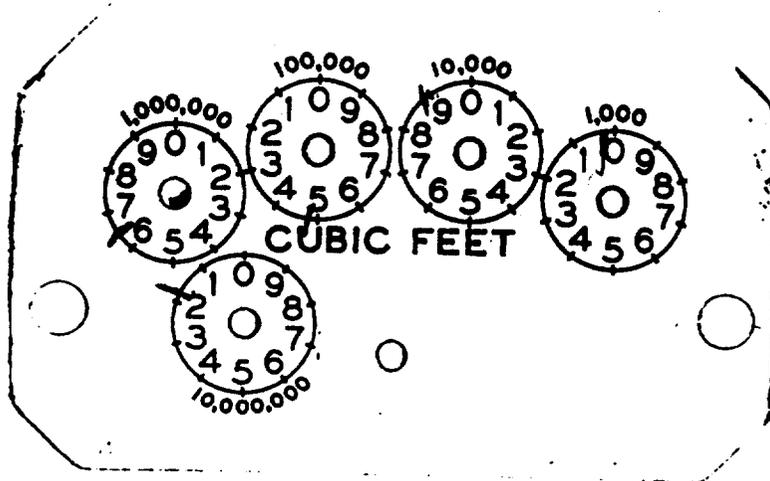
6/23/81

7:50 PM
(10)

End Test 1 & Begin Test 2



$$82100 = 6100$$

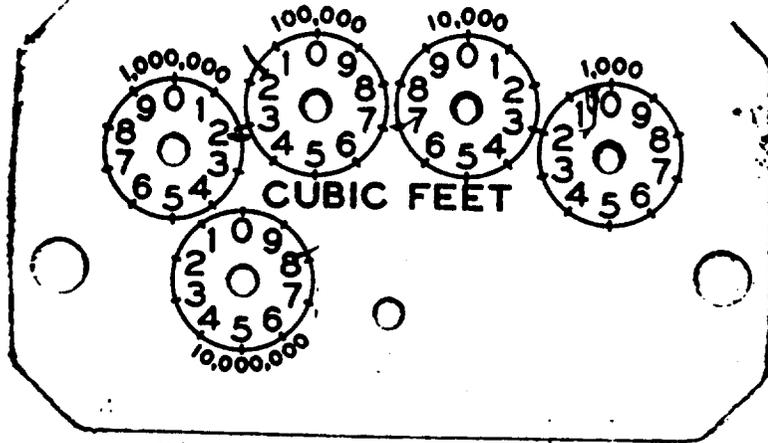


$$16480 = 5200$$

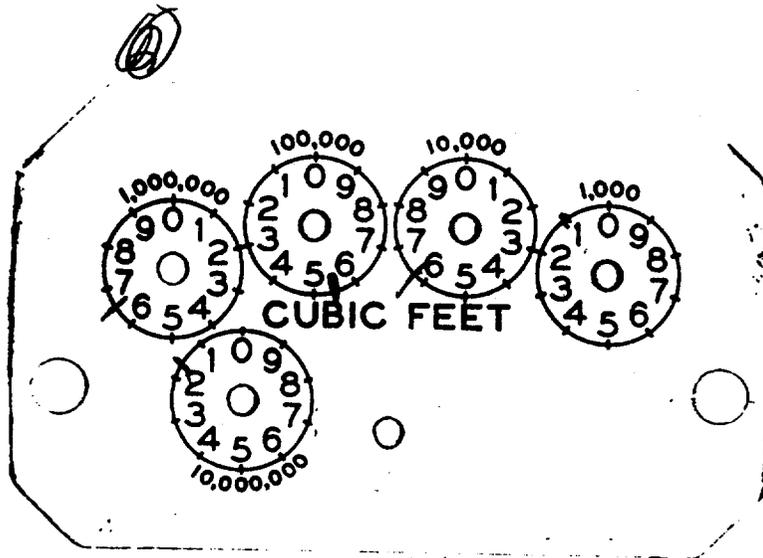
42318/

(II)

End Test 2 & Begin Test 3

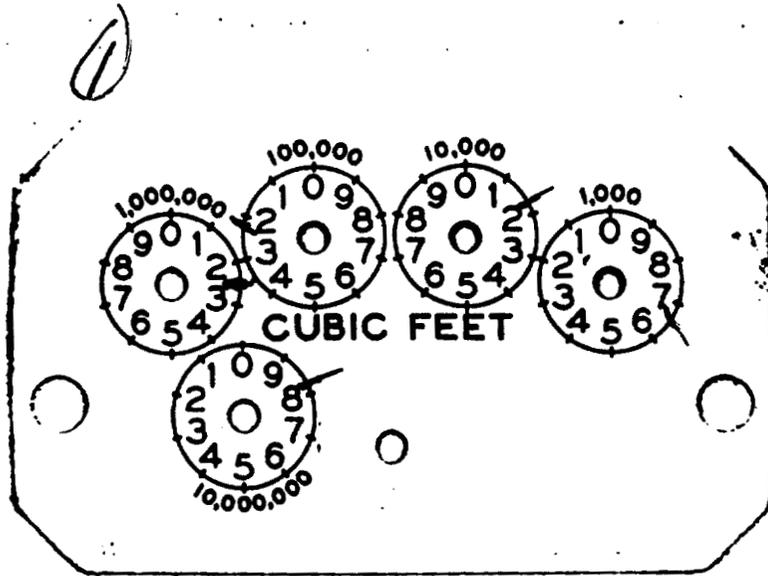


82170 = 70.00

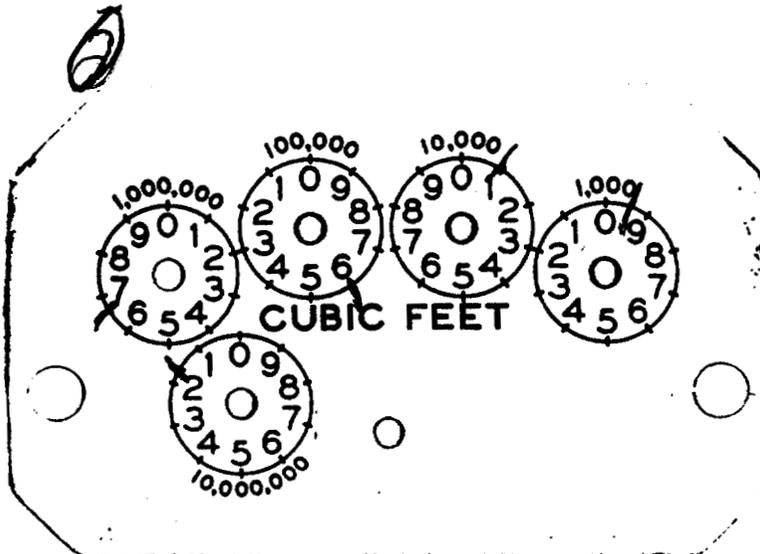


16561 = 81.00

6/23/87 End Test 3
(12)



$$82216 = 4600$$



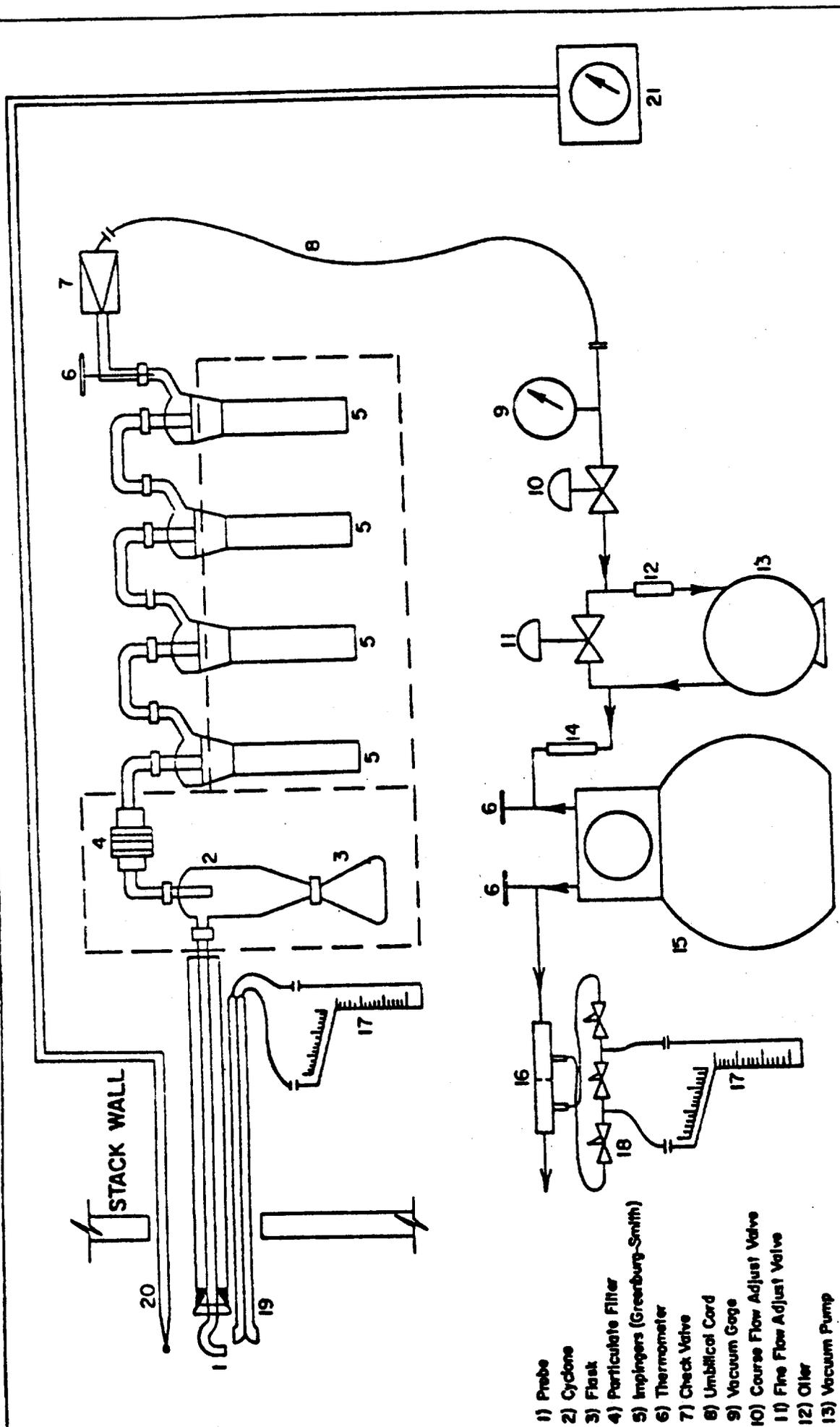
$$16009 = 4800$$

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 $\leq .001$.



SAMPLING TRAIN USED FOR ISOKINETIC SAMPLING

- 1) Probe
- 2) Cyclone
- 3) Flask
- 4) Particulate Filter
- 5) Impingers (Greenburg-Smith)
- 6) Thermometer
- 7) Check Valve
- 8) Umbilical Cord
- 9) Vacuum Gage
- 10) Course Flow Adjust Valve
- 11) Fine Flow Adjust Valve
- 12) Filter
- 13) Vacuum Pump
- 14) Filter
- 15) Dry Gas Meter
- 16) Orifice Tube
- 17) Incline Manometer
- 18) Snelrod Valves
- 19) Pilot
- 20) Thermocouple
- 21) Pyrometer

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.

SAMPLE ANALYTICAL DATA FORM

Plant Location Bi-Co Paving Relative humidity in lab 47 %

Sample Location hot mix asphalt plant Density of Acetone (ρ_a) .7853 mg/ml

Blank volume (V_a) 200 ml

Date/Time wt. blank 6/25/87

Gross wt. 96.3650 mg

Date/Time wt. blank 6/26/87

Gross wt. 96.3650 mg

Ave. Gross wt. 96.3650 mg

Tare wt. 96.3648 mg

Weight of blank (m_{ab}) .0002 mg

Acetone blank residue concentration (C_a) (C_a) = (M_{ab}) / (V_a) (ρ_a) = (.00002) / (200) (.7853) = (.000013 mg/g)

Weight of residue in acetone wash: $W_a = C_a V_{aw} \rho_a = (.000013)(200)(.7853) = (.0002)$

	Run # 1	Run # 2	Run # 3
Acetone rinse volume (V_{aw}) ml	200	200	200
Date/Time of wt <u>6/25/87 9:00</u> Gross wt g	93.5869	111.3370	97.3050
Date/Time of wt <u>6/26/87 3:00</u> Gross wt g	93.5869	111.3369	97.3048
Average Gross wt g	93.5869	111.3370	97.3049
Tare wt g	93.5333	111.2582	97.2360
Less acetone blank wt (W_a) g	.0002	.0002	.0002
Wt of particulate in acetone rinse (m_a) g	.0534	.0786	.0687

	Filter Numbers	#	KP-2142	KP-2141	KP-2140
Date/Time of wt <u>6/25/87 9:00</u> Gross wt g			.5453	.5463	.5439
Date/Time of wt <u>6/26/87 3:00</u> Gross wt g			.5451	.5462	.5439
Average Gross wt g			.5452	.5463	.5439
Tare wt g			.5374	.5367	.5374

Weight of particulate on filters(s) (m_f) g	.0078	.0096	.0065
Weight of particulate in acetone rinse g	.0534	.0786	.0687
Total weight of particulate (m_T) g	.0612	.0882	.0752

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 The "particulate" in the probe wash was an oily residue

Signature of analyst Kim Bea Signature of reviewer _____

VII. CALCULATIONS

NAME: BI CO PAVING COMPANY

LOCATION: RAGLEY, LOUISIANA

date 6/23/87 6/23/87 6/23/E

SUMMARY OF TEST DATA

RUN # 1 RUN # 2 RUN #

SAMPLING TRAIN DATA

start 08:30 10:50 15:07

finish 09:41 12:35 16:11

1	Sampling time, minutes	θ	60	60	60
2	Sampling nozzle diameter, in.	D_n	.310	.310	.310
3	Sampling nozzle cross-sectional area, ft^2	A_n	.000524	.000524	.000524
4	Isokinetic variation	I	110	109	108
5	Sample gas volume - meter conditions, cf.	V_m	36.41	36.87	36.56
6	Average meter temperature, $^{\circ}R$	T_m	567	577	585
7	Average orifice pressure drop, in. H_2O	ΔH	1.09	1.10	1.06
8	Total particulate collected mg.	M_n	61.2	88.2	75.2

VELOCITY TRAVERSE DATA

9	Stack area, ft^2	A	12.6	12.6	12.6
10	Absolute stack gas pressure, in. Hg.	P_s	30.18	30.18	30.18
11	Barometric pressure, in. Hg.	P_{bar}	30.18	30.18	30.18
12	Average absolute stack temperature, $^{\circ}R$	T_s	651	653	657
13	Average $\sqrt{\text{velocity head}}$, ($C_p = .79$)	$\sqrt{\Delta P}$.47	.47	.47
14	Average stack gas velocity ft. / sec.	V_s	29	29	29

STACK MOISTURE CONTENT

15	Total water collected by train, ml.	V_{ic}	318.0	307.0	312.0
16	Moisture in stack gas, %	B_{ws}	30.6	30.0	30.7

EMISSIONS DATA:

17	Stack gas flow rate, dscf/hr. (000's)	Q_{sd}	749	751	745
18	Total particulate concentration, gr/dscf	C_s	.0277	.0401	.0349
19	Total particulate concentration, lbs/hr	E	3.0	4.3	3.7
20	Total particulate concentration, lbs/mbtu	E^1	.0000	.0000	.0000

ORSAT DATA

21	Percent CO_2 by volume	CO_2	4.0	5.5	4.0
22	Percent O_2 by volume	O_2	10.5	11.0	12.0
23	Percent CO by volume	CO	.0	.0	.0
24	Percent N_2 by volume	N_2	85.5	83.5	84.0

Dry Gas Volume :

$$V_{m(\text{std})} = V_m \left[\frac{T_{(\text{std})}}{T_m} \right] \left[\frac{P_{\text{bar}} + \Delta H}{13.6} \right] = 17.64 \frac{^{\circ}\text{R}}{\text{in.Hg.}} Y V_m \left[\frac{P_{\text{bar}} + \Delta H}{13.6} \right] \left[\frac{1}{T_m} \right]$$

Where:

$V_{m(\text{std})}$ = 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 orifice meter, in. Hg.

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

T_m = Absolute temperature at meter $^{\circ}\text{R}$

T_{std} = Standard absolute temperature (528 $^{\circ}\text{R}$)

ΔH = Average pressure drop across orifice meter, in.H₂O

Y = Dry gas meter calibration factor

13.6 = Inches water per inches Hg.

$$\text{Run \# 1 } V_{m(\text{std})} = 17.64 (.99)(36.41) \left[\frac{(30.18) + \frac{1.09}{13.6}}{567} \right] = 34.07 \text{ ds}$$

$$\text{Run \# 2 } V_{m(\text{std})} = 17.64 (.99)(36.87) \left[\frac{(30.18) + \frac{1.10}{13.6}}{577} \right] = 33.91 \text{ ds}$$

$$\text{Run \# 3 } V_{m(\text{std})} = 17.64 (.99)(36.56) \left[\frac{(30.18) + \frac{1.06}{13.6}}{585} \right] = 33.16 \text{ ds}$$

Total contaminants by weight: 'GRAIN LOADING'

Particulate concentration C_s' gr./dscf.

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

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.

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

$$\text{Run \# 1: } C_s' = \left[0.0154 \frac{\text{gr}}{\text{mg}} \right] \left[\frac{61.2}{34.07} \right] = .0277 \text{ gr./dscf.}$$

$$\text{Run \# 2: } C_s' = \left[0.0154 \frac{\text{gr}}{\text{mg}} \right] \left[\frac{88.2}{33.91} \right] = .0401 \text{ gr./dscf.}$$

$$\text{Run \# 3: } C_s' = \left[0.0154 \frac{\text{gr}}{\text{mg}} \right] \left[\frac{75.2}{33.16} \right] = .0349 \text{ gr./dscf.}$$

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: $M_d = 0.44(4.0\%) + 0.32(10.5\%) + 0.28(.0\% + 85.5\%) = 29.1$
lb./lb.-mole

Run # 2: $M_d = 0.44(5.5\%) + 0.32(11.0\%) + 0.28(.0\% + 83.5\%) = 29.3$
lb./lb.-mole

Run # 3: $M_d = 0.44(4.0\%) + 0.32(12.0\%) + 0.28(.0\% + 84.0\%) = 29.1$
lb./lb.-mole

Water vapor condensed :

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

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

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) (308.0) = 14.5 cu.ft
 $V_{wsg(std)}$ = (0.04715) (10.0) = .5 cu.ft

Run # 2: $V_{wc(std)}$ = (0.04707) (295.0) = 13.9 cu.ft
 $V_{wsg(std)}$ = (0.04715) (12.0) = .6 cu.ft

Run # 3: $V_{wc(std)}$ = (0.04707) (300.0) = 14.1 cu.ft
 $V_{wsg(std)}$ = (0.04715) (12.0) = .6 cu.ft

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

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).

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

Run # 1:
$$B_{ws} = \frac{14.5 + .5}{14.5 + .5 + 34.07} \times 100 = 30.6 \%$$

Run # 2:
$$B_{ws} = \frac{13.9 + .6}{13.9 + .6 + 33.91} \times 100 = 30.0 \%$$

Run # 3:
$$B_{ws} = \frac{14.1 + .6}{14.1 + .6 + 33.16} \times 100 = 30.7 \%$$

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:
$$M_s = 29.1 (1 - .306) + 18 (.306) = 25.7 \text{ (lb./lb.-mole).}$$

Run # 2:
$$M_s = 29.3 (1 - .300) + 18 (.300) = 25.9 \text{ (lb./lb.-mole).}$$

Run # 3:
$$M_s = 29.1 (1 - .307) + 18 (.307) = 25.7 \text{ (lb./lb.-mole).}$$

Stack gas velocity:

$$V_s = K_p C_p \left[\Delta P \right]^{1/2} \text{ avg. } \left[\frac{T_s(\text{avg.})}{P_s M_s} \right]^{1/2}$$

Where:

- V_s = Average velocity of gas stream in stack, ft./sec.
 K_p = 85.49 ft/sec $\left[\frac{(\text{g/g-mole})-(\text{mm Hg})}{(^{\circ}\text{K})(\text{mm H}_2\text{O})} \right]^{1/2}$
 C_p = Pitot tube coefficient, (dimensionless).
 ΔP = Velocity head of stack gas, in. H₂O.
 P_{bar} = Barometric pressure at measurement site, (in.Hg).
 P_g = Stack static pressure (in.Hg).
 P_s = Absolute stack gas pressure, (in.Hg) = $P_{\text{bar}} + P_g$
 P_{std} = Standard absolute pressure, (29.92 in.Hg).
 t_s = Stack temperature, ($^{\circ}\text{f}$).
 T_s = Absolute stack temperature, ($^{\circ}\text{R}$). = 460 + t_s .
 M_s = Molecular weight of stack gas, wet basis, (lb/lb-mole).

$$\text{Run \# 1: } V = (85.49) (.79) (.47) \left[\frac{651}{(30.18)(25.70)} \right]^{1/2} = 29.08 \text{ ft/sec}$$

$$\text{Run \# 2: } V = (85.49) (.79) (.47) \left[\frac{653}{(30.18)(25.91)} \right]^{1/2} = 29.01 \text{ ft/sec}$$

$$\text{Run \# 3: } V = (85.49) (.79) (.47) \left[\frac{657}{(30.18)(25.69)} \right]^{1/2} = 29.22 \text{ ft/sec}$$

Stack gas flow rate:

$$Q_{sd} = 3600 \left[1 - B_{wc} \right] V_s A \left[\frac{T_{std}}{T_{stk}} \right] \left[\frac{P_s}{P_{std}} \right]$$

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:

$$Q_{sd} = 3600 (1-.306) (29.08) (12.6) \left[\frac{528}{651} \right] \left[\frac{30.18}{29.92} \right] = 748924 \text{ dscf/}$$

Run # 2:

$$Q_{sd} = 3600 (1-.300) (29.01) (12.6) \left[\frac{528}{653} \right] \left[\frac{30.18}{29.92} \right] = 751272 \text{ dscf/}$$

Run # 3:

$$Q_{sd} = 3600 (1-.307) (29.22) (12.6) \left[\frac{528}{657} \right] \left[\frac{30.18}{29.92} \right] = 744582 \text{ dscf/}$$

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).

$$\text{Run \# 1: } E = \frac{(.0277)(748924)}{7000} = 3.0 \text{ lb. / hr.}$$

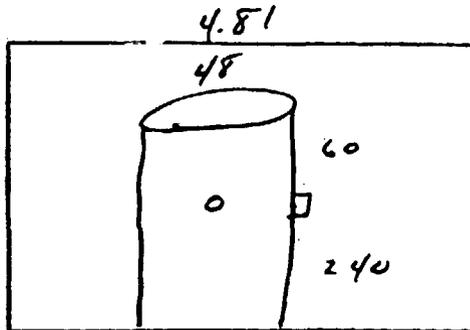
$$\text{Run \# 2: } E = \frac{(.0401)(751272)}{7000} = 4.3 \text{ lb. / hr.}$$

$$\text{Run \# 3: } E = \frac{(.0349)(744582)}{7000} = 3.7 \text{ lb. / hr.}$$

VIII. FIELD DATA

RAMCON ENVIRONMENTAL CORPORATION

Plant Bi-Cu
 Location Lake Charles La
 Operator K. H. Meadinger
 Date 6-23-87
 Run No. 1
 Sample Box No. 1
 Meter Box No. 646882
 Meter H @ 1.66
 C Factor .998
 Pitot Tube Coefficient Cp .79



Ambient Temperature 55
 Barometric Pressure 30.18 FINAL 508 318
 Assumed Moisture, % 2.5 INITIAL 200 308
 Probe Length, m(ft) 5 DIFFERENCE 308 10
 Nozzle Identification No. .0005241
 Avg. Calibrated Nozzle Dia., (in.) .319/.319/.310
 Probe Heater Setting 4.5
 Leak Rate, m³/min. (cfm) +1.003
 Probe Liner Material 316 Stainless
 Static Pressure, mm Hg (in. Hg) _____
 Filter No. LP-2142

Schematic of Stack Cross Section

TRAV. PT NO.	SAMPLING TIME (θ)min.	VACUUM in. Hg	STACK TEMP (Ts) °F	VELOCITY HEAD (Ps) in H2O	PRESSURE DIFF. ORF. MTR in H2O	GAS SAMPLE VOLUME ft ³	GAS SAMPLE TEMP. AT DRY GAS METER °F		FILTER HOLDER TEMP °F	GAS TEMP LVG CONDENSER OR LAST IMPINGER °F
							Inlet	Outlet		
A) 1	8:30:30 8:33	3	180	.25	1.2	879.13 880.58	90	55	265	60
2	8:35:30	3	180	.24	1.2	882.14	100	85	265	60
3	8:38	3	190	.24	1.3	883.81	105	90	260	60
4	8:40:30	3	190	.26	1.3	885.49	110	90	260	55
5	8:43	3	190	.27	1.3	887.18	110	90	260	55
6	8:45:30	3	190	.27	1.3	888.86	115	90	260	55
7	8:48	3	190	.23	1.1	890.83	115	90	260	55
8	8:50:30	3	190	.23	1.1	891.93	120	90	260	55
9	8:53	3	190	.23	1.1	893.44	120	90	260	55
10	8:55:30	3	190	.22	1.1	895.02	120	95	260	55
11	8:58	3	190	.22	1.1	896.55	120	95	260	55
12	9:00:30	3	195	.20	.96	898.922	120	95	260	55
B) 1	9:10:00 9:13:30	1	170	.10	.48	899.07	110	100	240	55

CO₂ = 4.0 4.0

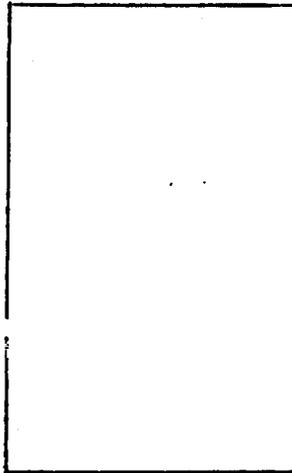
RAMCON emissions test log sheet, cont. DATE 6-23-87 LOCATION Lake Charles TEST NO. 1

TRAVERSE POINT	SAMPLING TIME o (min)	VACUUM mm Hg (in. Hg)	STACK TEMP T _s (°F)	VELOCITY HEAD ΔP _s (in. H ₂ O)	ORFICE DIFF. PRESSURE ΔH (in. H ₂ O)	GAS VOLUME V _m (ft. ³)	GAS SAMPLE TEMP. (°F)		SAMPLE BOX TEMP. (°F)	IMPINGER TEMP (°F)
							in	out		
2	9:14	3	195	.15	.72	900.31	120	100	250	55
3	9:18:30	3	195	.20	.96	901.73	120	100	250	55
4	9:21	3	195	.21	1.0	903.19	125	100	255	55
5	9:23:30	3	195	.21	1.0	904.68	125	100	255	55
6	9:24	3	195	.21	1.0	906.14	125	100	260	55
7	9:28:30	4	195	.23	1.1	907.68	125	100	260	55
8	9:31	4	195	.23	1.1	909.19	130	100	260	55
9	9:33:30	4	195	.23	1.1	910.69	130	100	260	55
10	9:36	4	195	.24	1.2	912.28	130	100	260	55
11	9:38:30	4	195	.24	1.2	913.91	130	100	260	55
12	9:41	4	195	.24	1.2	915.525	130	100	260	55

(bc)

RAMCON ENVIRONMENTAL CORPORATION

Plant A1-Co
 Location Lake Charles La
 Operator R. Allmendinger
 Date 6-23-87
 Run No. 2
 Sample Box No. 2
 Meter Box No. 676882
 Meter H @ 1.44
 C Factor 987
 Pitot Tube Coefficient Cp .78



Ambient Temperature 50
 Barometric Pressure 30.18
 Assumed Moisture, % 2.5
 Probe Length, m(ft) 5
 Nozzle Identification No. 0005241
 Avg. Calibrated Nozzle Dia., (in.) 3.10/3.10/3.10
 Probe Heater Setting 4.5
 Leak Rate, m³/min. (cfm) 1.002
 Probe Liner Material 3/6 steel/cas
 Static Pressure, mm Hg (in. Hg) 2.95
 Filter No. 12

Schematic of Stack Cross Section

TRAV. PT NO.	SAMPLING TIME (θ) min.	VACUUM in. Hg	STACK TEMP (Ts) °F	VELOCITY HEAD (Ps) in H2O	PRESSURE DIFF. ORF. MTR in H2O	GAS SAMPLE VOLUME ft ³	GAS SAMPLE TEMP. °F		FILTER HOLDER TEMP °F	GAS TEMP LVG CONDENSER OR LAST IMPINGER °F
							Inlet	Outlet		
A) 1	10:50:15 10:52:45	1	135	.18	.87	95.733 919.54	110	105	245	60
2	10:55:15	3	195	.25	1.2	920.18	120	105	245	60
3	10:57:45	3	195	.25	1.2	921.76	125	100	245	60
4	11:00:15	3	195	.25	1.2	923.36	125	100	250	55
5	11:02:45	3	195	.25	1.2	924.93	130	105	255	55
6	11:05:15	3	195	.22	1.1	925.99	125	105	255	55
7	11:06:15 11:08:15	3	200	.22	1.1	927.35	130	105	260	55
8	11:11:15	3	200	.22	1.1	929.03	120	110	260	55
9	11:18:40 11:21:10	3	195	.22	1.1	929.76	130	110	260	55
10	11:23:40	3	195	.22	1.1	930.70	125	110	260	55
11	11:24:10	3	195	.22	1.1	934.109	115	110	260	55
12	11:54:30 11:57	3	195	.22	1.1	935.34	120	110	260	55
B) 1	12:05:30 12:08	2	195	.15	.72					

CO₂ = 5.5

RAMCON emissions test log sheet, cont. DATE 6-23-87 LOCATION Lake Charles TEST NO. 2

TRAVERSE POINT	SAMPLING TIME (min)	VACUUM (in. Hg)	STACK TEMP (°F)	VELOCITY (ft/min)	ORIFICE DIFF. PRESSURE (in. H ₂ O)	GAS VOLUME (ft ³)	GAS SAMPLE TEMP. (°F)		SAMPLE BOX TEMP. (°F)	IMPINGER TEMP. (°F)
							in	out		
2	12:10:30	2	195	.15	.87	936.74	125	110	260	55
3	12:13	3	195	.20	.96	958.19	130	105	265	55
4	12:15:30	3	195	.20	.96	939.68	130	105	265	55
5	12:18	3	195	.20	.96	941.14	130	105	265	55
6	12:20:30	3	195	.23	1.1	942.73	130	105	265	55
7	12:23	3	195	.23	1.1	944.28	130	105	265	55
8	12:25:30	3	195	.24	1.2	945.93	130	105	265	55
9	12:28	4	195	.25	1.2	947.56	135	110	265	55
10	12:30:30	4	195	.25	1.2	949.18	135	110	265	55
11	12:33	4	195	.24	1.3	950.89	135	110	265	55
12	12:35:30	4	195	.24	1.3	952.606	135	110	265	55

RAMCON ENVIRONMENTAL CORPORATION

Plant B. Co
 Location Lake Charles La
 Operator R. Allmendinger
 Date 6-23-87
 Run No. 3
 Sample Box No. 3
 Meter Box No. 64682
 Meter H # 166
 C Factor 994
 Pitot Tube Coefficient Cp .75

Ambient Temperature 85
 Barometric Pressure 30.18
 Assumed Moisture, % 2.5
 Probe Length, m(ft) 4
 Nozzle Identification No. 0005241
 Avg. Calibrated Nozzle Dia., (in.) 3.01
 Probe Heater Setting 4.5
 Leak Rate, m³/min. (cfm) 4.002
 Probe Liner Material 3/6 stain/less
 Static Pressure, mm Hg (in. Hg) _____
 Filter No. _____

Schematic of Stack Cross Section

TRAV. PT NO.	SAMPLING TIME (θ) min.	VACUUM in. Hg	STACK TEMP (Ts) °F	VELOCITY HEAD (Ps) in H2O	PRESSURE DIFF. ORF. MTR in H2O	GAS SAMPLE VOLUME ft ³	GAS SAMPLE TEMP. AT DRY GAS METER °F		FILTER HOLDER TEMP °F	GAS TEMP LVG CONDENSER OR LAST IMPINGER °F
							Inlet	Outlet		
A) 1	3:07:20 3:09:50	2	195	.18	.87	953.46 954.87	120	120	270	65
2	3:12:20	3	195	.24	1.2	956.47	125	115	245	65
3	3:14:50	3	195	.24	1.2	958.09	130	115	245	60
4	3:17:20	3	195	.25	1.2	959.72	130	115	265	60
5	3:19:50	3	195	.25	1.2	961.30	135	110	245	60
6	3:22:20	3	195	.25	1.2	962.91	135	110	245	55
7	3:24:50	3	195	.25	1.2	964.50	135	110	265	55
8	3:27:20	3	200	.23	1.1	966.06	140	110	265	55
9	3:29:50	3	200	.21	1.0	967.52	140	110	260	55
10	3:32:20	3	200	.21	1.0	969.03	140	110	260	55
11	3:34:50	3	200	.21	1.0	970.53	140	110	260	55
12	3:37:20	3	200	.20	.96	972.00	140	110	260	55
B) 1	3:41:20 3:43:50	4	170	.22	1.1	973.49	130	115	260	55

0.2 = 12.0

IX. CALIBRATIONS

METER BOX CALIBRATION DATA AND CALCULATION FORM

(English units)

Date 6-29-87Meter box number 646882Barometric pressure, $P_b = 29.76$ in. Hg Calibrated by dot

Orifice manometer setting (ΔH), in. H ₂ O	Gas volume		Temperature				Time (θ), min	Y_i	$\Delta H @_i$ in. H ₂ O
	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	Outlet (t_{d_o}), °F	Avg ^a (t_d), °F			
0.5	5	486.97 478.024	86	120 120	85 85	102.5	12:29	1.017	1.75
1.0	5	477.63 482.658	86	115 120	85 85	101.25	8:53	1.016	1.78
1.5	10	466.14 476.19	86	115 120	85 85	101.25	14:32	1.019	1.79
2.0	10								
3.0	10								
4.0	10								
							Avg	1.017	1.78

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

METER BOX CALIBRATION DATA AND CALCULATION FORM

(English units)

Date 6-19-87Meter box number 646882Barometric pressure, $P_b = 29.96$ in. Hg Calibrated by WST

Orifice manometer setting (ΔH), in. H ₂ O	Gas volume		Temperature				Time (θ), min	Y_i	$\Delta H @_i$ in. H ₂ O
	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	Outlet (t_{d_o}), °F	Avg ^a (t_d), °F			
0.5	5	873.76 878.96	77	105 110	85 85	96.25	12:08	.978	1.41
1.0	5	866.96 872.122	77	110 110	80 85	92.25	8:44	1.001	1.67
1.5	10	855.25 865.58	77	105 110	80 85	95	14:22	1.003	1.70
2.0	10								
3.0	10								
4.0	10								
							Avg	.994	1.66

ΔH , in. H ₂ O	$\frac{\Delta H}{13.6}$	$Y_i = \frac{V_w P_b (t_d + 460)}{V_d (P_b + \frac{\Delta H}{13.6}) (t + 460)}$	$\Delta H @_i = \frac{0.0317 \Delta H}{P_b (t_d + 460)} \left[\frac{(t_w + 460) \theta}{V_w} \right]^2$
0.5	0.0368		
1.0	0.0737		
1.5	0.110		
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 JA 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%
C	6-23-87	85 °F	85 °F	0%

^aType of calibration system used.

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

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 Hand 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 6-23-87	85°F	85°F	0%

^aType of calibration system used.

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

PITOT TUBE CALIBRATION DATA

Calibration pitot tube: type 5 size (OD) 3/8 ID number 45'
 Type S pitot tube ID number 45 $C_{p(\text{std})} = \underline{1}$
 Calibration: date 1-8-87 performed by JK Allen, 2nd

A-Side Calibration

Δp_{std} cm (in.) H ₂ O	Δp_s cm (in.) H ₂ O	$C_{p(S)}^a$	DEV. ^b
.92	1.6	.78	.01
.74	1.15	.80	.01
.82	1.3	.79	.00
Average		.79	

B-Side Calibration

Δp_{std} cm (in.) H ₂ O	Δp_s cm (in.) H ₂ O	$C_{p(S)}^a$	DEV. ^b
.92	1.5	.78	.01
.74	1.15	.80	.01
.82	1.30	.79	.00
Average		.79	

$${}^a C_{p(S)} = C_{p(\text{std})} \sqrt{\frac{\Delta p_{\text{std}}}{\Delta p_s}} = \underline{\hspace{2cm}}$$

$${}^b \text{DEV} = C_{p(S)} - \bar{C}_p \quad (\text{must be } \leq 0.01)$$

$$\bar{C}_p(A) - \bar{C}_p(B) = \underline{\hspace{2cm}} \quad (\text{must be } \leq 0.01).$$

STACK TEMPERATURE SENSOR CALIBRATION DATA FORM

Date 12-17-86 Thermocouple number 45 (5')Ambient temperature 18.9 °C Barometric pressure 29.76 in. HgCalibrator ~~1/2~~ Reference: mercury-in-glass

other

Reference point number ^a	Source ^b (specify)	Reference thermometer temperature, °C	Thermocouple potentiometer temperature, °C	Temperature difference, % ^c
A	Ambient	66°F 18.9°C	66°F 18.9°C	.00
B	Ice water	34°F 1.1°C	36°F 2.22°C	-.004
C	Boiling water	212°F 100°C	212°F 100°C	.00
D	Boiling oil	347°F 175°C	348°F 175.6°C	-.001

^aEvery 30°C (50°F) for each reference point.^bType of calibration system used.^c
$$\left[\frac{(\text{ref temp, } ^\circ\text{C} + 273) - (\text{test thermom temp, } ^\circ\text{C} + 273)}{\text{ref temp, } ^\circ\text{C} + 273} \right] 100 \leq 1.5\%$$

RAMCON

Lear Siegler Stack Sampler

Heating Probe Calibration

Probe No. 45 Probe Length 5'

Date of Calibration 12-19-86 Signature K. B. Allen

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

