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

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

AP42 Section: 11.1

Reference Number: 97

Title: Source Sampling For Particulate Emissions, Reliable Contracting Asphalt Division, Gambrills, Maryland,

Ramcon Environmental Corporation, Memphis, TN,

July 17, 1984.

AP-42 Section 11.1
Reference
Report Sect. 4
Reference 97

RAMCON

ENVIRONMENTAL CORPORATION

RAMCON BUILDING 223 SCOTT STREET MEMPHIS, TENNESSEE 38112 TELEPHONE 901 / 458-7000 TELEX 53-806

RECEIVED
AUG 7 1984
AIR MANAGEMENT
ADMINISTRATION

SOURCE SAMPLING
for
PARTICULATE EMISSIONS
RELIABLE CONTRACTING ASPHALT DIVISION
GAMBRILLS, MARYLAND
July 17, 1984

Mr. Frank Scrivener
Reliable Contracting Company

G. Sumner Buck, III
President

Sam T. Turner
Team Leader

RAMCON ENVIRONMENTAL CORPORATION

RAMCON BUILDING 223 SCOTT STREET MEMPHIS, TENNESSEE 38112 TELEPHONE 901 / 458-7000 TELEX 53-806

July 31, 1984

Mr. Frank Scrivener
Reliable Contracting Company
Asphalt Division
Box 1, Church View Road
Millersville, MD 21108

Subject: Particulate Emissions Test - Gambrills, Maryland Plant

Dear Mr. Scrivener:

Enclosed are three copies of our report on particulate emissions. Based on our test results, your plant does pass both EPA new source performance standards and those set by the State of Maryland. The average grain loading of the three test runs was in compliance with State and Federal standards.

We have forwarded a copy to Mr. Don Andrew with the Maryland Office of Environmental Programs per your instructions.

We certainly have enjoyed working with you and hope to serve you again in the future.

Sincerely,

G. Sumner Buck, III
President

GSBIII:kr

Enclosures

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I. INTRODUCTION

On July 17 and 19, 1984, personnel from RAMCON Environmental Corporation (REC) conducted a source emissions test for particulate emissions compliance at Reliable Contracting Company Asphalt Division's H & B batch mix asphalt plant located in Gambrills, Maryland. RAMCON personnel conducting the test were Sam Turner, Team Leader and Miles Mason. Sam Turner was responsible for the laboratory analysis, including taring the beakers and filters and recording final data in the laboratory record books. Custody of the samples were limited to Mr. Turner and Mr. Mason.

The purpose of the test was to determine if the rate of emissions from the plant's baghouse and the total contaminants by weight (grain loading) are below limits set by the State of Maryland and by the U.S. Environmental Protection Agency.

II. TEST RESULTS

Table I summarizes the test results. The grain loading limitation 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 Maryland are found in C.O.M.A.R. 101806.03. Ms. Kathy Gunkel observed the testing conducted by RAMCON.

TABLE I

SUMMARY OF TEST RESULTS
July 17 & 19, 1984

Test Run	Time	Grain Loading	Isokinetic Variation	Actual Emissions
1	10:36 to 11:39	0.0090 gr/SCF	91%	2.6 lbs/hr
2	12:56 to 13:58	0.0094 gr/SCF	92%	2.6 lbs/hr
3	09:18 to 10:21	0.0189 gr/SCF	91%	5.3 lbs/hr
Average		0.0124 gr/SCF		3.5 lbs/hr

On the basis of these test results, the average grain loading of the three test runs was below the .04 gr/SCF limit set by EPA and the .03 gr/SCF limit set by the State of Maryland. Therefore, the plant is operating in compliance with State and Federal standards.

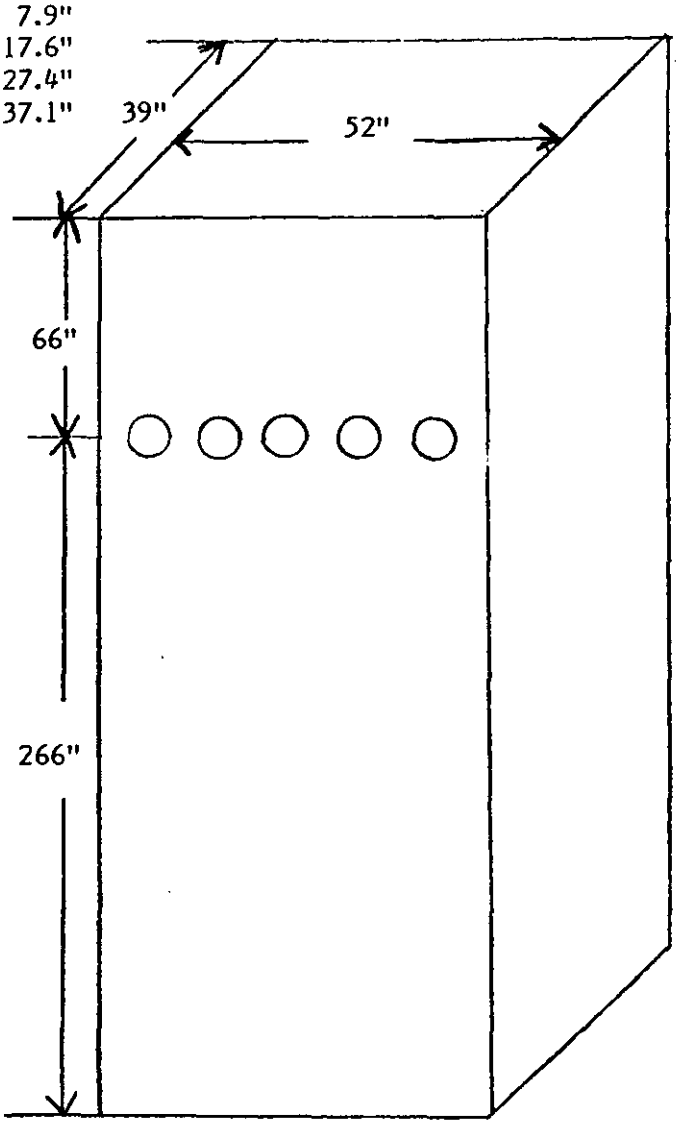
III. TEST PROCEDURES

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. All three test runs were sampled at three minutes each.

B. Problems Encountered: No problems were encountered.

C. Sampling Site: The emissions test was conducted after a baghouse on a rectangular stack measuring 39" x 52" with an equivalent diameter of 44.6". Five sampling ports were placed 66" down (1.5 diameters upstream) from the top of the stack and 266" up (5.9 diameters downstream) from the last flow disturbance. Twenty points were sampled, four through each port for three minutes each.

Points on a Diameter	Plus 3" Standoff	Probe Mark
1		7.9"
2		17.6"
3		27.4"
4		37.1"



IV. THE SOURCE

IV. THE SOURCE

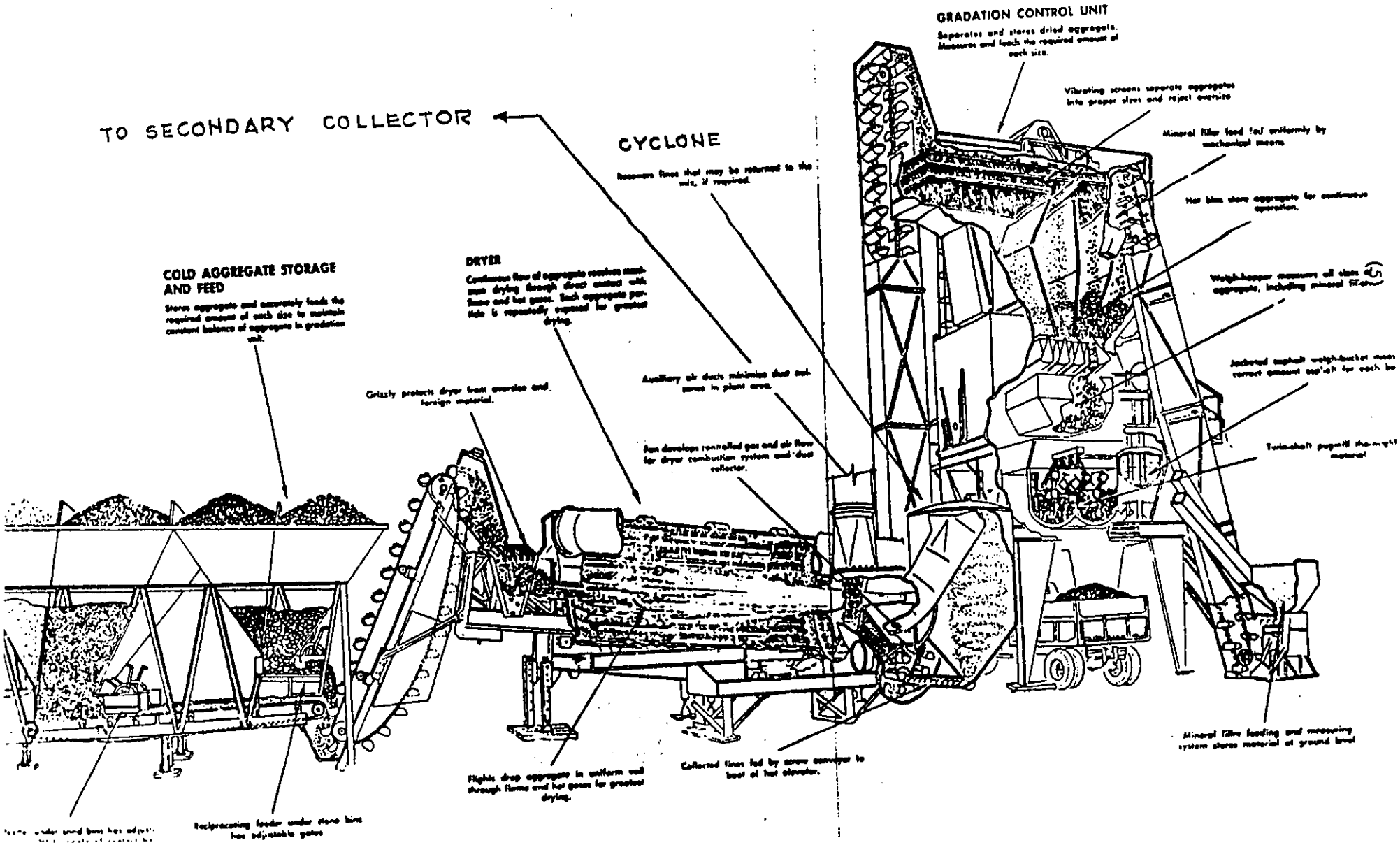
Reliable Contracting Company/Asphalt Division employs a H & B batch mix asphalt concrete plant which is used to manufacture asphalt concrete for road pavement. The process consists of blending prescribed portions of cold feed materials (sand, gravel, screenings, chips, etc.) uniformly and adding sufficient 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 separate bins which in turn feed a common continuous belt conveyor. The aggregate is dispensed from the bins in accordance with the desired formulation onto the cold feed system conveyor to an inclined 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 size 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 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 used a burner to heat air to dry the aggregate. The air is drawn into the system via an exhaust fan. After passing through the burner and 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 - 4 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 320 TPH @ 5 % moisture.
3. Actual operation rate 200 TPH @ 8 % moisture.
4. Startup date Aug 1979.
5. Type of fuel used in dryer Natural Gas.
6. Quanity of fuel consumption _____.

Aggregate

7. Name/type of mix S/N.
8. Percent asphalt in mix 5.9% %.
9. Temperature of asphalt 300°.
10. Sieve/Screening analysis: % Passing;

1"		~~3/8"~~ #8	55	#50	21
3/4"	100	#16	44	#100	10
3/8 ~~1/2"~~	89	#30	36	#200	3
#4	65				

Baghouse

11. Manufacturer H&B.
12. No. of bags 648. Type of bags Nomex.
13. Air to cloth ratio _____. Designed ACFM _____.
14. Square feet of bags _____.
15. Type of cleaning; pulse jet ✓, reverse air _____, plenum pulse _____, other _____.
16. Cleaning cycle time 10 Sec.
17. Interval between cleaning cycle _____.
18. Pressure drop across baghouse 3 psi.
19. Pulse pressure on cleaning cycle 110 psi.

COMPANY NAME Reliable Cont Co Inc DATE 7/17/84

PLANT DATA

COMPANY NAME Reliable Contracting Co Asphalt Division

COMPANY REP. Gene Ingron DATE 7-17-84 Phone # 293-0665

DATA SOURCE

PLANT LOCATION MD Rte 3 S. Brickhead Rd Gambrills Md. 21054

PLANT MANUFACTURER H+B PLANT MODEL NO. 1560 Tower 11240 PLANT TYPE 10,000 Lb Batch Plant

MIX SPECIFICATION NO. OIL SPECIFICATION NO.

TIME: START STOP A.T. °F R.H. %

TIME 24 HOUR	FUEL OIL ☐ NATURAL GAS ☒ PROPANE ☐	BURNER SETTING	AGGREGATE TPH	RECYCLE TPH	ASPHALT	MIX TEMPERATURE °F	VENTURI ☐ Baghouse ☑ DIFFERENTIAL
10 40		35%	195		11.8	285°	
10 55		37%	200		12	290°	
11 20		30%	200		12	285°	
11 45		35%	200		12	280°	
1 00		25%	200		12	295°	
1 17		35%	200		12	300°	
1 35		30%	200		12	295°	
2 05		28%	200		12	300°	
9 10		40%	200		12	300°	
9 25		45%	200		12	295°	
9 55		35%	200		12	305°	
10 12		40%	200		12	300°	

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 next page.

B. A Fisher Scientific 211-B airguide (uncorrected) aneroid barometer was used to check the barometric pressure.

C. Weston dial thermometers were used to check both stack and meter temperatures.

D. A Hays 621 Analyzer was used to measure the oxygen, carbon dioxide and carbon monoxide content of the stack gases.

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 approximately +0.2 mg and has a maximum capacity of 200 g. It is equipped with "pre-weighing" which enables an unknown mass to be quickly weighed to a +1 g level with no adjustment. It also has a tare weighing feature which is for quick net gain measurement without subtraction. 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 is now set to weigh items between 100 and 200 grams. 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 now 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, either. 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 South of Baltimore (Reliable)
Sample Location asphalt plant stack
Relative humidity in lab 50%
Density of acetone (ρ_a) .7899 g/ml

		RUN 1	RUN 2	RUN 3
Acetone rinse container number	#	PW1	PW2	PW3
Acetone rinse volume (V_{aw})	ml	300	300	300
Acetone blank residue concentration (C_a)	mg/g	0	0	0
$W_a = C_a V_{aw} \rho_a$ = (0)(300)(.7899) =	g	0	0	0
Date/time of wt 7-30-84 10AM Gross wt	g	147.5703	145.7945	94.5259
Date/time of wt 7-30-84 7PM Gross wt	g	147.5706	145.7942	94.5259
Average Gross wt	g	147.5705	145.7944	94.5259
PROBE WASH Tare wt	g	147.5461	145.7657	94.4292
Less acetone blank wt (W_a)	g	0	0	0
Wt of particulate in acetone rinse (m_a)	g	.0244	.0287	.0967
Filter numbers	#			
Date/time of wt 7-30-84 10AM Gross wt	g	.6815	.6806	.6456
Date/time of wt 7-30-84 7PM Gross wt	g	.6818	.6808	.6456
Average Gross wt	g	.6817	.6807	.6456
Tare wt	g	.6770	.6794	.6817
Weight of particulate on filters(s) (m_f)	g	.0047	.0013	-.0361
Weight of particulate in acetone rinse	g	.0244	.0287	.0967
Total weight of particulate (m_n)	g	.0291	.0300	.0606

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

Remarks Runs 2 and 3 Some filter was lost in probe wash.

Signature of analyst [illegible]
Signature of reviewer [illegible]

COMPANY NAME RELIABLE

Chloroform and Ethyl Ether Extraction for EPA Method 5 (back half)

Relative humidity in lab 45%

Density of chloroform and ethyl ether _____

		RUN 1	RUN 2	RUN 3
Chloroform and ethyl ether rinse volume	ml	150	150	150
Date/time of wt 7-30-84 8:45 Gross wt.	g	150.4080	150.8194	150.6142
Date/time of wt 7-30-84 3:30 Gross wt.	g	150.4084	150.8200	150.6132
Avg. Gross wt.	g	150.4082	150.8197	150.6137
Tare wt.	g	150.3984	150.8100	150.6047
Wt. of particulate in chloroform ethyl ether rinse	g	.0098	.0097	.0090
Water evaporation	#	10	11	8
Date/time of wt. 7-30-84 8:45 Gross wt.	g	147.9064	147.8376	147.7184
Date/time of wt. 7-30-84 3:30 Gross wt.	g	147.9070	142.8380	147.7170
Avg. Gross wt.	g	147.9067	142.8378	147.7176
Tare wt.	g	147.8880	142.8159	142.6976
Less chloroform & ehtyl either blank wt.	g	0	0	0
Weight of particulate from water (m_f)	g	.0187 .0142	.0219 .0207	.0200 .0211
Wt. of particulate in chloroform ethyl ether rinse	g	.0098	.0097	.0090
Total weight of particulate (m_n)	g	.0426	.0523	.0501

Note: In no case should a blank residue 0.02 mg/g or 0.001% of the weight of chloroform ethyl ether used be subtracted from the sample weight.

Remarks Two pages were used since the beakers were too small

Signature of Analyst Sam J Turner

Signature of Reviewer [illegible]

(14) Reliable

Chloroform and Ethyl Ether Extraction for EPA Method 5 (back half)

Relative humidity in Lab 45 %
Density of chloroform and ethyl ether

PAGE 2

		RUN 1	RUN 2	RUN 3
Chloroform and ethyl ether rinse volume	ml	150	150	150
Date/time of wt _____ Gross wt.	g			
Date/time of wt _____ Gross wt.	g			
Avg. Gross wt.	g			
Less chloroform ethyl ether blank et.	g			
Wt. of particulate in chloroform ethyl ether rinse	g			
Water evaporation	#	12	9	13
Date/time of wt. 7-30-84 9:45am Gross wt.	g	143.4340	151.2503	151.2161
Date/time of wt. 7-30-84 3:30pm Gross wt.	g	143.4342	151.2511	151.2149
Avg. Gross wt.	g	143.4341	151.2507	151.2155
Tare wt.	g	143.4200	151.2300	151.1944
		.0141	.0207	.0211
Weight of particulate from water (m_f)	g			
Weight of particulate in chloroform ethyl ether rinse	g			
Total weight of particulate (m_n)	g			

Note: In no case should a blank residue 0.01 mg/g or 0.001% of the weight of chloroform ethyl ether used be subtracted from the sample weight.

Remarks

Signature of Analyst [signature]

Signature of Reviewer [signature]

VII. CALCULATIONS

NAME: RELIABLE CONTRACTING COMPANY

LOCATION: GAMBRILLS, MARYLAND

		date	7/17/84	7/17/84	7/19/84
	SUMMARY OF TEST DATA		RUN # 1	RUN # 2	RUN # 3
	SAMPLING TRAIN DATA	start	10:36	12:56	09:18
		finish	11:39	13:58	10:21
1	Sampling time, minutes	θ	60	60	60
2	Sampling nozzle diameter, in.	Dn	.268	.268	.268
3	Sampling nozzle cross-sectional area, ft^2	An	.000391	.000391	.000391
4	Isokinetit variation	I	91	93	91
5	Sample gas volume - meter conditions, cf.	Vm	52.86	52.86	51.73
6	Average meter temperature, °R	Tm	550	557	547
7	Average oriface pressure drop, in.H_2O	ΔH	1.75	1.70	1.75
8	Total particulate collected mg.	Mn	29.1	30.0	60.6
	VELOCITY TRAVERSE DATA				
9	Stack area, ft^2.	A	14.1	14.1	14.1
10	Absolute stack gas pressure, in Hg.	Ps	29.29	29.29	29.40
11	Barometric pressure, in. Hg.	Pbar	29.29	29.29	29.40
12	Average absolute stack temperature, °R	Ts	636	641	642
13	Average $\sqrt{\text{velocity head}}$, (Cp= .79)	$\sqrt{\Delta P}$	.97	.95	.97
14	Average stack gas velocity ft./ sec.	Vs	58	57	58
	STACK MOISTURE CONTENT				
15	Total water collected by train, ml.	Vic	220.0	225.0	229.5
16	Moisture in stack gas, %	Bws	17.1	17.7	18.0
	EMISSIONS DATA:				
17	Stack gas flow rate, dscf/hr. (000's)	Qsd	1,974	1,915	1,951
18	Total particulate concentration, gr/dscf	Cs	.0090	.0094	.0189
19	Total particulate concentration, lbs/hr	E	2.5	2.6	5.3
20	Total particulate concentration, lbs/mbtu	E'	.0	.0	.0
	ORSAT DATA				
21	Percent CO2 by volume	CO2	10.0	10.0	10.0
22	Percent O2 by volume	O2	11.0	11.0	11.0
23	Percent CO by volume	CO	.0	.0	.0
24	Percent N2 by volume	N2	79.0	79.0	79.0

Buzzycalc

Total contamints 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 mater in stack gas, dry basis, corrected to standard conditions, g/dsf

M_n = Total amount of particulate mater colected, mg.

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

Run # 1: $$C_s' = \left[0.0154 \frac{gr}{mg} \right] \left[\frac{29.1}{49.88} \right] = .0090 \text{ gr./dscf.}$$

Run # 2: $$C_s' = \left[0.0154 \frac{gr}{mg} \right] \left[\frac{30.0}{49.24} \right] = .0094 \text{ gr./dscf.}$$

Run # 3: $$C_s' = \left[0.0154 \frac{gr}{mg} \right] \left[\frac{60.6}{49.26} \right] = .0189 \text{ gr./dscf.}$$

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: $M_d = 0.44(10.0\%) + 0.32(11.0\%) + 0.28(.0\% + 79.0\%) = 30.0$ lb./lb.-mole

Run # 2: $M_d = 0.44(10.0\%) + 0.32(11.0\%) + 0.28(.0\% + 79.0\%) = 30.0$ lb./lb.-mole

Run # 3: $M_d = 0.44(10.0\%) + 0.32(11.0\%) + 0.28(.0\% + 79.0\%) = 30.0$ lb./lb.-mole

Water vapor condenced :

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

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

Where:

0.04707 = Conversion factor $ft.^3/ml.$

0.04715 = Conversion factor $ft.^3/g.$

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

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

V_f = Final volume of impinger contents, mi.

V_i = Initial volume of impinger contents

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

R = Ideal gas constant, 21.85 (in.Hg.)(cu.ft./lb.-mole)($^\circ$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) (200.0) =	9.4	cu.ft
	$V_{wsg(std)}$	= (0.04715) (20.0) =	.9	cu.ft
Run # 2:	$V_{wc(std)}$	= (0.04707) (210.0) =	9.9	cu.ft
	$V_{wsg(std)}$	= (0.04715) (15.0) =	.7	cu.ft
Run # 3:	$V_{wsg(std)}$	= (0.04707) (215.0) =	10.1	cu.ft
	$V_{wc(std)}$	= (0.04715) (14.5) =	.7	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 ream.

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

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

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

Run # 1: $$B_{ws} = \frac{9.4 + .9}{9.4 + .9 + 49.88} \times 100 = 17.1\ \%$$

Run # 2: $$B_{ws} = \frac{9.9 + .7}{9.9 + .7 + 49.24} \times 100 = 17.7\ \%$$

Run # 3: $$B_{ws} = \frac{10.1 + .7}{10.1 + .7 + 49.26} \times 100 = 18.0\ \%$$

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

Where:

M_s = Molecular weight of stack gas, wet basis, (lb.1le).

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

Run # 1: M_s = 30.0 (1- .171) + 18 (.171) = 27.9 (lb./lb.-mole).

Run # 2: M_s = 30.0 (1- .177) + 18 (.177) = 27.9 (lb./lb.-mole).

Run # 3: M_s = 30.0 (1- .180) + 18 (.180) = 27.8 (lb./lb.-mole).

Stack gas velocity:

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

Where:

V_s = Avarage 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 = Satck 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, ($^{\circ}f$).

T_s = Absolute stack temperature, ($^{\circ}R$). = 460 + t_s.

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

Run # 1: $V = (85.48)\ (\ .79)\ (\ .97) \sqrt{\frac{636}{(29.29)(27.95)}} = 57.73$ ft/sec

Run # 2: $V = (85.48)\ (\ .79)\ (\ .95) \sqrt{\frac{641}{(29.29)(27.88)}} = 56.84$ ft/sec

Run # 3: $V = (85.48)\ (\ .79)\ (\ .97) \sqrt{\frac{642}{(29.40)(27.84)}} = 58.01$ 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	=	Satck 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:

$$Q_{sd} = 3600 \ (1-.171) \ (57.73) \ (14.1) \left[\frac{528}{636} \right] \left[\frac{29.29}{29.92} \right] = 1974498 \text{ dscf/hr}$$

Run # 2:

$$Q_{sd} = 3600 \ (1-.177) \ (56.84) \ (14.1) \left[\frac{528}{641} \right] \left[\frac{29.29}{29.92} \right] = 1914933 \text{ dscf/hr}$$

Run # 3:

$$Q_{sd} = 3600 \ (1-.180) \ (58.01) \ (14.1) \left[\frac{528}{642} \right] \left[\frac{29.40}{29.92} \right] = 1951494 \text{ dscf/hr}$$

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 mater in stack gas, dry basis, corrected to standard conditions (g/dsf).

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

Run # 1: $E = \frac{(.0090)(1974498)}{7000} = 2.5$ lb. / hr.

Run # 2: $E = \frac{(.0094)(1914933)}{7000} = 2.6$ lb. / hr.

Run # 3: $E = \frac{(.0189)(1951494)}{7000} = 5.3$ lb. / hr.

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

Where:

I	=	Precent 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, ml
T_m	=	Absolute average dry gas meter temperature, °R.
P_{bar}	=	Barometric pressure at sampling site, (inHg).
ΔH	=	Average pressure differential across the oriface meter, (in.H_2O)
13.6	=	Specific gravity of mercury.
60	=	conversion seconds to minutes
θ	=	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:

$$I = 100 \times 636 \left[\frac{(0.002669)(220.0) + \frac{52.9}{550}\left[29.29 + \frac{1.75}{13.6}\right]}{60\ (60)\ (57.73)\ (29.29)\ (.000391)} \right] = 91\ \%$$

Run # 2:

$$I = 100 \times 641 \left[\frac{(0.002669)(225.0) + \frac{52.9}{557}\left[29.29 + \frac{1.70}{13.6}\right]}{60\ (60)\ (56.84)\ (29.29)\ (.000391)} \right] = 93\ \%$$

Run # 3:

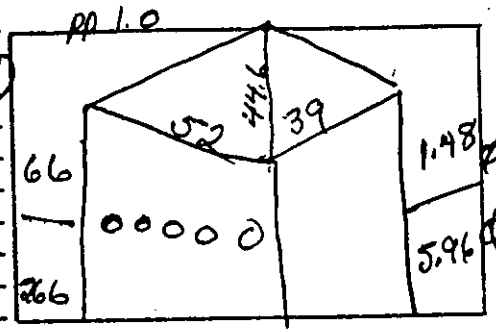
$$I = 100 \times 642 \left[\frac{(0.002669)(229.5) + \frac{51.7}{547}\left[29.40 + \frac{1.75}{13.6}\right]}{60\ (60)\ (58.01)\ (29.40)\ (.000391)} \right] = 91\ \%$$

VIII. FIELD DATA

RAMCON ENVIRONMENTAL CORPORATION

Plant Reliable Asphalt

Location Baltimore Md (Brickhead Road)
Operator Sam Lymes
Date 7-17-84
Run No. one
Sample Box No. one
Meter Box No. 700205
Meter H @ 1.26
C Factor 1.0
Pitot Tube Coefficient Cp .79



Schematic of Stack Cross Section

Ambient Temperature 80
Barometric Pressure 29.29
Assumed Moisture, % 25
Probe Length, m(ft) 5
Nozzle Identification No. .000391
Avg. Calibrated Nozzle Dia., (in.) .266/.268/.269
Probe Heater Setting 5
Leak Rate, m³/min. (cfm) -.02
Probe Liner Material Stainless Steel (316)
Static Pressure, mm Hg(in.Hg) 1.04/13.6
Filter No. RU 49

	IMPINGER VOLUME, ml	SILICA GEL WEIGHT, g
FINAL	400	515
INITIAL	200	495
DIFFERENCE	200	20

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	Outlet	FILTER HOLDER TEMP (°F)	GAS TEMP LVG CONDENSER OR LAST IMPINGER (°F)
A) 1	10:36 / 10:39	5	180	1.2	2.2	587.503 / 590.10	80	80	250	50
2	10:42	5	190	1.2	2.2	593.10	90	80	250	50
3	10:45	5	190	1.2	2.2	596.10	90	80	255	50
4	10:48	5	190	1.2	2.2	599.20	90	80	255	50
B) 1	10:49 / 10:52	5	180	1.0	1.85	602.90	95	80	255	50
2	10:55	5	170	1.0	1.85	604.50	100	80	255	50
3	10:58	5	170	1.0	1.85	607.40	100	80	255	50
4	11:01	5	170	1.0	1.85	610.40	100	80	255	50
C) 1	11:02 / 11:05	5	170	.92	1.70	613.00	100	80	255	50
2	11:08	5	160	.92	1.70	615.20	100	80	255	50
3	11:11	5	160	.90	1.70	617.99	100	80	260	50
4	11:14	5	160	.92	1.70	620.55	105	80	260	50
D) 1	11:15 / 11:18	5	170	1.0	1.85	623.55	105	80	260	50

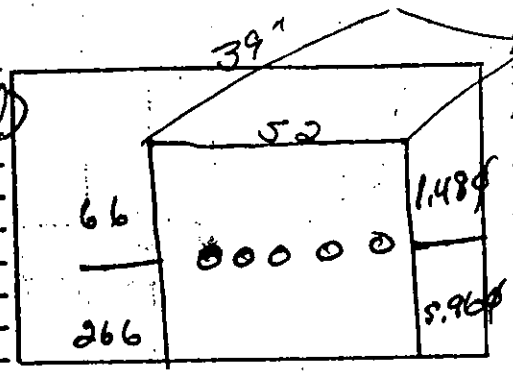
RAMCON emissions test log sheet, cont. DATE 7-17-84 LOCATION Baltimore Md TEST NO. 1

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 Vm (ft.^{3})	GAS SAMPLE TEMP. (°F) in	GAS SAMPLE TEMP. (°F) out	SAMPLE BOX TEMP. (°F)	IMPINGER TEMP (°F)
2	11:21	6	180	1.0	1.85	626.00	105	80	260	50
3	11:24	6	180	.75	1.40	628.70	105	80	260	55
4	11:27	6	180	.80	1.45	630.98	110	85	(87) 245 ~~260~~	55
E) 1	11:27:30 / 11:30	5	180	.80	1.45	633.40	110	85	245	55
2	11:33:30	5	180	.75	1.40	635.80	110	85	245	55
3	11:36:30	5	180	.75	1.40	638.90	110	85	245	55
4	11:39:30	5	180	.65	1.20	640.368	110	85	245	55

RAMCON ENVIRONMENTAL CORPORATION

Plant Reliable Asphalt

Location Baltimore Md (Brickhead Road)
Operator Sam T Turner
Date 7-17-83
Run No. Two
Sample Box No. Two
Meter Box No. 700205
Meter H @ 1.26
C Factor 1.0
Pitot Tube Coefficient Cp .79



Ambient Temperature 85
Barometric Pressure 29.29
Assumed Moisture, % 25
Probe Length, m(ft) 5
Nozzle Identification No. .000391
Avg. Calibrated Nozzle Dia., (in.) .261/.268/.269
Probe Heater Setting 5
Leak Rate, m³/min. (cfm) -.02
Probe Liner Material Stainless Steel
Static Pressure, mm Hg (in. Hg) 1.007
Filter No. RV 50

	IMPINGER VOLUME, ml	SILICA GEL WEIGHT, g
FINAL		
INITIAL		
DIFFERENCE		

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	Outlet	FILTER HOLDER TEMP (°F)	GAS TEMP LVG CONDENSER OR LAST IMPINGER (°F)
A) 1	12:56 / 12:59	6	170	1.4	2.6	640.867 / 644.50	90	85	255	60
2	13:02	6	170	1.2	2.2	647.20	100	85	255	60
3	13:05	6	175	1.2	2.2	650.20	105	85	255	60
4	13:08	6	175	1.1	2.0	653.30	105	85	255	60
B) 1	13:08:30 / 13:11	6	175	1.1	2.0	656.00	105	85	260	60
2	13:14	6	175	1.1	2.0	658.90	110	85	260	60
3	13:17	6	174	1.0	1.85	662.00	110	85	260	60
4	13:20:30	6	180	.92	1.70	664.22	110	85	260	60
C) 1	13:21 / 13:24	5	180	.92	1.70	667.30	110	85	255	60
2	13:27	5	180	.92	1.70	670.00	110	85	255	60
3	13:30	5	180	.92	1.70	672.10	110	85	255	60
4	13:33	5	175	.92	1.70	674.85	110	85	255	60
D) 1	13:33:30 / 13:36	5	175	.92	1.70	677.50	110	85	265	55

RAMCON emissions test log sheet, cont. DATE 7-17-84 LOCATION Baltimore md 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 Vm (ft^3)	GAS SAMPLE TEMP. (°F) in	GAS SAMPLE TEMP. (°F) out	SAMPLE BOX TEMP. (°F)	IMPINGER TEMP (°F)
2	13:39:30	5	175	.75	1.40	680.10	110	85	250	60
3	13:42:30	5	180	.86	1.60	682.50	110	85	250	60
4	13:45:30	4	180	.60	1.1	684.785	110	85	250	60
E) 1	13:46 / 13:49	4	190	.65	1.2	686.90	110	90	255	55
2	13:52	4	200	.75	1.4	689.30	110	90	255	55
3	13:55	4	195	.65	1.2	691.60	110	90	255	55
4	13:58	4	200	.55	1.0	693.78	115	90	255	55
						693.73				

RAMCON ENVIRONMENTAL CORPORATION

Plant RELIABLE ASPHALT

PP 1.0

Location BALTIMORE MD. (BRICKHEAD RD.)
Operator MILES MASON
Date 7-19-84
Run No. THREE
Sample Box No. THREE
Meter Box No. 700205
Meter H @ 1.26
C Factor 1.0
Pitot Tube Coefficient Cp .79

Ambient Temperature 70°F
Barometric Pressure 29.4 FINAL
Assumed Moisture, % 25 INITIAL
Probe Length, m(ft) 5' DIFFERENCE

IMPINGER VOLUME, ml	SILICA GEL WEIGHT, g

Nozzle Identification No. .000391
Avg. Calibrated Nozzle Dia., (in.) .266/.268/.26
Probe Heater Setting 5
Leak Rate, m³/min. (cfm)
Probe Liner Material STAINLESS STEEL
Static Pressure, mm Hg (in. Hg)
Filter No. RV56

Schematic of Stack Cross Section

TRAV. PT NO.	SAMPLING TIME (θ) min. (AM)	VACUUM (in. Hg)	STACK TEMP (T_s) (°F)	VELOCITY HEAD (P_s) (in) H_2O	PRESSURE DIFF. ORF. MTR (in H_2O)	GAS SAMPLE VOLUME (ft^3)	GAS SAMPLE TEMP. AT DRY GAS METER (°F) Inlet	Outlet	FILTER HOLDER TEMP (°F)	GAS TEMP LVG CONDENSER OR LAST IMPINGER (°F)
A) 1	~~9:18:30~~ 9:21	5	160	.75	1.4	~~899.566~~ 901.6	80	70	250	55
2	9:24	5	160	.75	1.4	903.9	80	70	250	55
3	9:27	5	160	.70	1.3	906.3	90	70	250	55
4	9:30	5	170	.60	1.1	908.6	90	70	250	55
B) 1	~~9:31:30~~ 9:34:30	5	180	.80	1.5	910.6	90	70	250	55
2	9:37	5	190	.85	~~1.7~~ 1.65 RN	913.2	100	70	265	50
3	9:40	9	200	1.1	2.0	916.0	100	80	265	50
4	9:43	8	200	.75	1.4	918.8	100	80	265	50
C) 1	~~9:44~~ 9:47	9	200	.85	~~1.7~~ 1.65 RN	921.1	100	80	265	50
2	9:50	9	200	.9	1.7	~~940.0~~ 924.0 RN	100	80	265	55
3	9:53	7	190	.85	1.65	926.6	100	80	265	55
4	9:56	7	180	1.0	1.85	929.4	100	80	265	55
D) 1	~~9:56:30~~ 9:59:30	7	180	1.1	2.0	932.0	100	80	265	55

RAMCON emissions test log sheet, cont. DATE_____ LOCATION_____ TEST NO._____

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)		SAMPLE BOX TEMP. (°F)	IMPINGER TEMP (°F)
							in	out		
2	10:02:30	8	180	1.1	2.0	934.8	100	80	265	55
3	10:05	8	180	1.2	2.2	937.8	100	80	265	55
4	10:08	7	180	1.1	2.0	940.8	100	80	265	55
E) 1	~~10:08:30~~ 10:11:30	8	180	1.2	2.2	943.3	100	80	265	55
2	10:14:30	9	180	1.1	2.0	945.3	100	80	265	55
3	10:17:30	9	180	1.1	2.0	948.4	100	80	265	55
4	10:20:30	8	180	1.1	2.0	951.3	100	80	265	55

IX. CALIBRATIONS

POSTTEST DRY GAS METER CALIBRATION DATA FORM
EPA CALIBRATED ORIFICE

Sam T. Tenney

Calibration Date 8-2-84
Device Number 2
Device K' 2.498 x 10^{-4}
Meter Box No. C-282
D.G.M. No. 700205
P_{bar} 29.39 mmHg

Sampling Time (θ) min.	Vacuum (in. Hg)	Pressure Diff. Orf. Mtr (H_2O)	Gas Sample Volume (ft^3)	Gas Sample Temp. At Dry Gas Meter (°F) Inlet	Outlet
Start / Stop		ΔH avg.	V_m / $V_{m}std$	°F / °R	°C / °K
0 / 15	19"	.34	956.20 / 962.149	84 / 84	78 / 78
RUN 1	19"	—	5.949 / 5.706	81 / 541	27 / 300
0 / 15	19"	.34	966.00 / 971.964	84 / 83	78 / 77
RUN 2	19"	—	5.964	82.5 / 541	27 / 300
	19"	.34	972.10 / 978.05	83 / 83	77 / 77
RUN 3	19"	—	5.950	80 / 540	27 / 300

$V_{m}std = V_s$

$$V_s = \frac{K' P_o \theta}{\sqrt{T_o}}$$

Where;

$V_{m}std$ = Dry gas volume through meter at standard conditions, cu.ft. (Determine using Method 5 formulas and procedures.)
V_s = Dry gas volume through calibrated orifice at standard conditions.
K' = Calibrated orifice constant (Determined by EPA).
P_o = Pressure at entry to orifice mm Hg.
T_o = Temperature at entry to orifice °K.

$$V_s = \frac{(.0002498)\ (746.5)\ (15)}{(17.3)}$$

$$V_{m}std = 17.64\,(5.949)\left[\frac{(29.39 + \frac{13.6}{(.34)})}{(541)}\right]$$

$$Y = \frac{V_s}{V_{m}std} = \frac{5.7097}{5.7060} = 1.0007$$

$$V_s = \frac{(.0002498)\ (746.5)\ (15)}{(17.3)}$$

$$V_{m}std = 17.64\,(5.919)\left[\frac{(29.39 + \frac{13.6}{(.39)})}{(541)}\right]$$

$$Y = \frac{V_s}{V_{m}std} = \frac{5.7097}{5.720} = .9982$$

$$V_s = \frac{(.0002498)\ (746.5)\ (15)}{(17.3)}$$

$$V_{m}std = 17.64\,(5.95)\left[\frac{(29.39 + \frac{13.6}{(.34)})}{(541)}\right]$$

$$Y = \frac{V_s}{V_{m}std} = \frac{5.7097}{5.717} = .9987$$

POSTTEST DRY GAS METER CALIBRATION DATA FORM
EPA CALIBRATED ORIFICE

Sam T. Turner

Calibration Date 7-13-84
Device Number 2
Device K' 2.498 x 10^{-4}
Meter Box No. C-282
D.G.M. No. 700205
Pbar 29.34 mmHg

Sampling Time (θ) min.	Vacuum (in. Hg)	Pressure Diff. Orf. Mtr (H_2O)	Gas Sample Volume (ft^3)	Gas Sample Temp. At Dry Gas Meter (°F) Inlet	Outlet
Start / Stop		ΔH avg.	V_m / $V_{m}std$	°F / °R	°C / °K
0 / 15	19"	.34	568.70 / 574.652	88 / 90	82 / 82
RUN 1	19"	—	5.952 / 5.64	86 / 546	30 / 303
	19"	.34	575.20 / 581.153	89 / 90	82 / 82
RUN 2	19"	—	5.953 / 5.679	86 / 546	30 / 303
	19"	.34	581.30 / 587.334	90 / 90	82 / 82
RUN 3	19"		6.034 / 5.72	86 / 546	30 / 303

$V_m std = V_s$

$V_s = \frac{K' P_o \theta}{\sqrt{T_o}}$

Where;

$V_m std$ = Dry gas volume through meter at standard conditions, cu.ft. (Determine using Method 5 formulas and procedures.)
V_s = Dry gas volume through calibrated orifice at standard conditions.
K' = Calibrated orifice constant (Determined by EPA).
P_o = Pressure at entry to orifice mm Hg.
T_o = Temperature at entry to orifice °K.

$$V_s = \frac{(.0002498)\ (745.2)\ (15)}{(17.4)}$$

$$V_m std = \frac{17.64\ (5.95)}{} \left[\frac{(29.34) + \frac{(.34)}{13.6}}{(546)} \right]$$

$$Y = \frac{V_s}{V_m std} = \frac{5.67}{5.64} = 1.005$$

$$V_s = \frac{(.0002498)\ (745.2)\ (15)}{(17.4)}$$

$$V_m std = \frac{17.64\ (5.95)}{} \left[\frac{(29.34) + \frac{(.34)}{13.6}}{(546)} \right]$$

$$Y = \frac{V_s}{V_m std} = \frac{5.67}{5.679} = .9998$$

$$V_s = \frac{(.0002498)\ (745.2)\ (15.2)}{(17.4)}$$

$$V_m std = \frac{17.64\ (6.034)}{} \left[\frac{(29.34) + \frac{(.34)}{13.6}}{(546)} \right]$$

$$Y = \frac{V_s}{V_m std} = \frac{5.74}{5.72} = 1.003$$

METER BOX CALIBRATION DATA AND CALCULATION FORM

(English units)

Date 8-29-81 Meter box number 700205

Barometric pressure, P_b = 29.90 in. Hg Calibrated by Sumar Tsuch

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	Temperatures: Wet test meter (t_w), °F	Temperatures: Dry gas meter: Inlet (t_{d_i}), °F	Temperatures: Dry gas meter: Outlet (t_{d_o}), °F	Temperatures: Dry gas meter: Avg[a] (t_d), °F	Time (θ), min	Y_i	$\Delta H@_i$ in. H_2O
0.5	~~8~~9.5	9.8	78	82	107	95	20.80	.9987	1.32
1.0	~~8~~15.17	15.66	78	84	105	95	23.50	.9968	1.32
1.5	10								
2.0	~~10~~ 11.80	12.26	78	84	108	96	13.0	.9941	1.33
3.0	~~10~~ 12.85	13.22	78	84	108	96	11.5	1.004	1.33
4.0	10		78	85	111	98	7.75	.9914	1.32
							Avg	.997	1.32

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

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

Date 7-13-84 Thermocouple number Inlet/outlet

Ambient temperature 77 °F Barometric pressure 29.34 in. Hg

Calibrator S Turner Reference: mercury-in-glass 77 °F

other

Reference point number[a]	Source[b] (specify)	Reference Thermometer Temperature, °C	Thermocouple Potentiometer Temperature, °C	Temperature Difference,[c] %
77	Inlet Ambient	77 °F	77 °F	100 %
77 °F	Outlet Ambient	77 °F	77 °F	100 %

[a]Every 30°C (50°F) for each reference point.

[b]Type of calibration system used.

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

Figure 2.5 stack temperature sensor calibration data form.

Date 7-12-84 Thermocouple number Hotbox

Ambient temperature 25 °C Barometric pressure 29.34 in. Hg

Calibrator Turner Reference: mercury-in-glass ✓

other

Reference point number[a]	Source[b] (specify)	Reference Thermometer Temperature, °C	Thermocouple Potentiometer Temperature, °C	Temperature Difference,[c] %
100°C	boiling H2O	100 °C	100 °C	100 %
76°F	Ambient	Mercury 75.8 F	75 °C	99.9 %

[a]Every 30°C (50°F) for each reference point.

[b]Type of calibration system used.

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

Figure 2.5 stack temperature sensor calibration data form.

Date 8-2-84 Thermocouple number 5'

Ambient temperature 74 °C Barometric pressure 29.39 in. Hg

Calibrator Sam Turner Reference: mercury-in-glass ✓

other

Reference point number[a]	Source[b] (specify)	Reference Thermometer Temperature, °C	Thermocouple Potentiometer Temperature, °C	Temperature Difference,[c] %
74°F	ambient	Merc. 74°F	74 F	100 %
32°F	ice bath	32°F	32°F	100 %

[a]Every 30°C (50°F) for each reference point.

[b]Type of calibration system used.

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

Figure 2.5 stack temperature sensor calibration data form.

RAMCON ENVIRONMENTAL (26) 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. 5' Date 8·2·84

Calibrated by: Sam T. Turner

"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	.43	.72	.773	-.01
2	.57	.95	.775	-.01
3	.74	1.20	.785	-.01
		$\bar{C}_p$ (SIDE A)	.778	

"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	.45	.75	.775	-.01
2	.50	.81	.786	-.01
3	.71	1.16	.782	-.01
		$\bar{C}_p$ (SIDE B)	.781	

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

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

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

Form No. EED-17-1

RAMCON

Lear Siegler Stack Sampler

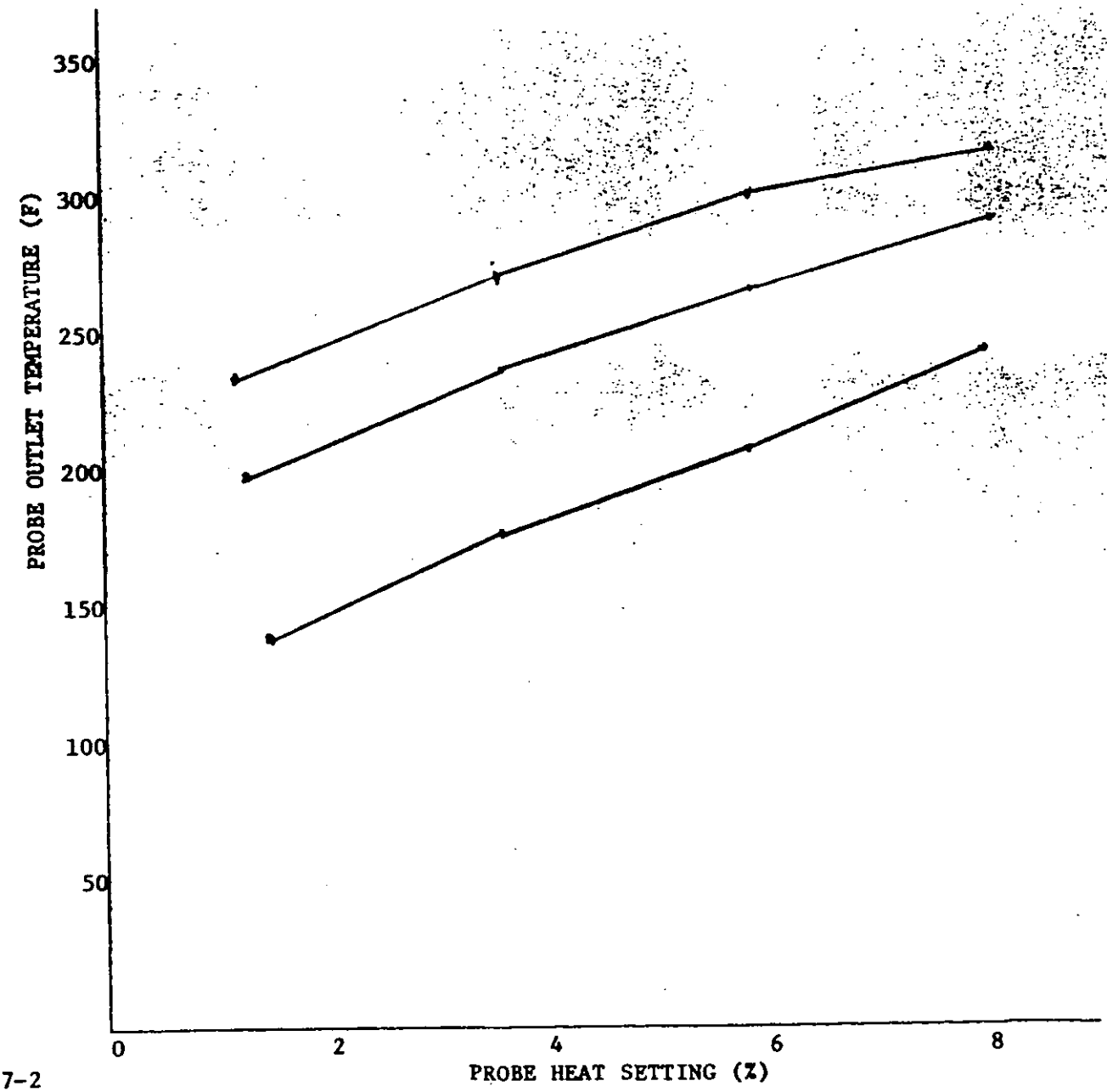
Heating Probe Calibration

Probe No. 2 Probe Length 5'

Date of Calibration 8-2-84 Signature Sam T. Turner

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



Form No. EED-17-2

X. RAMCON PERSONNEL

RAMCON Environmental Stack Test Team

Sumner Buck - President & Field Supervisor

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 100 asphalt plants. He is 40 years old and a graduate of the University of Mississippi with graduate studies at Memphis State University and State Technical Institute of Memphis.

Sam Turner - Team Leader

Sam Turner has three years experience in the Air Division and is qualified as a team leader. He has sampled over twenty large boiler stacks and approximately 75 asphalt plants. He is a graduate of State Technical Institute of Memphis, and holds an Associate Degree in Environmental Engineering. He also has another year's experience in the wet chemistry lab.