RAMCON

ENVIRONMENTAL CORPORATION

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.

SOURCE SAMPLING
for
PARTICULATE EMISSIONS
I.A. CONSTRUCTION CORPORATION
BROOKLYN, MARYLAND
August 3 & 4, 1989

Roger Apel
I.A. Construction Corporation

G. Sumner Buck, III
President

Dave Armstrong
Team Leader

RAMCON BUILDING, 223 SCOTT STREET, MEMPHIS, TENNESSEE 38112
TELEPHONE 800/458-4567 IN TENNESSEE 901/458-7000 FAX 901-458-3868

RAMCON

ENVIRONMENTAL CORPORATION

August 24, 1989

Mr. Roger Apel
I.A. Construction Corporation
P.O. Box 38
Punxsutawney, PA 15767

Re: Particulate Emissions Test: Brooklyn, Maryland

Dear Mr. Apel:

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

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

Mr. Craig Holdefer
Maryland Air Management
Div. of Environmental Affairs
P.O. Box 13387
Baltimore, MD 21203

You will need to keep one copy of the report at the plant. We certainly have enjoyed working with you. Please let us know if we can be of further assistance.

Sincerely,

G. Sumner Buck, III
President

GSBIII:kr

Enclosures

RAMCON BUILDING, 223 SCOTT STREET, MEMPHIS, TENNESSEE 38112
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I. INTRODUCTION

On August 3 & 4, 1989, personnel from RAMCON Environmental Corporation conducted a source emissions test for particulate emissions compliance at I.A. Construction's McCarter batch mix asphalt plant located in Brooklyn, Maryland. RAMCON personnel conducting the test were Dave Armstrong, Team Leader, and David Bailey. Bruce Shrader 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 was limited to Mr. Armstrong and Mr. Shrader.

The purpose of the test was to determine if the rate of particulate emissions from this plant's baghouse is below or equal to the allowable N.S.P.S. emissions limit set by US EPA and the State of Maryland.

II. TEST RESULTS

Table I summarizes the test results. The grain loading limitation for EPA is .04 gr/dscf as 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 the same as those set by EPA.

TABLE I

SUMMARY OF TEST RESULTS

August 3 & 4, 1989

Test Run	Time	Grain Loading	Isokinetic Variation	Actual Emissions
1	09:51 to 13:49	0.0172 gr/DSCF	94.1%	4.4 lbs/hr
2	08:07 to 09:12	0.0064 gr/DSCF	97.4%	1.7 lbs/hr
3	10:15 to 11:18	0.0042 gr/DSCF	100.4%	1.0 lbs/hr
	Average:	0.0093 gr/DSCF		2.4 lbs/hr

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

III. TEST PROCEDURES

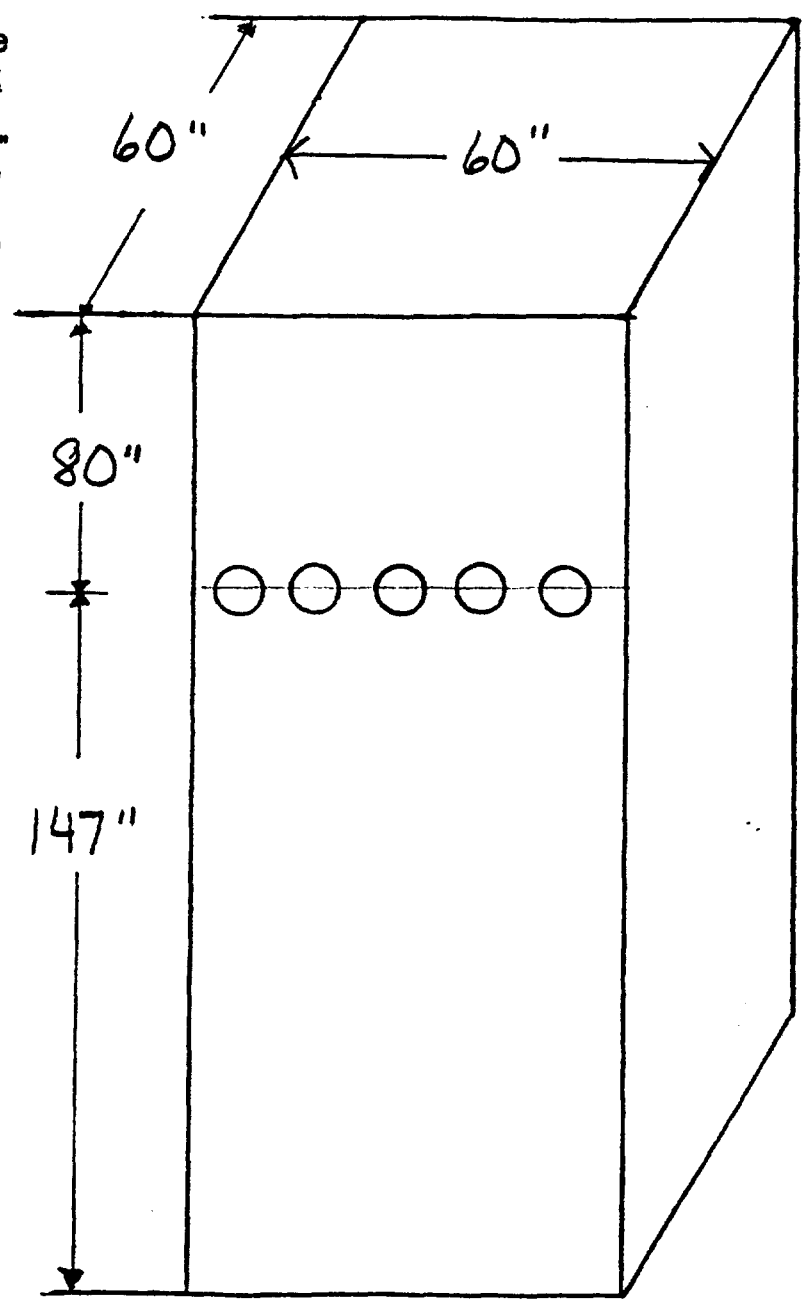
A. Method Used: Method 5 source sampling was conducted in accordance with requirements of the U.S. Environmental Protection Agency as set forth in 39 FR 9314, March 8, 1974, 60.93, as amended.

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

C. Sampling Site: The emissions test was conducted after a baghouse on a square stack measuring 60.0" x 60.0" with an equivalent diameter of 60.0". Five sampling ports were placed 80.0" down (1.3 diameters upstream) from the top of the stack and 147" up (2.5 diameters downstream) from the last flow disturbance. The ports were evenly spaced on 12.0" centers. The two outside ports are 6.0" from the side walls of the stack. Twenty points were sampled, four through each port for three minutes each.

Points on a Diameter	Probe Mark
1	*10.5"
2	25.5"
3	40.5"
4	55.5"

*Measurements include a 3" standoff.



IV. THE SOURCE

IV. THE SOURCE

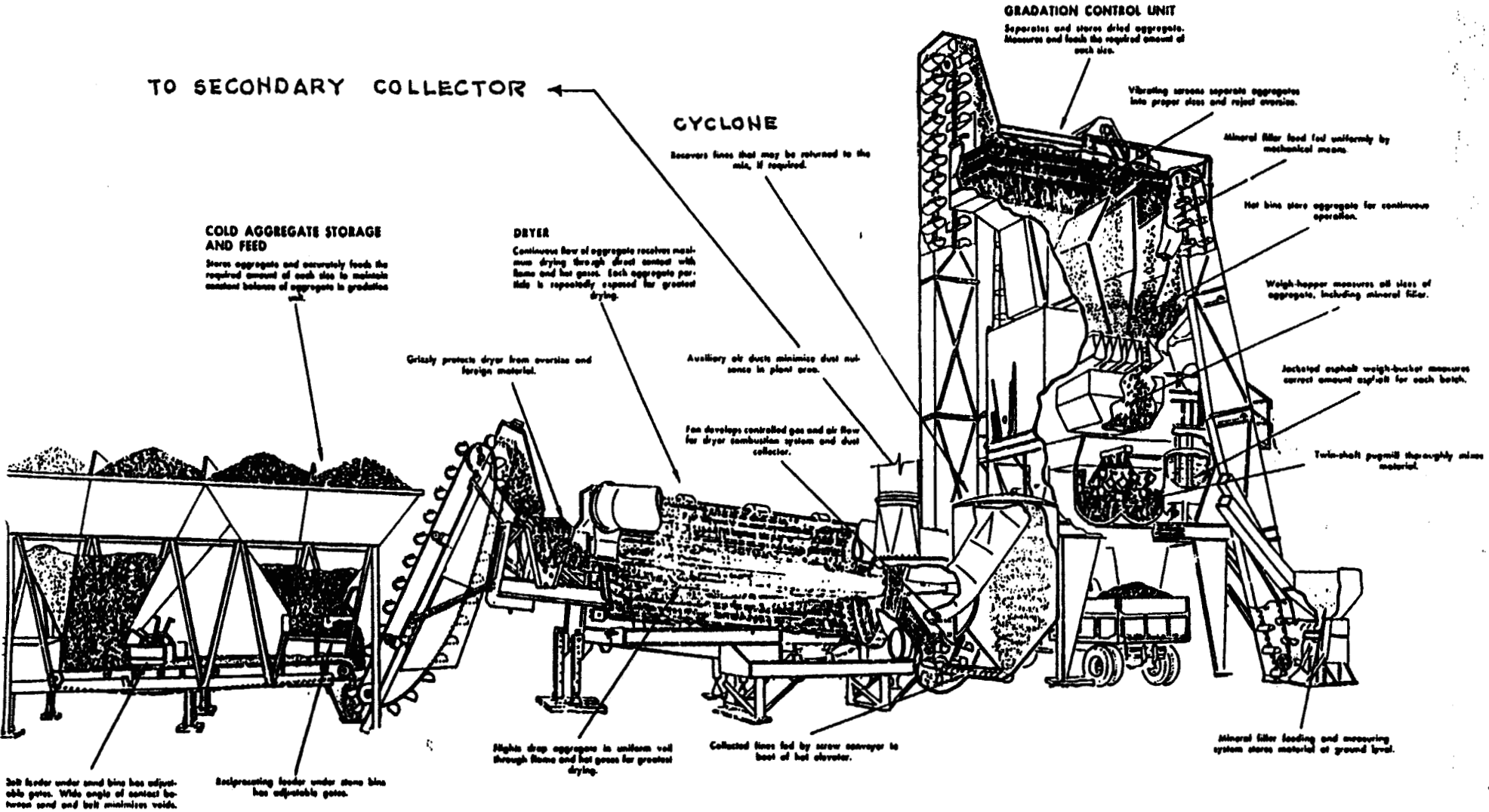
I.A. Construction Materials employs a McCarter batch mix asphalt plant which is used to manufacture hot mix asphalt for road pavement. The process consists of blending prescribed portions of cold feed materials (sand, gravel, screenings, chips, etc.) uniformly and adding sufficient hot asphalt oil to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

The following to a general description of the plant's manufacturing process: The cold feed materials (aggregate) are dumped into four separate bins which in turn feed a common continuous conveyor. The aggregate is dispensed from the bins in accordance with the desired formulation onto the cold feed system conveyor, to an inclined weigh conveyor, then to a rotating drum for continuous mixing and drying at approximately 300°F. The dried aggregate is pulled by a bucket elevator to the top of a gradation control unit which separates and stores the aggregate by size. The required amount of each aggregate is dispensed into a weigh-hopper and from there into a pugmill where the hot liquid asphalt pavement is mixed thoroughly with the aggregate. The hot asphalt mix is then discharged from the storage silo through a slide gate into waiting dump trucks which transports 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 mixer uses a burner fired with natural gas to heat air to dry the aggregate. The air is drawn into the system via an exhaust fan. After passing through the gas burner, the air passes through a baghouse. The baghouse is manufactured by McCarter. The exhaust gas is drawn through the baghouse and discharged to the atmosphere through the stack. The design pressure drop across the tube sheet is 1 - 2 inches of water. The particulate matter, which is removed by the baghouse, is reinjected into the pugmill.

Figure 4-1

ASPHALT BATCH MIX PLANT - AN EXPLODED VIEW



Source: Asphalt Plant Manual, The Asphalt Institute, 1967

(5)

DATA SUMMARY

Plant

1. Manufacturer of plant McCarter.
2. Designed maximum operating capacity 250 TPH @ 3 % moisture.
3. Actual operation rate 200 TPH @ 2 % moisture.
4. Startup date 8-3-89.
5. Type of fuel used in dryer Natural Gas.
6. Quanity of fuel consumption 300 Cu/ft. per Ton.

Aggregate

7. Name/type of mix BI - Base.
8. Percent asphalt in mix 5.1 %.
9. Temperature of asphalt 290.
10. Sieve/Screening analysis: % Passing;

1"	100	3/8"	67	# 16	38
3/4"	93	# 4	58	# 50	14
1/2"		# 8	48	#200	4.1

Baghouse

11. Manufacturer McCarter.
12. No. of bags 648. Type of bags Nomex.
13. Air to cloth ratio 6 : 1. Designed ACFM 52,000.
14. Square feet of bags 8400.
15. Type of cleaning; pulse jet X, reverse air ____, plenum pulse ____, other ____.
16. Cleaning cycle time 75 Milliseconds.
17. Interval between cleaning cycle 5 Seconds.
18. Pressure drop across baghouse 1.3 psi.
19. Pulse pressure on cleaning cycle 100 psi.

COMPANY NAME IA Construction Corporation DATE 8-3-89

COMPANY REPRESENTATIVE Paul Taylor

Form #REC-03

PLANT DATA

COMPANY NAME J. A. CONSTRUCTION

COMPANY REP. PAUL TAYLOR DATE 8-3-89 PHONE # 301-355-5431

DATA SOURCE

PLANT LOCATION BROOKLYN MD

PLANT MFG. McCARTER PLANT MODEL # PLANT TYPE BATCH

MIX SPECIFICATION # OIL SPECIFICATION #

Time 24 Hour	Fuel Oil / Nat. Gas / Propane / Coal 300 cu/ft per ton	Burner Setting	Aggregate TPH	Recycle TPH	Liquid Asphalt TPH	Mix Temp. °F	Venturi / Baghouse Pressure Drop Inches Water
9:52	NATURAL GAS	5.0%	189.8		10.2	295	1.4
[illegible]	NATURAL GAS	5.6%	189.8		10.2	300	1.4
[illegible]	NATURAL GAS	5.6%	189.8		10.2	300	1.4
1:17	NATURAL GAS	2.6%	189.8		10.2	295	1.4
1:32	NATURAL GAS	3.6%	189.8		10.2	300	1.4
1:47	NATURAL GAS	5.0%	189.8		10.2	295	1.4

DATA SUMMARY

Plant

1. Manufacturer of plant IA Construction Corp.
2. Designed maximum operating capacity 250 TPH @ 3 % moisture.
3. Actual operation rate 200 TPH @ 2 % moisture.
4. Startup date 8-4-89.
5. Type of fuel used in dryer Natural Gas.
6. Quanity of fuel consumption 300 CU/FT PER TON.

Aggregate

7. Name/type of mix SC TOP SURFACE.
8. Percent asphalt in mix 5.4 %.
9. Temperature of asphalt 300. F.
10. Sieve/Screening analysis: % Passing;

1"		3/8"	83	# 16	35
3/4"	100	# 4	64	# 30	23
1/2"	99	# 8	52	#200	5.3

Baghouse

11. Manufacturer McCarter.
12. No. of bags 648. Type of bags Nomex.
13. Air to cloth ratio 6:1. Designed ACFM 52,000.
14. Square feet of bags 8400.
15. Type of cleaning; pulse jet X, reverse air ____, plenum pulse ____, other ____.
16. Cleaning cycle time 75 Milliseconds.
17. Interval between cleaning cycle 5 Seconds.
18. Pressure drop across baghouse 1.4 psi.
19. Pulse pressure on cleaning cycle 100 psi.

COMPANY NAME IA Construction DATE 8-4-89

COMPANY REPRESENTATIVE [illegible]

PLANT DATA

COMPANY NAME: T.A. CONSTRUCTION

COMPANY REP. PAUL TAYLOR DATE 8-4-89 PHONE # 301-355-5431

DATA SOURCE

PLANT LOCATION BROOKLYN MD

PLANT MFG. McCARTER PLANT MODEL # PLANT TYPE BATCH

MIX SPECIFICATION # OIL SPECIFICATION #

Time 24 Hour	Fuel Oil / Nat. Gas / Propane / Coal (300 cu/ft per ton)	Burner Setting	Aggregate TPH	Recycle TPH	Liquid Asphalt TPH	Mix Temp. °F	Venturi / Baghouse Pressure Drop Inches Water
8:10	NATURAL GAS	13.3%	189.2		10.8	300	1.4
8:25	NATURAL GAS	16.9%	189.2		10.8	300	1.5
8:40	NATURAL GAS	14.0%	189.2		10.8	305	1.4
8:55	NATURAL GAS	14.3%	189.2		10.8	300	1.4
9:10	NATURAL GAS	12.0%	189.2		10.8	300	1.4
9:25	NATURAL GAS	12.7%	189.2		10.8	300	
10:15	NATURAL GAS	14.4%	189.2		10.8	305	1.2
10:30	NATURAL GAS	19.9%	189.2		10.8	300	1.4
10:45	NATURAL GAS	15.9%	189.2		10.8	300	1.4
11:00	NATURAL GAS	16.5%	189.2		10.8	300	1.4
11:15	NATURAL GAS	16.4%	189.2		10.8	300	1.4
11:30	NATURAL GAS	15.6%	189.2		10.8	300	1.4

V. EQUIPMENT USED

V. EQUIPMENT USED

Equipment used on conducting the particulate emissions test was:

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

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

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

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

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

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

VI. LABORATORY PROCEDURES & RESULTS

LABORATORY PROCEDURES FOR PARTICULATE SAMPLING

I. Field Preparation

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

Filters are removed from their box and numbered on the back side with a felt pen. The numbering system is continuous from job to job. The filters are placed in a desiccator to dry for at least 24 hours. Clean plastic petri dishes, also numbered, top and bottom, are placed in the desiccator with the filters. After desiccation, 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 books. 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 at 175°C for two hours. The open jars are removed and placed in a desiccator until cool for two hours and then tightly sealed. The jars are then numbered and weighed on the triple beam balance to the closest tenth of a gram. 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 petri dishes. In the lab, the dishes are opened and placed into a desiccator for at least 24 hours. Then the filters are weighed continuously every six hours until a constant weight is achieved. All data is recorded on the laboratory forms that will be bound in the test report.

B. SILICA GEL: The silica gel used in the stack test is returned to the appropriate mason jar and sealed for transport to the laboratory where it is reweighed to a constant weight on a triple beam balance to the nearest tenth of a gram.

C. PROBE RINSINGS: In all tests where a probe washout analysis is necessary, this is accomplished in accordance with procedures specified in "EPA Reference Method 5". These samples are returned to the lab in sealed mason jars for analysis. The front half of the filter holder is washed in accordance with the same procedures and included with the probe wash. Reagent or ACS grade acetone is used as the solvent. The backhalf of the filter holder is washed with deionized water into the impinger catch for appropriate analysis.

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

E. ACETONE: A blank analysis of acetone is conducted from the one gallon glass container used in the field preparation. This acetone was used in the field for rinsing the probe, nozzle, and top half of the filter holder. A blank analysis is performed prior to testing on all new containers of acetone received from the manufacturer to insure that the quality of the acetone used will be 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. 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 the "zero" position. The beam arrest lever (on the lower left hand side toward the rear of the balance) is then slowly pressed downward to the full release position. The lighted vernier scale on the front of the cabinet should align with 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 the 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 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.

Form REC#8

(14)

SAMPLE ANALYTICAL DATA FORM

Plant Location F.A. CONSTRUCTION Relative humidity in lab 50 %

Sample Location hot mix batch mixing stack Density of Acetone (pa) .7857 mg/ml

Blank volume (V_a) 200 ml

Date/Time wt. blank 8-9-89 8:00 Gross wt. 127.4682 mg

Date/Time wt. blank 8-9-89 3:00 Gross wt. 127.4676 mg

Ave. Gross wt. 127.4679 mg

Tare wt. 127.4679 mg

Weight of blank (m_{ab}) 0 mg

Acetone blank residue concentration (C_a) (C_a) = (M_{ab}) / (V_a) (P_a) = (0 mg/g)

Weight of residue in acetone wash: $W_a = C_a V_{aw} P_a$ = (0)(200)(.7857) = (0)

		Run # 1	Run # 2	Run # 3
Acetone rinse volume (V_{aw})	ml	200	200	200
Date/Time of wt 8-9-89; 8:00 Am Gross wt	g	143.4015	126.5792	134.3538
Date/Time of wt 8-9-89; 3:00 pm Gross wt	g	143.4017	126.5791	134.3540
Average Gross wt	g	143.4016	126.5791	134.3539
Tare wt	g	143.3800	126.5657	134.3445
Less acetone blank wt (W_a)	g	0	0	0
Wt of particulate in acetone rinse (m_a)	g	0.0216	0.0134	0.0094

Filter Numbers	#	BS-3478	BS-3479	BS-3480
Date/Time of wt 8-9-89; 8:00 Am Gross wt	g	0.5540	0.5369	0.5333
Date/Time of wt 8-9-89; 3:00 pm Gross wt	g	0.5539	0.5367	0.5331
Average Gross wt	g	0.5539	0.5368	0.5332
Tare wt	g	0.5331	0.5333	0.5320

Weight of particulate on filters(s) (m_f)	g	0.0208	0.0035	0.0012
Weight of particulate in acetone rinse	g	0.0216	0.0134	0.0094
Total weight of particulate (m_n)	g	0.0424	0.0169	0.0106

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

Remarks

Signature of analyst Bruce Shrader Signature of reviewer Sam Turner

COMPANY NAME I.A. CONSTRUCTION

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

Relative humidity in lab 50%

Density of chloroform and ethyl ether _____

1.484 g/ml 0.7079 g/ml

		RUN 1	RUN 2	RUN 3
		315 ml	430 ml	420 ml
Chloroform and ethyl ether rinse volume	ml	150	150	150
Date/time of wt 8-14-89; 8:00 AM Gross wt.	g	120.3022	125.6604	127.0315
Date/time of wt 8-15-89; 8:00 AM Gross wt.	g	120.3018	125.6603	127.0311
Avg. Gross wt.	g	120.3020	125.6603	127.0313
Tare wt.	g	120.2750	125.6490	127.0202
Wt. of particulate in chloroform ethyl ether rinse	g	0.0270	0.0113	0.0111
Water evaporation	#	1	2	3
Date/time of wt. 8-14-89; 8:00 AM Gross wt.	g	124.6350	126.9992	158.7435
Date/time of wt. 8-15-89; 8:00 AM Gross wt.	g	124.6348	126.9990	158.7430
Avg. Gross wt.	g	124.6349	126.9991	158.7432
Tare wt.	g	124.6267	126.9895	158.7292
Less chloroform & ehtyl ETHER blank wt.	g	0.0005	0.0005	0.0005
Weight of particulate from water (m_f)	g	0.0082	0.0096	0.0140
Wt. of particulate in chloroform ethyl ether rinse	g	0.0265	0.0108	0.0106
Total weight of particulate (m_n)	g	0.0347	0.0204	0.0246

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 _____

Signature of Analyst Bruce Shroder

Signature of Reviewer [illegible]

I.A. Construction
Company Name

8-3-89
Date

REFERENCE METHOD 3: GAS ANALYSIS BY FYRITE

FUEL	F_o FACTORS
WOOD	1.0540
BARK	1.0830
ANTHRACITE	1.0699
BITUMINOUS	1.1398
LIGNITE	1.0761
OIL	1.3465
GAS	1.7489
PROPANE	1.5095
BUTANE	1.4791

$O_2\% = 20.9 - [F_o \times CO_2\%]$

RUN #1: 15.7 = 20.9 - [1.7489 x 3.5]

RUN #2: 13.9 = 20.9 - [1.7489 x 4.0]

RUN #3 14.3 = 20.9 - [1.7489 x 3.8]

RUN 1:	$CO_2\%$	3.0	$CO_2\%$	3.0	$CO_2\%$	4.5	AVG.	3.5
	$O_2\%$		$O_2\%$		$O_2\%$		AVG.	15.7
	$N_2\%$		$N_2\%$		$N_2\%$		AVG.	80.8
RUN 2:	$CO_2\%$	4.0	$CO_2\%$	4.0	$CO_2\%$	4.0	AVG.	4.0
	$O_2\%$		$O_2\%$		$O_2\%$		AVG.	13.9
	$N_2\%$		$N_2\%$		$N_2\%$		AVG.	82.1
RUN 3:	$CO_2\%$	3.5	$CO_2\%$	4.0	$CO_2\%$	4.0	AVG.	3.8
	$O_2\%$		$O_2\%$		$O_2\%$		AVG.	14.3
	$N_2\%$		$N_2\%$		$N_2\%$		AVG.	81.9

VII. CALCULATIONS

I.A. CONSTRUCTION COMPANY (17)
BROOKLYN, MARYLAND

SUMMARY OF TEST DATA

		8-3-89 RUN #1	8-4-89 RUN #2	8-4-89 RUN #3
SAMPLING TRAIN DATA				
	start	09:51	08:07	10:15
	finish	13:49	09:12	11:18
1. Sampling time, minutes	θ	60.0	60.0	60.0
2. Sampling nozzle diameter, in.	D_n	.3220	.3220	.3220
3. Sampling nozzle cross-sect. area, ft^2	A_n	.000566	.000566	.000566
4. Isokinetic variation	I	94.1	97.4	100.4
5. Sample gas volume - meter cond., cf.	V_m	39.700	43.190	42.220
6. Average meter temperature, ^oR	T_m	557	554	563
7. Avg. oriface pressure drop, in. H_2O	dH	1.60	1.79	1.60
8. Total particulate collected, mg.	M_n	42.40	16.90	10.60
VELOCITY TRAVERSE DATA				
9. Stack area, ft^2	A	25.00	25.00	25.00
10. Absolute stack gas pressure, in. Hg.	P_s	30.36	29.64	29.64
11. Barometric pressure, in. Hg.	P_{bar}	30.36	29.64	29.64
12. Avg. absolute stack temperature, R^o	T_s	620	655	652
13. Average $-\sqrt{\text{vel. head}}$, (C_p= .80)	$-\sqrt{dP}$	0.48	0.52	0.48
14. Average stack gas velocity, ft./sec.	V_s	28.57	32.25	29.66
STACK MOISTURE CONTENT				
15. Total water collected by train, ml.	V_{ic}	199.00	224.00	206.00
16. Moisture in stack gas, %	B_{ws}	19.86	20.73	19.93
EMISSIONS DATA				
17. Stack gas flow rate, dscf/hr.(000's)	Q_{sd}	1780	1837	1714
18. Stack gas flow rate, cfm	acfm	42855	48375	44490
19. Particulate concentration, gr/dscf	C_s	0.0172	0.0064	0.0042
20. Particulate concentration, lb/hr	E	4.38	1.68	1.03
21. Particulate concentration, lb/mBtu	E'	0.00000	0.00000	0.00000
ORSAT DATA				
22. Percent CO_2 by volume	CO_2	3.50	4.00	3.80
23. Percent O_2 by volume	O_2	15.70	13.90	14.30
24. Percent CO by volume	CO	.00	.00	.00
25. Percent N_2 by volume	N_2	80.80	82.10	81.90

Format: summryR3

I.A. CONSTRUCTION COMPANY (18)
BROOKLYN, MARYLAND

Dry Gas Volume

$$V_{m(std)} = V_m \left[\frac{T_{(std)}}{T_m}\right]\left[\frac{P_{bar} + \frac{dH}{13.6}}{P_{(std)}}\right] = 17.64 \frac{^oR}{in.Hg} \; Y \; V_m \left[\frac{P_{bar} + \frac{dH}{13.6}}{T_m}\right]$$

Where:

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

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

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

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

T_m = Absolute temperature at meter ^oR.

T_{std} = Standard absolute temperature (528^oR).

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

Y = Dry gas meter calibration factor.

13.6 = Inches water per inches Hg.

RUN 1:

$$V_{m(std)} = (17.64)(.990)(39.700)\left[\frac{(30.36) + \frac{1.60}{13.6}}{557}\right] = 37.936 \text{ dscf}$$

RUN 2:

$$V_{m(std)} = (17.64)(.990)(43.190)\left[\frac{(29.64) + \frac{1.79}{13.6}}{554}\right] = 40.533 \text{ dscf}$$

RUN 3:

Total Contaminants by Weight: GRAIN LOADING

Particulate concentration C_s' gr./dscf.

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

Where:

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

M_n = Total amount of particulate matter collected, mg.

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

Run 1:

$$C_s' = \left[0.0154 \frac{gr}{mg} \right] \left[\frac{42.40}{37.936} \right] = 0.0172 \text{ gr./dscf.}$$

Run 2:

$$C_s' = \left[0.0154 \frac{gr}{mg} \right] \left[\frac{16.90}{40.533} \right] = 0.0064 \text{ gr./dscf.}$$

Run 3:

$$C_s' = \left[0.0154 \frac{gr}{mg} \right] \left[\frac{10.60}{38.971} \right] = 0.0042 \text{ gr./dscf.}$$

Dry Molecular Weight

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

Where:

M_d = Dry molecular weight, lb./lb.-mole.

$\%CO_2$ = Percent carbon dioxide by volume (dry basis).

$\%O_2$ = Percent oxygen by volume (dry basis).

$\%N_2$ = Percent nitrogen by volume (dry basis).

$\%CO$ = Percent carbon monoxide by volume (dry basis).

0.264 = Ratio of O_2 to N_2 in air, v/v.

0.28 = Molecular weight of N_2 or CO, divided by 100.

0.32 = Molecular weight of O_2 divided by 100.

0.44 = Molecular weight of CO_2 divided by 100.

Run 1:

$$M_d = 0.44(\ 3.50\%) + 0.32(15.70\%) + 0.28(\ .00\% + 80.80\%) = 29.19 \ \frac{lb}{lb\text{-}mole}$$

Run 2:

$$M_d = 0.44(\ 4.00\%) + 0.32(13.90\%) + 0.28(\ .00\% + 82.10\%) = 29.20 \ \frac{lb}{lb\text{-}mole}$$

Run 3:

$$M_d = 0.44(\ 3.80\%) + 0.32(14.30\%) + 0.28(\ .00\% + 81.90\%) = 29.18 \ \frac{lb}{lb\text{-}mole}$$

Water Vapor Condensed

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

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

Where:

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

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

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

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

$V_f - V_i$ = Final volume of impinger contents less initial volume, ml.

$W_f - W_i$ = Final weight of silica gel less initial weight, g.

p_w = Density of water, 0.002201 lb/ml.

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

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

T_{std} = Absolute temperature at standard conditions, 528^oR.

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

Run 1:

$V_{wc(std)}$ = (0.04707) (185.0) = 8.7 cu.ft
$V_{wsg(std)}$ = (0.04715) (14.0) = 0.7 cu.ft

Run 2:

$V_{wc(std)}$ = (0.04707) (212.0) = 10.0 cu.ft
$V_{wsg(std)}$ = (0.04715) (12.0) = 0.6 cu.ft

Run 3:

$V_{wc(std)}$ = (0.04707) (190.0) = 8.9 cu.ft
$V_{wsg(std)}$ = (0.04715) (16.0) = 0.8 cu.ft

Moisture Content of Stack Gases

$$B_{ws} = \frac{V_{wc_{std}} + V_{wsg_{std}}}{V_{wc_{std}} + V_{wsg_{std}} + V_{m_{std}}} \times 100$$

Where:

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

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

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

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

Run 1:

$$B_{ws} = \frac{8.7 + 0.7}{8.7 + 0.7 + 37.936} \times 100 = 19.86\ \%$$

Run 2:

$$B_{ws} = \frac{10.0 + 0.6}{10.0 + 0.6 + 40.533} \times 100 = 20.73\ \%$$

Run 3:

$$B_{ws} = \frac{8.9 + 0.8}{8.9 + 0.8 + 38.971} \times 100 = 19.93\ \%$$

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 = 29.19 (1 - 19.86) + 18 (19.86) = 26.97 (lb./lb.-mole)

Run 2:

M_s = 29.20 (1 - 20.73) + 18 (20.73) = 26.88 (lb./lb.-mole)

Run 3:

M_s = 29.18 (1 - 19.93) + 18 (19.93) = 26.95 (lb./lb.-mole)

Stack Gas Velocity

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

Where:

V_s	=	Average velocity of gas stream in stack, ft./sec.
K_p	=	85.49 ft/sec $\left[(g/g\text{-mole})\text{-}(mm\ Hg)\ /\ (^oK)(\ mm\ H_2O \right]^{1/2}$
C_p	=	Pitot tube coefficient, (dimensionless).
dP	=	Velocity head of stack gas, in. H_2O.
P_{bar}	=	Barometric pressure at measurement site, (in. Hg).
P_g	=	Stack static pressure, (in. Hg).
P_s	=	Absolute stack gas pressure, (in. Hg) = $P_{bar} + P_g$
P_{std}	=	Standard absolute pressure, (29.92 in. Hg).
t_s	=	Stack temperature, (^of).
T_s	=	Absolute stack temperature, (^oR). = 460 + t_s.
M_s	=	Molecular weight of stack gas, wet basis, (lb/lb-mole).

Run 1:

$$V = (85.49)\ (\ .80)\ (\ 0.48)\ \sqrt{\frac{620}{(30.36)(26.97)}} = 28.57\ ft/sec.$$

Run 2:

$$V = (85.49)\ (\ .80)\ (\ 0.52)\ \sqrt{\frac{655}{(29.64)(26.88)}} = 32.25\ ft/sec.$$

Run 3:

$$V = (85.49)\ (\ .80)\ (\ 0.48)\ \sqrt{\frac{652}{(29.64)(26.95)}} = 29.66\ ft/sec.$$

I.A. CONSTRUCTION COMPANY
BROOKLYN, MARYLAND

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, (^{o}f).

T_s = Absolute stack temperature, (^{o}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:

$$Q_{sd}=3600(1-\ .1986\ )(\ 28.57)(\ 25.00)\left[\frac{528}{620}\right]\left[\frac{30.36}{29.92}\right] = 1780674.3\ \frac{dscf}{hr}$$

Run 2:

$$Q_{sd}=3600(1-\ .2073\ )(\ 32.25)(\ 25.00)\left[\frac{528}{655}\right]\left[\frac{29.64}{29.92}\right] = 1837343.3\ \frac{dscf}{hr}$$

Run 3:

$$Q_{sd}=3600(1-\ .1993\ )(\ 29.66)(\ 25.00)\left[\frac{528}{652}\right]\left[\frac{29.64}{29.92}\right] = 1714693.2\ \frac{dscf}{hr}$$

Emissions Rate from Stack

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

Where:

E = Emissions rate, lb/hr.

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

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

Run 1:

$$E = \frac{(0.0172)\ (1780674.3)}{7000} = 4.38\ lb. / hr.$$

Run 2:

$$E = \frac{(0.0064)\ (1837343.3)}{7000} = 1.68\ lb. / hr.$$

Run 3:

$$E = \frac{(0.0042)\ (1714693.2)}{7000} = 1.03\ lb. / hr.$$

Isokinetic Variation

$$I = 100\ T_s \left[\frac{0.002669\ V_{ic}}{60\ \theta} + \frac{(V_m / T_m)\ (P_{bar} + dH / 13.6)}{V_s\ P_s\ A_n} \right]$$

Where:

I	=	Percent isokinetic sampling.
100	=	Conversion to percent.
T_s	=	Absolute average stack gas temperature, ^oR.
0.002669	=	Conversion factor, Hg - ft^3/ml - ^oR.
V_{ic}	=	Ttl vol of liquid collected in impingers and silica gel, ml.
T_m	=	Absolute average dry gas meter temperature, ^oR.
P_{bar}	=	Barometric pressure at sampling site, (in. Hg).
dH	=	Av 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:

$$I = (100)(620) \left[\frac{(0.002669)(199.00)}{60\ (60.0)\ (28.57)} + \frac{39.700}{557} \frac{\left[30.36 + \frac{1.60}{13.6}\right]}{(30.36)\ (.000566)} \right] = 94.1\%$$

Run 2:

$$I = (100)(655) \left[\frac{(0.002669)(224.00)}{60\ (60.0)\ (32.25)} + \frac{43.190}{554} \frac{\left[29.64 + \frac{1.79}{13.6}\right]}{(29.64)\ (.000566)} \right] = 97.4\%$$

Run 3:

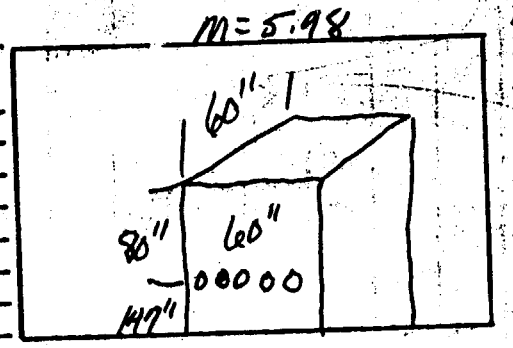
$$I = (100)(652) \left[\frac{(0.002669)(206.00)}{60\ (60.0)\ (29.66)} + \frac{42.220}{563} \frac{\left[29.64 + \frac{1.60}{13.6}\right]}{(29.64)\ (.000566)} \right] = 100.4\%$$

VIII. FIELD DATA

RAMCON ENVIRONMENTAL CORPORATION

Plant J. A. Cowan

Location Balt. M.D.
Operator Wade Armstrong
Date 8-3-89
Run No. 1
Sample Box No. 1
Meter Box No. 6206775 / C-185
Meter H @ 1.94
C Factor .987
Pitot Tube Coefficient Cp .802



Schematic of Stack Cross Section

Ambient Temperature 76°F
Barometric Pressure 30.36
Assumed Moisture, % 27%
Probe Length, m(ft) 6 (61)
Nozzle Identification No. .00055655
Avg. Calibrated Nozzle Dia., (in.) .322/.323/.322
Probe Heater Setting 5
Leak Rate, m³/min. (cfm) +.010 @ 18"
Probe Liner Material Stainless Steel
Static Pressure, mm Hg (in. Hg) +.05"
Filter No. RS-3478/.5531

	IMPINGER VOLUME, ml	SILICA GEL WEIGHT, g
FINAL	385	214
INITIAL	200	200
DIFFERENCE	185	14

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	9:51 / 9:54	2	152	.28	1.7	924.578 / 926.77	86	78	230	55
2	9:57	3	156	.49	2.9	929.50	94	78	235	55
3	10:00	4	158	.70	4.2	932.76	98	78	245	55
4	10:03	3	162	.45	2.7	935.51	102	78	245	55
B 1	10:04 / 10:07	2	156	.18	1.1	937.26	100	78	255	55
2	10:10	2.5	164	.21	1.3	939.09	106	78	250	55
3	10:13	2.5	164	.08	.48	940.22	106	80	245	55
4	10:16	2.5	164	.10	.60	941.39	106	80	240	55
C 1	10:17 / 10:20	2	158	.05	.30	942.32	102	80	235	55
2	10:23	2	160	.05	.30	943.29	104	80	235	55
3	1:17 / 1:20	1	150	.10	.60	944.75	100	92	250	55
4	1:23	4	156	.68	4.1	948.08	108	94	250	55
D 1	1:24 / 1:27	1	156	.11	.67	949.60	112	94	250	55

Form #REC-06

RAMCON emissions test log sheet, cont. DATE 8-3-89 LOCATION Balt, 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	1:30	1.5	160	.22	1.3	951.52	112	94	260	55
3	1:33	2	164	.26	1.6	953.73	116	94	260	55
4	1:36	3	166	.39	2.3	956.32	118	94	265	55
E 1	1:37 / 1:40	1	160	.09	.54	957.62	116	94	275	55
2	1:43	1	164	.13	.78	959.41	118	94	275	55
3	1:46	1.5	164	.20	1.2	961.12	118	94	275	55
4	1:49	3.5	166	.55	3.3	964.221	118	94	275	55

RAMCON ENVIRONMENTAL CORPORATION

Plant I. M. Const.

Location Baltimore, Md.
Operator Dave Armstrong
Date 8-4-89
Run No. 2
Sample Box No. 2
Meter Box No. 670775 / C-185
Meter H @ 1.94
C Factor .987
Pitot Tube Coefficient Cp .802

m = ~~5.96~~ 6.02

Schematic of Stack Cross Section

Ambient Temperature 85°F
Barometric Pressure 29.64
Assumed Moisture, % 15
Probe Length, m(ft) 6 (6)
Nozzle Identification No. 0005655
Avg. Calibrated Nozzle Dia., (in.) ~~.322~~ / ~~.322~~ / .322
Probe Heater Setting 5
Leak Rate, m³/min. (cfm) +.006 @ 2"
Probe Liner Material Stainless Steel
Static Pressure, mm Hg (in. Hg) +.05"
Filter No. RS-3479 / 15333

	IMPINGER VOLUME, ml	SILICA GEL WEIGHT, g
FINAL	412	212
INITIAL	200	200
DIFFERENCE	212	12

TRAV. PT NO.	SAMPLING TIME (θ) min.	VACUUM in. Hg	STACK TEMP (T_s) °F	VELOCITY HEAD (P_s) in H20	PRESSURE DIFF. ORF. MTR in H_2O	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	~~8:07~~ 8:10	1	180	.15	.90	~~964.408~~ 966.21	92	76	240	55
2	8:13	1	198	.15	.90	967.74	96	76	250	55
3	8:16	1.5	198	.18	1.1	969.49	98	76	255	55
4	8:19	1.5	198	.19	1.1	971.48	100	76	265	55
B 1	~~8:20~~ 8:23	1	192	.08	.48	972.60	100	76	275	55
2	8:26	1	196	.10	.60	974.07	104	76	275	55
3	8:29	1.5	198	.18	1.1	976.18	106	76	275	55
4	8:32	2	198	.26	1.6	977.82	110	76	275	55
C 1	~~8:33~~ 8:36	1	192	.09	.54	979.46	108	76	270	55
2	8:39	1	194	.09	.54	981.07	112	78	270	55
3	8:42	2	196	.21	1.3	982.23	114	78	260	55
4	8:45	2.5	196	.35	2.1	984.64	116	78	260	55
D 1	~~8:46~~ 8:49	2	194	.27	1.6	986.91	116	80	265	55

Form #REC-06

RAMCON emissions test log sheet, cont. DATE 9-4-89 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	8:52	2.5	196	.31	1.9	989.50	118	80	265	55
3	8:55	3.5	198	.52	3.1	992.18	120	80	270	55
4	8:58	4.5	196	.66	4.0	995.55	120	80	275	55
E 1	9:00 / 9:03	3	194	.35	2.1	998.03	116	80	275	55
2	9:06	4	196	.50	3.0	1001.99	118	80	275	55
3	9:09	4.5	196	.62	3.7	1004.47	120	80	275	55
4	9:12	5	196	.70	4.2	1007.588	120	80	275	55

RAMCON ENVIRONMENTAL CORPORATION

Plant J.H. Construction

Location Baltimore, Md.
Operator Dave Christiano
Date 8-4-89
Run No. 3
Sample Box No. 2
Meter Box No. 670775 / C-185
Meter H @ 1.94
C Factor .987
Pitot Tube Coefficient Cp .802

M= 6.02

Schematic of Stack Cross Section

Ambient Temperature 94°F
Barometric Pressure 29.64
Assumed Moisture, % 15
Probe Length, m(ft) 6(61)
Nozzle Identification No. .0005655
Avg. Calibrated Nozzle Dia., (in.) .322/.322/.322
Probe Heater Setting 5
Leak Rate, m³/min. (cfm) +.005@6"
Probe Liner Material Stainless Steel
Static Pressure, mm Hg (in. Hg) +.05
Filter No. BS-3480 / 5320

	IMPINGER VOLUME, ml	SILICA GEL WEIGHT, g
FINAL	390	216
INITIAL	200	200
DIFFERENCE	190	16

TRAV. PT NO.	SAMPLING TIME (θ) min.	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	10:15 / 10:18	1	164	.05	.30	7.640 / 9.05	98	90	235	60
2	10:21	1	180	.05	.30	10.37	104	90	250	60
3	10:23	1	184	.12	.72	12.12	108	90	260	60
4	10:25	1	186	.12	.72	13.65	110	90	265	60
B 1	10:27 / 10:30	1	192	.10	.60	15.58	106	90	275	60
2	10:33	1	188	.10	.60	16.85	108	90	275	60
3	10:36	1.5	192	.14	.84	18.52	112	90	275	60
4	10:39	2.5	196	.41	2.5	21.16	114	90	275	60
C 1	10:40 / 10:43	1	192	.08	.48	22.52	114	90	275	60
2	10:46	1	196	.08	.49	23.85	118	90	275	60
3	10:49	2	198	.21	1.3	25.98	118	90	275	60
4	10:52	4.5	198	.62	3.7	28.84	120	90	275	60
D 1	10:53 / 10:56	2	196	.20	1.2	30.76	118	90	270	60

Form #REC-06

RAMCON emissions test log sheet, cont. DATE 8-4-89 LOCATION Baltimore, Md. TEST NO. 3

TRAVERSE POINT	SAMPLING TIME θ (min)	VACUUM mm Hg (in. Hg)	STACK TEMP T_s (°F)	VELOCITY HEAD ΔP_s (in. H_2O)	ORFICE DIFF. PRESSURE ΔH (in. H_2O)	GAS VOLUME Vm (ft^3)	GAS SAMPLE TEMP. (°F) in	GAS SAMPLE TEMP. (°F) out	SAMPLE BOX TEMP. (°F)	IMPINGER TEMP (°F)
2	10:59	2	196	.24	1.4	32.84	120	90	265	60
3	11:02	4	198	.50	3.0	35.77	122	90	260	60
4	11:05	4.5	198	.71	4.3	39.27	122	90	260	60
E 1	11:06 / 11:09	2.5	196	.28	1.7	41.56	122	90	265	60
2	11:12	2.5	198	.34	2.0	44.09	122	90	270	60
3	11:15	3.5	198	.47	2.8	46.64	122	90	270	60
4	11:18	3.5	198	.50	3.0	49.857	122	90	275	60

IX. CALIBRATION

METER BOX CALIBRATION DATA AND CALCULATION FORM

(English units)

Date 14 March 89 Meter box number C-185/670775

Barometric pressure, P_b = 29.76 in. Hg Calibrated by D. Armstrong

Orifice manometer setting (ΔH), in. H_2O	Gas volume: Wet test meter (V_w), ft^3	Gas volume: Dry gas meter (V_d), ft^3	Temperature: Wet test meter (t_w), °F	Temperature: Dry gas meter: Inlet (t_{d_i}), °F	Temperature: Dry gas meter: Outlet (t_{d_o}), °F	Temperature: Dry gas meter: Avg[a] (t_d), °F	Time (θ), min	Y_i	$\Delta H@_i$ in. H_2O	CFM
0.5	5	913.187 / 908.160	72	96 / 82	70 / 68	79	12.43	.994	1.84	.397
1.0	5	907.926 / 902.802	72	96 / 82	68 / 68	78.5	9.13	.987	1.86	.561
1.5	10	902.385 / 892.150	72	96 / 82	68 / 68	78.5	15.33	.989	1.97	.668
2.0	10	891.535 / 881.400	72	96 / 84	68 / 68	79	13.28	.994	1.97	.764
3.0	10	881.135 / 870.950	72	100 / 80	68 / 68	79	10.87	.987	1.98	.937
4.0	10	870.544 / 860.530	72	100 / 80	68 / 68	79	9.48	.973	2.01	1.09
							Avg	.987	1.94	.736

ΔH, in. H_2O	$\frac{\Delta H}{13.6}$	$Y_i = \frac{V_w P_b (t_d + 460)}{V_d (P_b + \frac{\Delta H}{13.6})(t + 460)}$	$\Delta H@_i = \frac{0.0317\ \Delta H}{P_b (t_d + 460)} \left[\frac{(t_w + 460)\ \theta}{V_w}\right]^2$
0.5	0.0368	.994	1.84
1.0	0.0737	.987	1.86
1.5	0.110	.989	1.97
2.0	0.147	.994	1.97
3.0	0.221	.987	1.98
4.0	0.294	.973	2.01

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

Form #REC-02

STACK TEMPERATURE SENSOR CALIBRATION DATA FORM

Date 5-7-89 Thermocouple number inlet/outlet

Ambient temperature 20 °C Barometric pressure 29.88 in. Hg

Calibrator Turner Reference: mercury-in-glass ✓

other _____

Reference point number	Source[a] (specify)	Reference thermometer temperature, °C	Thermocouple potentiometer temperature, °C	Temperature difference,[b] %
A	Ice Bath	32	32	0
B	Boiling water	212	212	0
C	Boiling oil	381	381	0
D	Ambient 8-3-89	76	76	0

[a]Type of calibration system used.

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

STACK TEMPERATURE SENSOR CALIBRATION DATA FORM

Date 5-7-89 Thermocouple number Hotbox

Ambient temperature 20 °C Barometric pressure 29.88 in. Hg

Calibrator Turner Reference: mercury-in-glass ✓

other _____

Reference point number	Source[a] (specify)	Reference thermometer temperature, °C	Thermocouple potentiometer temperature, °C	Temperature difference,[b] %
A	Ice Bath	32°F	32	0
B	Boiling water	212	212	0
C	Boiling oil	381	381	0
D	Ambient 6-3-89	76	76	0

[a]Type of calibration system used.

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

RAMCON ENVIRONMENTAL CORPORATION

Lear Siegler Stack Sampler

Nozzle Diameter Calibration

Date _____ Signature _____

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

Pitot Tube Calibration (S Type)

Pitot Tube Identification No. 61 Date 5-6-89

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	0.90	1.4	.802	
2	0.60	.93	.803	
3	0.41	.64	.800	
		$\bar{C}_p$ (SIDE A)	.802	

"B" SIDE CALIBRATION

Run No.	Δp std cm H_2O (in. H_2O)	$\Delta p(s)$ cm H_2O in. H_2O)	$C_p(s)$	DEVIATION $C_p(s)-\bar{C}_p(B)$
1	0.90	1.39	.805	
2	0.60	.94	.799	
3	0.41	.63	.807	
		$\bar{C}_p$ (SIDE B)	.804	

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

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

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

Form No. EED-17-1

RAMCON

Lear Siegler Stack Sampler

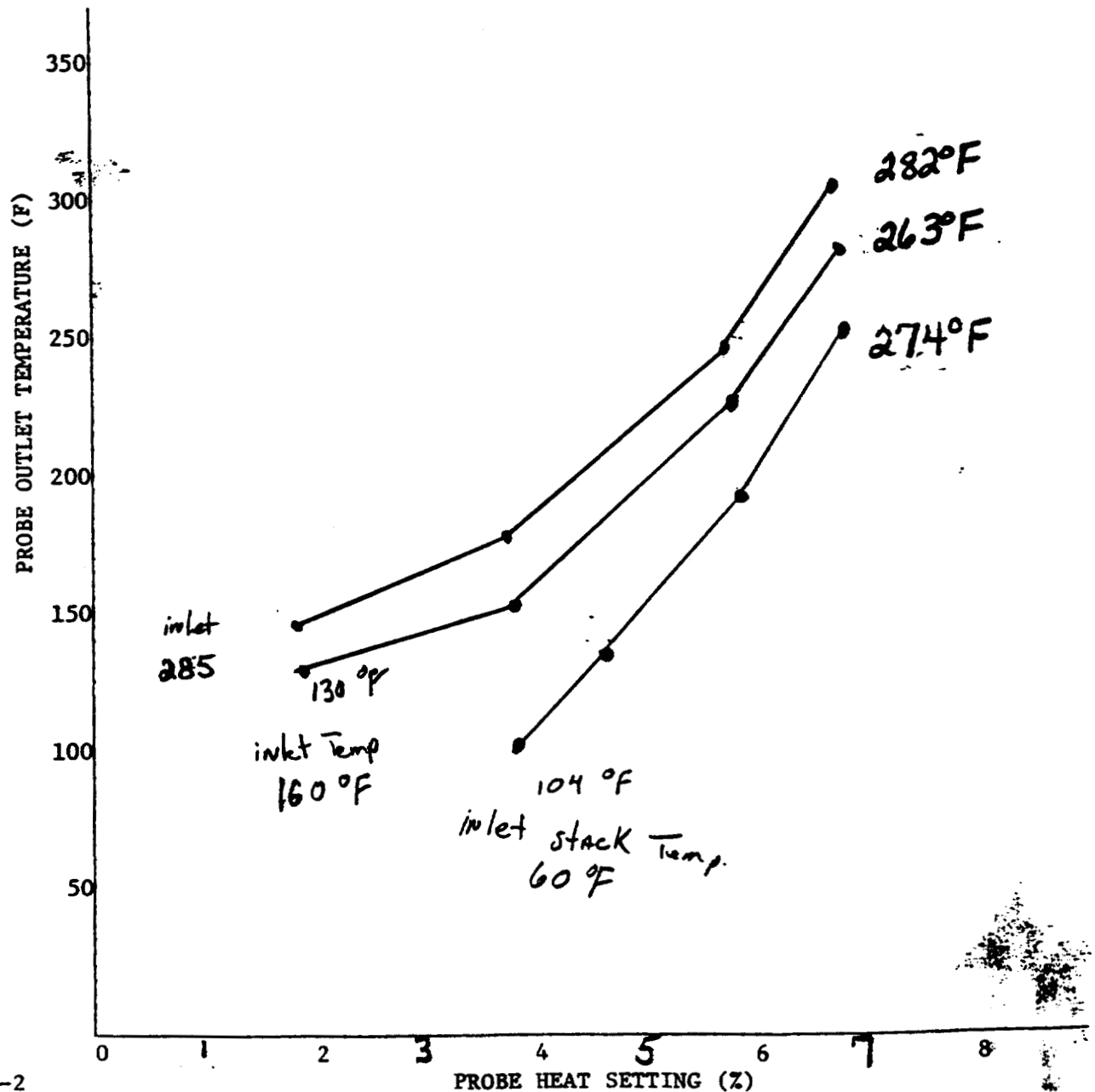
Heating Probe Calibration

Probe No. 61 Probe Length 6'

Date of Calibration 5-8-89 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



STACK TEMPERATURE SENSOR CALIBRATION DATA FORM

Date 5-5-89 Thermocouple number 61

Ambient temperature 20 °C Barometric pressure 29.88 in. Hg

Calibrator Turner 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	212	212	0
B	Boiling oil	381	381	0
C	Ice Bath	32	32	0
D	Ambient 5-3-85	76	76	0

[a]Type of calibration system used.

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

X. RAMCON PERSONNEL

RAMCON Environmental Stack Test Team

Sumner Buck - President

Sumner Buck is the President of RAMCON Environmental Corporation. He is a graduate of the EPA 450 "Source Sampling for Particulate Pollutant's" course and the 474 "Continuous Emissions Monitoring" course all given at RTP. Mr. Buck is a certified V.E. reader with current certification. Mr. Buck has personally sampled over 400 stacks including over 300 asphalt plants. He is 47 years old and a graduate of the University of Mississippi with graduate studies at Memphis State University and State Technical Institute of Memphis.

Dave Armstrong - Team Leader

Dave Armstrong has been with RAMCON Environmental for two years. He was promoted to Team Leader in 1988 and altogether has sampled almost 200 stacks of all types. Dave is a current V.E. reader and has extensive training in EPA Methods 1 - 9.