RAMCON
ENVIRONMENTAL CORPORATION

SOURCE SAMPLING
for
PARTICULATE EMISSIONS
BOWEN CONSTRUCTION COMPANY
LEES SUMMIT, MISSOURI
August 24, 1989

Ken Whisler
Bowen Construction Company

G. Sumner Buck, III
President

Ken Allmendinger
Field Supervisor

RAMCON
ENVIRONMENTAL CORPORATION

September 14, 1989

Mr. Ken Whisler
Bowen Construction Company
2501 Manchester Traffic Way
Kansas City, MO 64129

Re: Particulate Emissions Test: Lees Summit, Missouri

Dear Mr. Whisler:

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 do pass both EPA New Source Performance Standards and those set by the State of Missouri. 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. Tom Scheppers
Missouri DNR
P.O. Box 176
Jefferson City, MO 65102

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
TELEPHONE 800/458-4567 IN TENNESSEE 901/458-7000 FAX 901-458-3868

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I. INTRODUCTION

On August 24, 1989, personnel from RAMCON Environmental Corporation conducted a source emissions test for particulate emissions compliance at Bowen Construction Company's CMI drum mix asphalt plant located in Lees Summit, Missouri. RAMCON personnel conducting the test were Ken Allmendinger, Field Supervisor and David Bailey. Kim Hipson 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. Allmendinger and Ms. Hipson.

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

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 Missouri are the same as those set by EPA.

Mr. Thom Sheppers of Missouri's Department for Natural Resources and Environmental Protection observed the testing conducted by RAMCON Environmental Corporation. The opacity test (Reference Method 9) was not conducted due to overcast skies and light drizzle.

TABLE I

SUMMARY OF TEST RESULTS

August 24, 1989

Test Run	Time	Grain Loading	Isokinetic Variation	Actual Emissions
1	09:11 to 10:21	0.0139 gr/DSCF	100.5%	2.3 lbs/hr
2	11:10 to 12:12	0.0135 gr/DSCF	99.7%	2.1 lbs/hr
3	13:00 to 14:02	0.0294 gr/DSCF	101.9%	4.5 lbs/hr
	Average:	0.0176 gr/DSCF		3.0 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 Missouri. Therefore, the plant is operating in compliance with State and Federal Standards.

III. TEST PROCEDURES

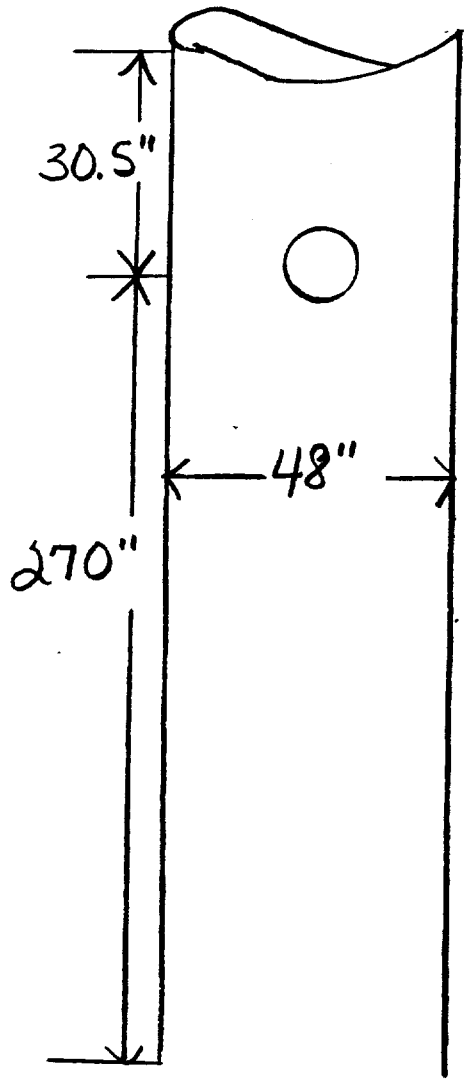
A. Method Used: Method 5 source sampling was conducted in accordance with requirements of the U.S. Environmental Protection Agency as set forth in 39 FR 9314, March 8, 1974, 60.93, as amended.

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

C. Sampling Site: The emissions test was conducted after a baghouse on a round stack with a diameter of 48". The sampling ports were placed 30.5" down (0.6 diameters upstream) from the top of the stack and 270" up (5.6 diameters downstream) from the last flow disturbance. Thirty points were sampled, ten through each traverse for three minutes each for a total testing time of 60 minutes.

Points on a Diameter	Probe Mark
1	*7.2"
2	9.9"
3	13.0"
4	16.8"
5	22.4"
6	37.6"
7	43.2"
8	47.0"
9	50.1"
10	52.8"

*Measurements include a 6" standoff.



IV. THE SOURCE

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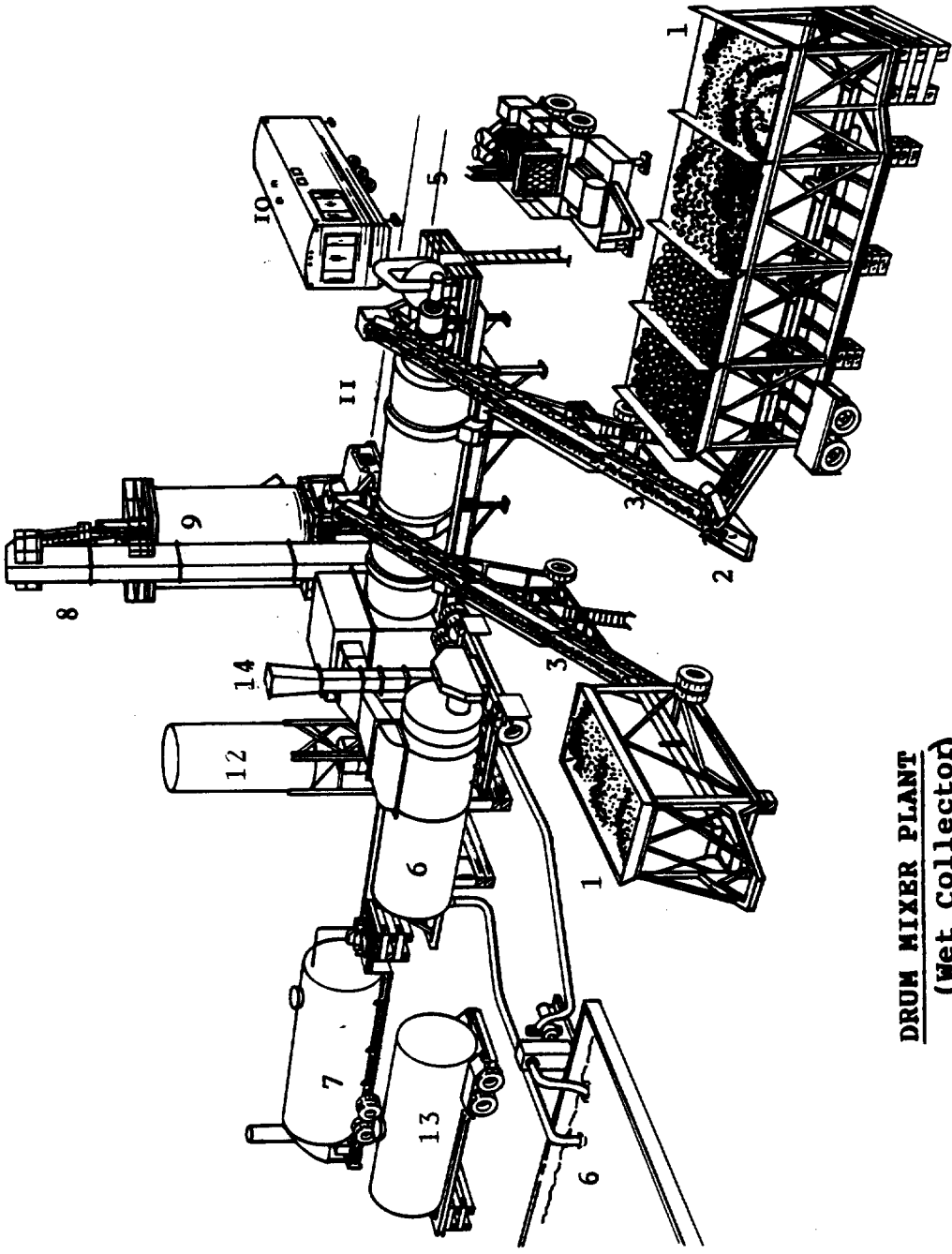
Bowen Construction Company employs a CMI drum mix asphalt plant which is used to manufacture hot mix asphalt for road pavement. The process consists of blending prescribed portions of cold feed materials (sand, gravel, screenings, chips, etc.) uniformly and adding sufficient hot asphalt oil to bind the mixture together. After the hot asphalt mix is manufactured at the plant, it is transported to the location where it is to be applied. The hot asphalt mix is spread evenly over the surface with a paver 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 required amount of hot asphalt oil is then injected onto and mixed into the dried aggregate. The now newly formed hot asphalt mix is pulled to the top of a storage silo by a conveyor. 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 high efficiency scrubber. The scrubber is manufactured by Standard Havens. The exhaust gases are blown through the scrubber and discharged to the atmosphere through the stack. The design pressure drop across the venturi is in excess of 15 inches of water. The particulate matter, which is removed by the scrubber, is fed into a scrubber pond where it drops out of suspension.



DRUM MIXER PLANT
(Wet Collector)

1. Aggregate bins: Virgin and recycled aggregate is fed individually into each of the bins by type. It is metered onto a conveyor belt running under the bins to a shaker screen. The proportion of each aggregate type is determined by the job mix formula and pre-set to be metered out to meet these specifications.

2. Preliminary oversize screen: The aggregate is fed through a shaker screen where oversize rocks and foreign material is screened out of the mix.

3. Weigh conveyor belt: The aggregate is conveyed to the rotary drum dryer on a conveyor belt which weighs the material. The production rate is determined by this weight reading.

4. Rotary drum dryer/mixer: The aggregate is fed into the rotary drum dryer where it is tumbled by flighting into a veil in front of a gas flame which drives off the moisture. Further mixing is also accomplished in this drum. Hot liquid asphalt is injected approximately one-third of the way down the inclined drum where it is mixed with the aggregate.

5. Burner: The fuel fired burner is used to dry the rough aggregate and sand in the rotating drum as well as reheat recycled asphalt when it is part of the mix.

6. Wet scrubbing system: A system of cyclonic action, spray nozzles and a venturi removes 99% of particulates in the gas stream.

7. Liquid asphalt storage: The liquid asphalt is stored in this heated tank until it is needed in the mixer. The amount of asphalt content and its temperature are pre-set for each different type job.

8. Conveyor to surge/storage bin: The finished product of aggregate mixed with liquid asphalt is conveyed to a surge bin.

9. Surge/storage bin: The asphaltic cement is dumped into this surge bin and metered out to dump trucks which pull underneath the slide gate at the bottom of the bin.

10. Control/operators house: The entire plant operation is controlled from this operator's house.

11. Truck loading scale: As the trucks receive the asphalt from the storage/surge bin they are weighed on the loading scale which tells the plant operator the amount of asphalt that is being trucked on each individual load.

12. Mineral filler system (when used).

13. Burner fuel storage (when used).

14. Stack.

DATA SUMMARY

Plant

1. Manufacturer of plant CMI.
2. Designed maximum operating capacity 300 TPH @ 5 % moisture.
3. Actual operation rate _____ TPH @ 4.0 % moisture.
4. Startup date _____.
5. Type of fuel used in dryer Nat. Gas.
6. Quanity of fuel consumption _____.

Aggregate

7. Name/type of mix APWA Type III.
8. Percent asphalt in mix 5.2 %.
9. Temperature of asphalt 305.
10. Sieve/Screening analysis: % Passing;

1"	100	3/8"	80.0	#40	23.4
3/4"	100	# 4	59.2	#80	7.6
1/2"	91.3	# 10	42.6	#200	5.8

Baghouse

11. Manufacturer Standard Havens.
12. No. of bags 462. Type of bags 14oz. Nomex.
13. Air to cloth ratio 5.14 to 1. Designed ACFM _____.
14. Square feet of bags 10,593.
15. Type of cleaning; pulse jet X, reverse air _____, plenum pulse _____, other _____.
16. Cleaning cycle time _____.
17. Interval between cleaning cycle 12 sec.
18. Pressure drop across baghouse _____ psi.
19. Pulse pressure on cleaning cycle 120 psi.

COMPANY NAME Bowen Const Co DATE Aug. 24, 89

COMPANY REPRESENTATIVE Kenneth Whisler

PLANT DATA

COMPANY NAME Bowen Const Co

COMPANY REP. Larry Elliott DATE Aug 24 1989 PHONE # 921-8200

DATA SOURCE

PLANT LOCATION 7 hwy & Langsford Rd

PLANT MFG. CMI PLANT MODEL # 2280 PLANT TYPE Drum Mix

MIX SPECIFICATION # Type 3 OIL SPECIFICATION # AC 20

Time 24 Hour	___ Fuel Oil ___ Nat. Gas ✓ Propane ___ Coal ___	Burner Setting	Aggregate TPH	Recycle TPH	Liquid Asphalt TPH	Mix Temp. °F	___ Venturi ___ Baghouse Pressure Drop Inches Water
9:15		7	250		12.15	300	1
9:30		7	270		13.10	285	1
9:45		7.5	275		13.50	280	1
10:00		8.5	278		14.20	294	1
10:15		8.5	264		14.50	309	1.4
10:30		7.4	271		15.30	306	1.4
11:15		7	290		15.70	280	1
11:30		7.5	303		15.75	292	1.4
11:45		7.6	301		15.54	295	1.2
12:00		7.8	300		15.16	293	1
12:15		7.8	306		16.02	302	1.2
12:30		2.2	159		8.90	315	1
12:45		7	300		15.20	300	1
1:00		7	302		15.60	295	1.1
1:15		7	305		15.20	309	1
1:30		7	300		14.95	296	1
1:45		7	300		16.24	296	1
2:00		7.4	302		15.50	290	1.2

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

(13)

SAMPLE ANALYTICAL DATA FORM

Plant Location Bowen — Relative humidity in lab 45 %

Sample Location botanic asphalt plant — Density of Acetone (pa) .7857 mg/ml

Blank volume (V_a) 200 ml

Date/Time wt. blank 9-6-89 — Gross wt. 140.3314 mg

Date/Time wt. blank 9-7-89 — Gross wt. 140.3314 mg

Ave. Gross wt. 140.3314 mg

Tare wt. 140.3308 mg

Weight of blank (m_{ab}) 0.0006 mg

Acetone blank residue concentration (C_a) (C_a) = (M_{ab}) / (V_a) (p_a) = (.000038 mg/g)

Weight of residue in acetone wash: $W_a = C_a V_{aw} p_a$ = (.000038)(200)(.7857) = (200)

		Run # 1	Run # 2	Run # 3
Acetone rinse volume (V_{aw})	ml	200	200	200
Date/Time of wt 9-6-89 - 9 am/pm Gross wt	g	154.0031	136.4408	163.5115
Date/Time of wt 9-6-89 4 pm/am Gross wt	g	154.0029	136.4405	163.5110
Average Gross wt	g	154.0030	136.4407	163.5113
Tare wt	g	153.9709	136.4089	163.4437
Less acetone blank wt (W_a)	g	0.0006	0.0006	0.0006
Wt of particulate in acetone rinse (m_a)	g	0.0315	0.0312	0.0670

Filter Numbers	#	BS-3521	BS-3410	BS-3411
Date/Time of wt 9/6/89 2:00 Gross wt	g	0.5258	0.5300	0.5313
Date/Time of wt 9-7-89 9: am/pm Gross wt	g	0.5255	0.5300	0.5310
Average Gross wt	g	0.5257	0.5300	0.5312
Tare wt	g	0.5231	0.5297	0.5301

Weight of particulate on filters(s) (m_f)	g	0.0026	0.0003	0.0011
Weight of particulate in acetone rinse	g	0.0315	0.0312	0.0670
Total weight of particulate (m_n)	g	0.0341	0.0315	0.0681

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 K. Hixson — Signature of reviewer

Bowen Const. — Company Name

8-24-89 — 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: ____ = 20.9 - [[redacted] x ____]

RUN #2: ____ = 20.9 - [____ x ____]

RUN #3 ____ = 20.9 - [____ x ____]

RUN 1:	$CO_{2\%}$	5.0	$CO_{2\%}$	5.0	$CO_{2\%}$	5.0	AVG.	5.0
	$O_{2\%}$	8.0	$O_{2\%}$	8.5	$O_{2\%}$	8.0	AVG.	8.2
	$N_{2\%}$		$N_{2\%}$		$N_{2\%}$		AVG.	86.8
RUN 2:	$CO_{2\%}$	4.5	$CO_{2\%}$	4.5	$CO_{2\%}$	5.0	AVG.	4.7
	$O_{2\%}$	12.0	$O_{2\%}$	12.0	$O_{2\%}$	12.5	AVG.	12.2
	$N_{2\%}$		$N_{2\%}$		$N_{2\%}$		AVG.	83.1
RUN 3:	$CO_{2\%}$	4.0	$CO_{2\%}$	4.5	$CO_{2\%}$	4.5	AVG.	4.3
	$O_{2\%}$	12.5	$O_{2\%}$	12.5	$O_{2\%}$	12.0	AVG.	12.3
	$N_{2\%}$		$N_{2\%}$		$N_{2\%}$		AVG.	83.4

VII. CALCULATIONS

BOWEN CONSTRUCTION COMPANY
LEES SUMMIT, MISSOURI

SUMMARY OF TEST DATA

		8-24-89 RUN #1	8-24-89 RUN #2	8-24-89 RUN #3
SAMPLING TRAIN DATA				
	start	09:11	11:10	13:00
	finish	10:21	12:12	14:02
1. Sampling time, minutes	θ	60.0	60.0	60.0
2. Sampling nozzle diameter, in.	D_n	.2750	.2750	.2750
3. Sampling nozzle cross-sect. area, ft^2	A_n	.000413	.000413	.000413
4. Isokinetic variation	I	100.5	99.7	101.9
5. Sample gas volume - meter cond., cf.	V_m	39.408	38.249	38.048
6. Average meter temperature, ^oR	T_m	549	557	560
7. Avg. oriface pressure drop, in. H_2O	dH	1.21	1.11	1.07
8. Total particulate collected, mg.	M_n	34.10	31.50	68.10
VELOCITY TRAVERSE DATA				
9. Stack area, ft^2	A	12.60	12.60	12.60
10. Absolute stack gas pressure, in. Hg.	P_s	29.25	29.25	29.25
11. Barometric pressure, in. Hg.	P_{bar}	29.25	29.25	29.25
12. Avg. absolute stack temperature, R^o	T_s	766	773	777
13. Average $-\sqrt{\text{vel. head}}$, (C_p= .81)	$-\sqrt{dP}$	0.78	0.75	0.73
14. Average stack gas velocity, ft./sec.	V_s	54.59	52.57	51.37
STACK MOISTURE CONTENT				
15. Total water collected by train, ml.	V_{ic}	366.00	339.00	340.00
16. Moisture in stack gas, %	B_{ws}	31.33	30.73	30.96
EMISSIONS DATA				
17. Stack gas flow rate, dscf/hr.(000's)	Q_{sd}	1145	1102	1068
18. Stack gas flow rate, cfm	acfm	41270	39743	38836
19. Particulate concentration, gr/dscf	C_s	0.0139	0.0135	0.0294
20. Particulate concentration, lb/hr	E	2.28	2.13	4.49
21. Particulate concentration, lb/mBtu	E'	0.00000	0.00000	0.00000
ORSAT DATA				
22. Percent CO_2 by volume	CO_2	5.00	4.70	4.30
23. Percent O_2 by volume	O_2	8.20	12.20	12.30
24. Percent CO by volume	CO	.00	.00	.00
25. Percent N_2 by volume	N_2	86.80	83.10	83.40

Format: summryR3

BOWEN CONSTRUCTION COMPANY
LEES SUMMIT, MISSOURI

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:

$$V_{m(std)} = (17.64)(1.015)(39.408)\left[\frac{(29.25) + \frac{1.21}{13.6}}{549}\right] = 37.707 \text{ dscf}$$

RUN 2:

$$V_{m(std)} = (17.64)(1.015)(38.249)\left[\frac{(29.25) + \frac{1.11}{13.6}}{557}\right] = 36.063 \text{ dscf}$$

RUN 3:

$$V_{m(std)} = (17.64)(1.015)(38.048)\left[\frac{(29.25) + \frac{1.07}{13.6}}{560}\right] = 35.678 \text{ dscf}$$

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:

$$C_s' = \left[0.0154 \frac{gr}{mg}\right] \left[\frac{34.10}{37.707}\right] = 0.0139 \text{ gr./dscf.}$$

Run 2:

$$C_s' = \left[0.0154 \frac{gr}{mg}\right] \left[\frac{31.50}{36.063}\right] = 0.0135 \text{ gr./dscf.}$$

Run 3:

$$C_s' = \left[0.0154 \frac{gr}{mg}\right] \left[\frac{68.10}{35.678}\right] = 0.0294 \text{ gr./dscf.}$$

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:

$$M_d = 0.44(\ 5.00\%) + 0.32(\ 8.20\%) + 0.28(\ .00\% + 86.80\%) = 29.13 \ \frac{lb}{lb\text{-mole}}$$

Run 2:

$$M_d = 0.44(\ 4.70\%) + 0.32(12.20\%) + 0.28(\ .00\% + 83.10\%) = 29.24 \ \frac{lb}{lb\text{-mole}}$$

Run 3:

$$M_d = 0.44(\ 4.30\%) + 0.32(12.30\%) + 0.28(\ .00\% + 83.40\%) = 29.18 \ \frac{lb}{lb\text{-mole}}$$

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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) (355.0) = 16.7 cu.ft
$V_{wsg(std)}$ = (0.04715) (11.0) = 0.5 cu.ft

Run 2:

$V_{wc(std)}$ = (0.04707) (325.0) = 15.3 cu.ft
$V_{wsg(std)}$ = (0.04715) (14.0) = 0.7 cu.ft

Run 3:

$V_{wc(std)}$ = (0.04707) (330.0) = 15.5 cu.ft
$V_{wsg(std)}$ = (0.04715) (10.0) = 0.5 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:

$$B_{ws} = \frac{16.7 + 0.5}{16.7 + 0.5 + 37.707} \times 100 = 31.33\ \%$$

Run 2:

$$B_{ws} = \frac{15.3 + 0.7}{15.3 + 0.7 + 36.063} \times 100 = 30.73\ \%$$

Run 3:

$$B_{ws} = \frac{15.5 + 0.5}{15.5 + 0.5 + 35.678} \times 100 = 30.96\ \%$$

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 = 29.13 (1 - 31.33) + 18 (31.33) = 25.64 (lb./lb.-mole)

Run 2:

M_s = 29.24 (1 - 30.73) + 18 (30.73) = 25.79 (lb./lb.-mole)

Run 3:

M_s = 29.18 (1 - 30.96) + 18 (30.96) = 25.72 (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 $\left[\frac{(g/g\text{-mole})\text{-(mm Hg)}}{(^{o}K)(\text{mm } H_2O)}\right]^{1/2}$

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, (^{o}f).

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

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

Run 1:

$$V = (85.49)\ (\ .81)\ (\ 0.78) \sqrt{\frac{766}{(29.25)(25.64)}} = 54.59 \text{ ft/sec.}$$

Run 2:

$$V = (85.49)\ (\ .81)\ (\ 0.75) \sqrt{\frac{773}{(29.25)(25.79)}} = 52.57 \text{ ft/sec.}$$

Run 3:

$$V = (85.49)\ (\ .81)\ (\ 0.73) \sqrt{\frac{777}{(29.25)(25.72)}} = 51.37 \text{ ft/sec.}$$

Stack Gas Flow Rate

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

Where:

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

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

3600 = Conversion factor, (sec./hr.).

t_s = Stack temperature, (^{o}f).

T_s = Absolute stack temperature, (^{o}R).

T_{std} = Standard absolute temperature, ($528^{o}R$).

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:

$$Q_{sd}=3600(1-\ .3133\ )(\ 54.59)(\ 12.60)\left[\frac{528}{766}\right]\left[\frac{29.25}{29.92}\right]=\ 1145836.4\ \frac{dscf}{hr}$$

Run 2:

$$Q_{sd}=3600(1-\ .3073\ )(\ 52.57)(\ 12.60)\left[\frac{528}{773}\right]\left[\frac{29.25}{29.92}\right]=\ 1102998.5\ \frac{dscf}{hr}$$

Run 3:

$$Q_{sd}=3600(1-\ .3096\ )(\ 51.37)(\ 12.60)\left[\frac{528}{777}\right]\left[\frac{29.25}{29.92}\right]=\ 1068711.7\ \frac{dscf}{hr}$$

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Emissions Rate from Stack

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

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:

$$E = \frac{(0.0139)\ (1145836.4)}{7000} = 2.28 \text{ lb. / hr.}$$

Run 2:

$$E = \frac{(0.0135)\ (1102998.5)}{7000} = 2.13 \text{ lb. / hr.}$$

Run 3:

$$E = \frac{(0.0294)\ (1068711.7)}{7000} = 4.49 \text{ lb. / hr.}$$

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

Where:

I	=	Percent isokinetic sampling.
100	=	Conversion to percent.
T_s	=	Absolute average stack gas temperature, ^{o}R.
0.002669	=	Conversion factor, Hg - ft^3/ml - ^{o}R.
V_{ic}	=	Ttl vol of liquid collected in impingers and silica gel, ml.
T_m	=	Absolute average dry gas meter temperature, ^{o}R.
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:

$$I = (100)(\ 766\ ) \left[\frac{(0.002669)(366.00) + \frac{39.408}{549} \left[29.25 + \frac{1.21}{13.6} \right]}{60\ (\ 60.0\ )\ (\ 54.59\ )\ (\ 29.25\ )\ (\ .000413\ )} \right] = 100.5\%$$

Run 2:

$$I = (100)(\ 773\ ) \left[\frac{(0.002669)(339.00) + \frac{38.249}{557} \left[29.25 + \frac{1.11}{13.6} \right]}{60\ (\ 60.0\ )\ (\ 52.57\ )\ (\ 29.25\ )\ (\ .000413\ )} \right] = 99.7\%$$

Run 3:

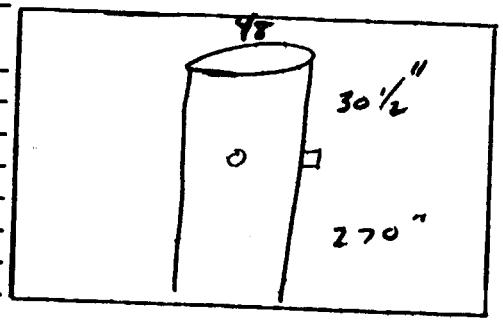
$$I = (100)(\ 777\ ) \left[\frac{(0.002669)(340.00) + \frac{38.048}{560} \left[29.25 + \frac{1.07}{13.6} \right]}{60\ (\ 60.0\ )\ (\ 51.37\ )\ (\ 29.25\ )\ (\ .000413\ )} \right] = 101.9\%$$

VIII. FIELD DATA

RAMCON ENVIRONMENTAL CORPORATION

Plant Bowen Const

Location Lees Summit Mo.
Operator K. Allensdinger
Date 8-24-89
Run No. 1
Sample Box No. 1
Meter Box No. 646882 C-124
Meter H @ 1.50
C Factor 1.015
Pitot Tube Coefficient Cp .81



Schematic of Stack Cross Section

Ambient Temperature 75
Barometric Pressure 29.25
Assumed Moisture, % 30
Probe Length, ft 5
Nozzle Identification No. .0004/125
Avg. Calibrated Nozzle Dia., (in.) .275/.275/.275
Probe Heater Setting 5.0
Leak Rate, m^3/min, (cfm) .007@8"
Probe Liner Material Pyrex
Static Pressure, mm Hg (In. Hg) .05
Filter No. 85-3521 .5231

	IMPINGER VOLUME, ml	SILICA GEL WEIGHT, g
FINAL	555	305
INITIAL	200	294
DIFFERENCE	355	11

TRAV. PT NO.	SAMPLING TIME (θ) min.	VACUUM in. Hg	STACK TEMP (Ts) °F	VELOCITY HEAD (Ps) in H20	PRESSURE DIFF. ORF. MTR in H20	GAS SAMPLE VOLUME ft3	GAS SAMPLE TEMP. AT DRY GAS METER °F		FILTER HOLDER TEMP °F	GAS TEMP LVG CONDENSER OR LAST IMPINGER °F
							Inlet	Outlet		
A) 1	9:11 / 9:14	1	300	.53	1.0	831.211 / 833.03	80	75	240	65
2	9:17	1	300	.60	1.2	834.95	90	75	245	60
3	9:20	2	305	.85	1.6	837.29	95	75	255	60
4	9:23	2	315	.90	1.7	839.63	95	75	255	60
5	9:31:30 / 9:34	2	315	.87	1.7	842.00	85	75	255	60
6	9:37	1	310	.57	1.1	843.95	95	75	260	60
7	9:40	1	305	.55	1.1	845.82	100	75	250	60
8	9:43	1	305	.57	1.1	847.73	100	80	250	60
9	9:46	1	300	.53	1.0	849.55	100	80	250	60
10	9:49:30	1	300	.68	1.3	851.59	105	80	250	60
B) 1	9:51:15 / 9:54	1	290	.35	.67	853.05	100	80	255	60
2	9:57	1	305	.30	.58	854.47	100	80	255	60
3	10:00	1	305	.30	.58	855.85	100	80	255	60

Form #REC-06

RAMCON emissions test log sheet, cont. DATE 8-24-89 LOCATION Lee Summit TEST NO. 1

TRAVERSE POINT	SAMPLING TIME θ (min)	VACUUM mm Hg (in. Hg)	STACK TEMP T_s (°F)	VELOCITY HEAD ΔP_s (in. H_2O)	ORFICE DIFF. PRESSURE ΔH (in. H_2O)	GAS VOLUME V_m (ft^3)	GAS SAMPLE TEMP. (°F)		SAMPLE BOX TEMP. (°F)	IMPINGER TEMP (°F)
							in	out		
4	10:03	1	305	.37	.71	857.42	105	80	260	60
5	10:06	1	305	.37	.71	855.00	105	80	260	60
6	10:09	1	305	.50	.96	860.81	105	80	260	60
7	10:12	2	305	.90	1.7	863.09	110	80	255	60
8	10:15	2	310	.95	1.8	865.72	110	80	255	60
9	10:18	2	315	.95	1.8	868.15	110	80	255	60
10	10:21:15	2	315	.95	1.8	870.619	110	80	255	60

(LE)

RAMCON ENVIRONMENTAL CORPORATION

Plant Bowen Const.

Location Lees Summit Mo.
Operator K. Allemendinger
Date 8-24-89
Run No. 2
Sample Box No. 2
Meter Box No. 6/6882 C-124
Meter H @ 1.50
C Factor 1.015
Pitot Tube Coefficient Cp .81

Ambient Temperature 95
Barometric Pressure 29.25
Assumed Moisture, % 30
Probe Length, ft 5 2
Nozzle Identification No. .0004/25
Avg. Calibrated Nozzle Dia., (in.) .276/.275/.275
Probe Heater Setting 5.0
Leak Rate, m^3/min. (cfm) +.005@5"
Probe Liner Material Quartz
Static Pressure, mm Hg (in. Hg) .05
Filter No. AS-3410 .5257

	IMPINGER VOLUME, ml	SILICA GEL WEIGHT, g
FINAL	525	320
INITIAL	200	306
DIFFERENCE	325	14

Schematic of Stack Cross Section

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	GAS SAMPLE TEMP. AT DRY GAS METER °F Outlet	FILTER HOLDER TEMP °F	GAS TEMP LVG CONDENSER OR LAST IMPINGER °F
A) 1	11:10:30 / 11:13	2	300	.30	.58	870.803 / 872.32	90	85	250	70
2	11:16	4	305	.68	1.3	874.32	100	85	255	65
3	11:19	4	310	.73	1.4	876.36	100	80	255	65
4	11:22	3	320	.52	.99	878.25	105	80	255	65
5	11:25	4	315	.73	1.4	880.35	105	85	260	60
6	11:28	4	315	.65	1.2	882.43	110	85	260	60
7	11:31	4	320	.65	1.2	845.54	110	85	260	60
8	11:34	4	320	.65	1.2	886.56	110	85	260	60
9	11:37	4	320	.63	1.2	888.59	110	85	260	60
10	11:40:30	4	320	.60	1.2	890.64	110	85	260	60
B) 1	11:42 / 11:45	1	295	.20	.38	891.89	105	85	255	60
2	11:48	2	305	.30	.58	893.21	110	85	255	60
3	11:51	2	310	.32	.61	894.76	110	85	255	60

Form #REG-05

Form #REC-06

RAMCON emissions test log sheet, cont. DATE 8-24-84 LOCATION Lees Summit TEST NO. 2

TRAVERSE POINT	SAMPLING TIME θ (min)	VACUUM mm Hg (in. Hg)	STACK TEMP T_s (°F)	VELOCITY HEAD ΔP_s (in. H_2O)	ORFICE DIFF. PRESSURE ΔH (in. H_2O)	GAS VOLUME V_m (ft^3)	GAS SAMPLE TEMP. (°F)		SAMPLE BOX TEMP. (°F)	IMPINGER TEMP (°F)
							in	out		
4	11:54	3	320	.40	.77	896.38	110	85	255	60
5	11:57	3	320	.40	.77	898.01	110	85	255	60
6	12:00 N	5	320	.70	1.3	900.11	110	85	250	60
7	12:03	6	315	.77	1.5	902.28	110	85	250	60
8	12:06	5	315	.75	1.4	904.45	115	85	250	60
9	12:09	6	310	.82	1.6	906.76	115	90	250	60
10	12:12	6	310	.82	1.6	909.054	115	90	250	60

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RAMCON ENVIRONMENTAL CORPORATION

Plant Bowen Const.

Location Lees Summit Mo.
Operator K. Allmendinger
Date 5-24-89
Run No. 3
Sample Box No. 1
Meter Box No. 6/6882 C-124
Meter H @ 1.5
C Factor 1.015
Pitot Tube Coefficient Cp .81

Ambient Temperature 77
Barometric Pressure 29.25
Assumed Moisture, % 30
Probe Length, ft 52
Nozzle Identification No. .0004/125
Avg. Calibrated Nozzle Dia., (in.) .275/.275/.275
Probe Heater Setting 5.0
Leak Rate, m^3/min. (cfm) +.005 @ 10"
Probe Liner Material Quartz
Static Pressure, mm Hg (in. Hg) .05
Filter No. BS-3411 .5301

	IMPINGER VOLUME, ml	SILICA GEL WEIGHT, g
FINAL	530	521
INITIAL	200	511
DIFFERENCE	330	10

Schematic of Stack Cross Section

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		FILTER HOLDER TEMP °F	GAS TEMP LVG CONDENSER OR LAST IMPINGER °F
							Inlet	Outlet		
A) 1	1:00:30 / 1:03	1	300	.63	1.2	909.29 / 911.24	90	90	230	70
2	1:06	1	320	.60	1.2	913.27	105	90	235	65
3	1:09	1	320	.60	1.2	915.23	110	90	240	65
4	1:12	1	325	.62	1.2	917.22	110	90	250	60
5	1:15	1	325	.55	1.1	919.21	110	90	250	60
6	1:18	1	325	.50	.96	921.05	110	90	255	60
7	1:21	1	325	.50	.96	922.86	110	90	255	60
8	1:24	1	325	.50	.96	924.68	110	90	255	60
9	1:27	1	325	.50	.96	926.54	115	90	260	60
10	1:30:30	1	320	.48	.92	928.35	115	90	260	60
B) 1	1:31:45 / 1:34	1	290	.25	.48	929.79	110	90	260	60
2	1:37	1	305	.30	.58	931.21	110	90	260	60
3	1:40	1	315	.35	.67	932.77	110	90	260	60

Form #REC-05

Form #REC-06

RAMCON emissions test log sheet, cont. DATE 8-24-89 LOCATION Last Summit 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 V_m (ft^3)	GAS SAMPLE TEMP.(°F)		SAMPLE BOX TEMP. (°F)	IMPINGER TEMP (°F)
							in	out		
4	1:43	1	315	.35	.67	934.29	110	90	260	60
5	1:47	1	315	.42	.81	936.02	110	90	260	60
6	1:50	1	315	.45	.86	937.80	110	90	260	60
7	1:53	2	320	.95	1.8	940.25	115	90	250	60
8	1:56	2	320	.70	1.3	942.38	115	90	250	60
9	1:59	2	310	.70	1.3	944.58	115	90	250	60
10	2:02:45	4	320	1.2	2.3	947.338	115	90	245	60

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IX. CALIBRATION

METER BOX CALIBRATION DATA AND CALCULATION FORM

(English units)

Date 9-5-89 Meter box number 646882 C-124

Barometric pressure, P_b = 30.17 in. Hg Calibrated by KH

Orifice manometer setting (ΔH), in. H_2O	Gas volume: Wet test meter (V_w), ft^3	Gas volume: Dry gas meter (V_d), ft^3	Temperature: Wet test meter (t_w), °F	Temperature: Dry gas meter Inlet (t_{d_i}), °F	Temperature: Dry gas meter Outlet (t_{d_o}), °F	Temperature: Dry gas meter Avg[a] (t_d), °F	Time (θ), min	Y_i	$\Delta H@_i$ in. H_2O
0.5	5	295.73 / 300.875	77	108 / 108	85 / 85	96.5	11:55	1.002	1.547
1.0	5	279.83 / 284.975	77	111 / 110	86 / 85	98	8:26	1.007	1.544
1.5	10	266.82 / 277.061	77	110 / 112	86 / 86	98.5	13:36	1.019	1.505
2.0	10	255.38 / 265.541	77	112 / 112	85 / 85	98.5	11:51	1.015	1.524
3.0	10								
4.0	10								
							Avg	1.011	1.53

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		
1.0	0.0737		
1.5	0.110		
2.0	0.147		
3.0	0.221		
4.0	0.294		

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

METER BOX CALIBRATION DATA AND CALCULATION FORM

(English units)

Date 8-18-89 Meter box number 246882 C-124

Barometric pressure, P_b = 30.17 in. Hg Calibrated by NA

Orifice manometer setting (ΔH), in. H_2O	Gas volume: Wet test meter (V_w), ft^3	Gas volume: Dry gas meter (V_d), ft^3	Temperature: Wet test meter (t_w), °F	Temperature: Dry gas meter: Inlet (t_{d_i}), °F	Temperature: Dry gas meter: Outlet (t_{d_o}), °F	Temperature: Dry gas meter: Avg[a] (t_d), °F	Time (Θ), min	Y_i	$\Delta H@_i$ in. H_2O
0.5	5								
1.0	5	829.53 / 834.03	77	106 / 108	84 / 84	95.5	5:21	1.012	1.52
1.5	10	814.57 / 824.74	77	108 / 108	84 / 84	96	13:33	1.014	1.50
2.0	10	803.15 / 813.27	77	108 / 110	82 / 84	96	11:37	1.018	1.47
3.0	10								
4.0	10								
							Avg	1.015	1.497

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		
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.

Quality Assurance Handbook M4-2.3A (front side)

Form #REC-02

STACK TEMPERATURE SENSOR CALIBRATION DATA FORM

Date 4-5-89 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	32	0
B	Boiling water	212	212	0
C	Boiling oil	381	381	0
D	Ambient 4-24-89	73	73	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 4-5-89 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, °F	Thermocouple potentiometer temperature, °F	Temperature difference,[b] %
A	ice Bath	32	32	0
B	Boiling oil	381	381	0
C	Boiling water	212	212	0
D	ambient 8-24-88	73	73	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. 52 Date 5-8-89

Calibrated by: Sam O.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	0.98	1.5	.809	2.01
2	0.85	1.30	.809	2.01
3	0.64	.99	.804	2.01
		$\bar{C}_p$ (SIDE A)	.807	

"B" SIDE CALIBRATION

Run No.	Δp std cm H_2O (in. H_2O)	Δp(s) cm H_2O in. H_2O)	$C_p(s)$	DEVIATION $C_{p(s)}-\bar{C}_p(B)$
1	0.98	1.55	.795	2.01
2	0.85	1.30	.809	2.01
3	0.64	0.99	.804	2.01
		$\bar{C}_p$ (SIDE B)	.803	

$$\text{AVERAGE DEVIATION} = \sigma(\text{A OR B}) = \frac{\sum_1^3 |C_p(s)-\bar{C}_p(\text{A OR B})|}{3} \leftarrow \text{MUST BE} \leq 0.01$$

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

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

Form No. EED-17-1

STACK TEMPERATURE SENSOR CALIBRATION DATA FORM

Date 5-5-89 Thermocouple number 52

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	210	.009
C	oil	381	378	.008
D	Ambient + 8-24-89	73	73	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

Lear Siegler Stack Sampler

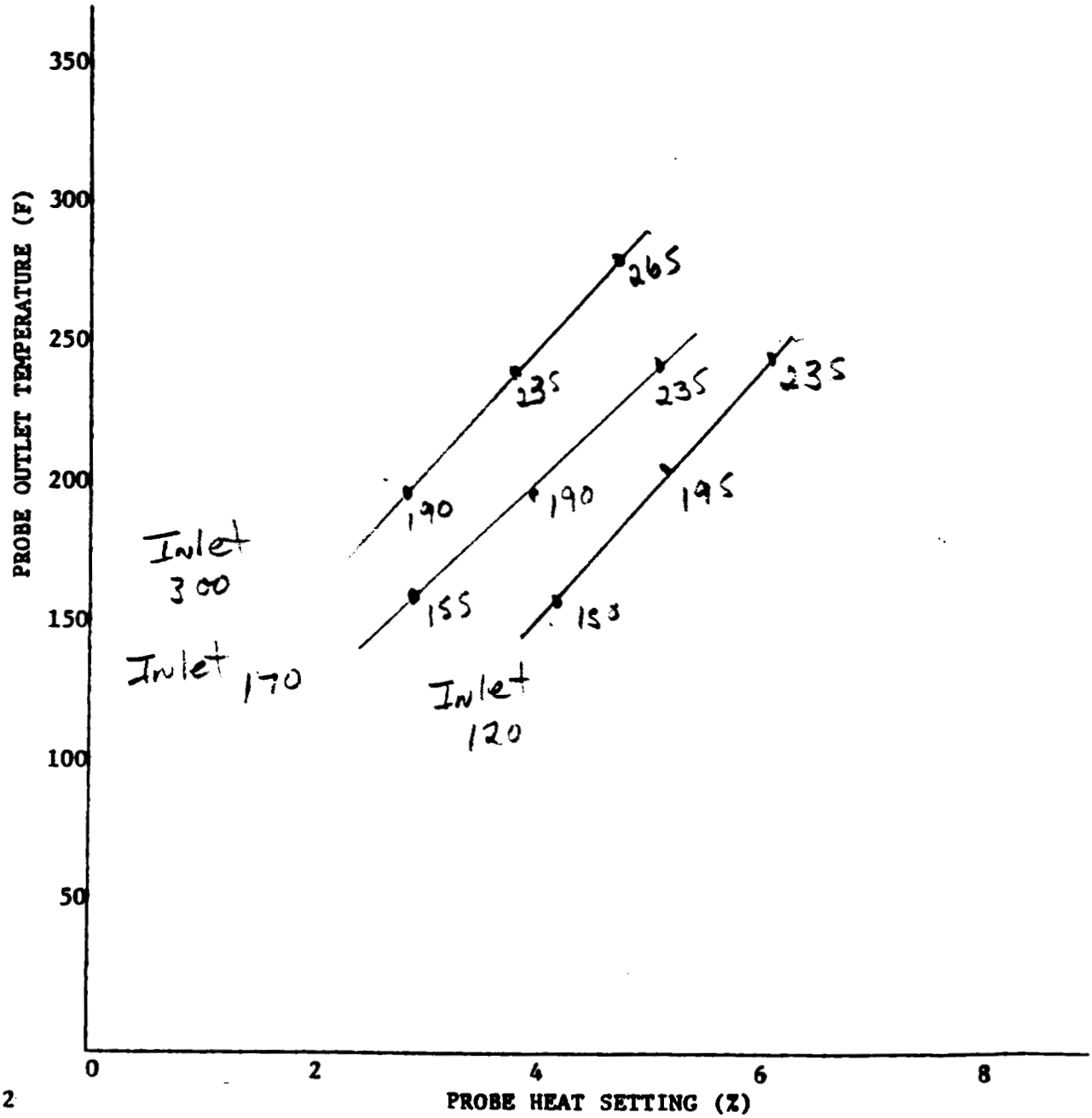
Heating Probe Calibration

Probe No. 52 Probe Length 5'

Date of Calibration 5-7-89 Signature Sam 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



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.

Ken Allmendinger - Field Supervisor

Ken Allmendinger has been employed with RAMCON Environmental for four years. He has personally sampled over 300 asphalt plants and 100 incinerators and boilers. He has extensive training in Methods 1 through 9. He has a current certification as a V.E. reader and has attended several plant manufacturers' schools to understand the stacks he is testing. He has recently been promoted to Field Supervisor and has responsibility for three other stack sampling teams.