RAMCON
ENVIRONMENTAL CORPORATION

SOURCE SAMPLING
for
PARTICULATE EMISSIONS
CURTMAN CONTRACTING, INC.
OWENSVILLE, MISSOURI
October 16, 1989

Wendell Curtman
Wendell Curtman
Curtman Contracting

Sumner Buck
G. Sumner Buck, III
President

Frank Kuhn
Frank Kuhn
Team Leader

RAMCON
ENVIRONMENTAL CORPORATION

October 23, 1989

Mr. Wendall Curtman
Curtman Contracting, Inc.
RR 1, Box 281
Owensville, MO 65066

Re: Particulate Emissions Test: Owensville, Missouri

Dear Mr. Curtman:

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. Steven Feeler
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:kh

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 October 16, 1989, personnel from RAMCON Environmental Corporation conducted a source emissions test for particulate emissions compliance at Curtman Contracting, Inc.'s CMI drum mix asphalt plant located in Owensville, Missouri. RAMCON personnel conducting the test were Frank Kuhn, Team Leader and Billy Lockett. Heather Baldick 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. Kuhn and Ms. Baldick.

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. Steven Feeler of Missouri's Department of Natural Resources observed the testing conducted by RAMCON.

TABLE I

SUMMARY OF TEST RESULTS

October 16, 1989

Test Run	Time	Grain Loading	Isokinetic Variation	Actual Emissions
1	09:45 to 10:49	0.0368 gr/DSCF	100.2%	1.1 lbs/hr
2	11:40 to 12:44	0.0290 gr/DSCF	98.9%	1.0 lbs/hr
3	14:38 to 15:44	0.0157 gr/DSCF	98.7%	0.5 lbs/hr
	Average:	0.0272 gr/DSCF		0.9 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

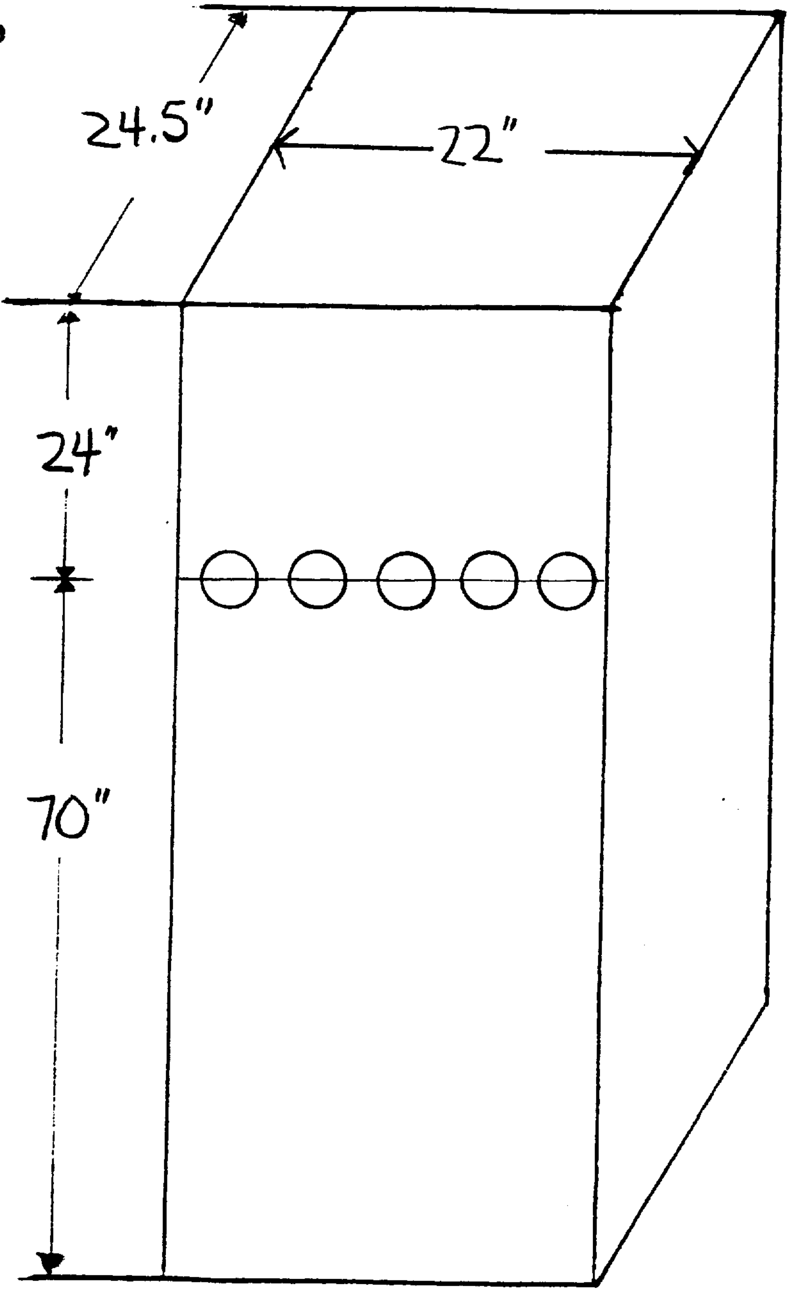
A. Method Used: Method 5 source sampling was conducted in accordance with requirements of the U.S. Environmental Protection Agency as set forth in 39 FR 9314, March 8, 1974, 60.93, as amended.

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

C. Sampling Site: The emissions test was conducted after a scrubber on a rectangular stack measuring 22.0" x 24.5" with an equivalent diameter of 23.1". Five sampling ports were placed 24.0" down (1.0 diameters upstream) from the top of the stack and 70.0" up (3.0 diameters downstream) from the last flow disturbance. The ports were evenly spaced on 4.4" centers. The two outside ports are 2.2" from the side walls of the stack. Thirty points were sampled, six through each port for two minutes each.

Points on a Diameter	Probe Mark
1	*5.3"
2	10.5"
3	15.8"
4	21.0"
5	26.3"
6	31.5"

*Measurements include a 7" standoff.



IV. THE SOURCE

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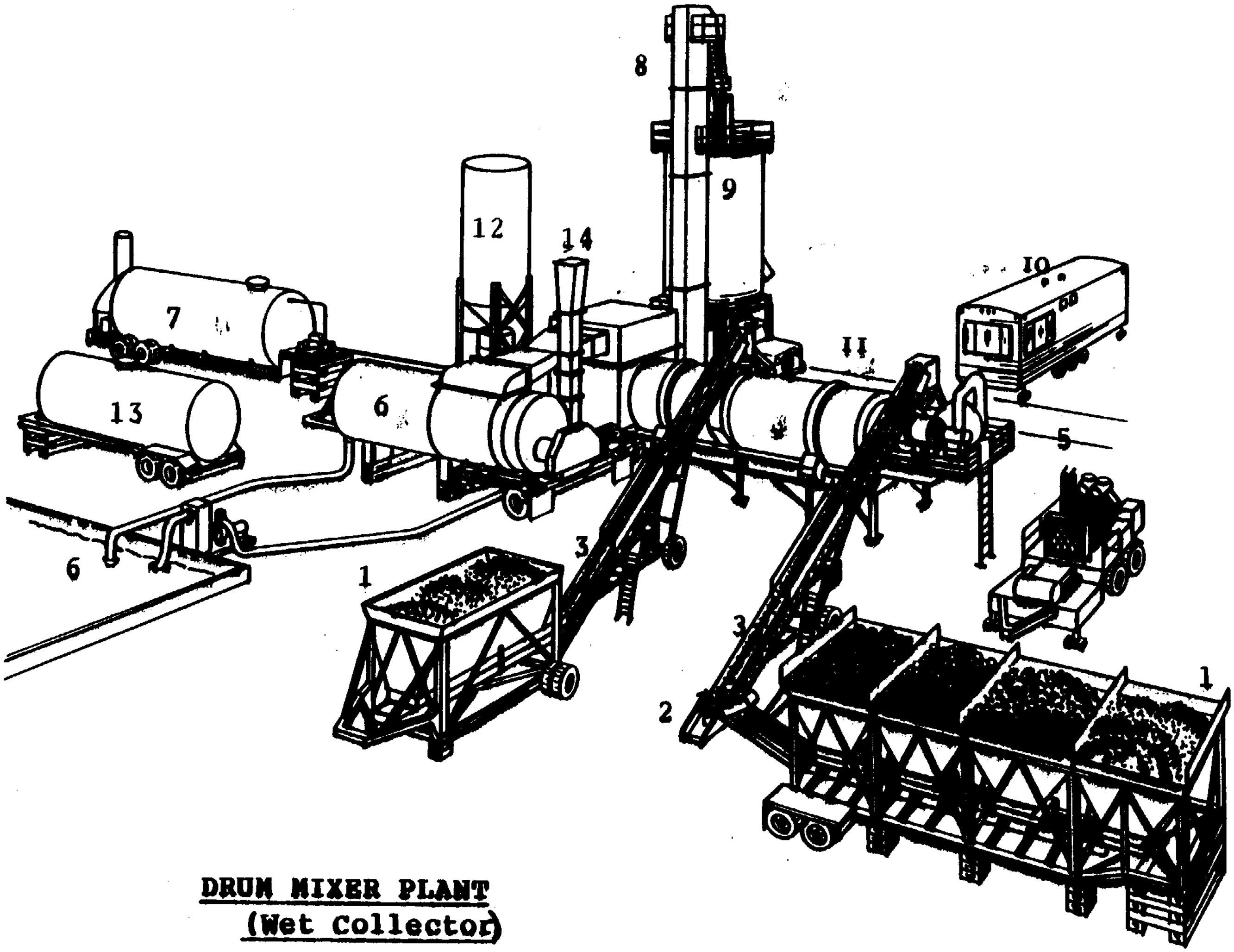
Curtman Contracting employs a CMI drum mix asphalt plant which is used to manufacture hot mix asphalt for road pavement. The process consists of blending prescribed portions of cold feed materials (sand, gravel, screenings, chips, etc.) uniformly and adding sufficient hot asphalt oil to bind the mixture 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 #2 fuel oil 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 CMI. 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 9 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 Corporation.
2. Designed maximum operating capacity 150 TPH @ 5 % moisture.
3. Actual operation rate 75 TPH @ 6 % moisture.
4. Startup date Aug. 89.
5. Type of fuel used in dryer No. 2 Diesel.
6. Quanity of fuel consumption ______.

Aggregate

7. Name/type of mix AC-10 Hot Mix Bituminous.
8. Percent asphalt in mix 6.9 %.
9. Temperature of asphalt 280° - 295°.
10. Sieve/Screening analysis: % Passing;

1"	100%	3/8"	64 %	#	
3/4"	100%	#10	45%	#	
1/2"	98%	#40	23%	#200	9%

Scrubber Control System

11. Manufacturer CMI Corp.
12. Type; Venturi ✓; Wet Washer ______; Spray Booth ______; Other ______.
13. Water line pressure 25 top / 100 bottom psi.
14. Pressure drop across system ______ psi.
15. Gallons per minute through system 33.6 top/72 bottom/105.6 Total
16. Water source 2 ponds (i.e., lagoon, pond, etc.)
17. Number of spray nozzles 16 / 8-1/4 / 8-3/8.

COMPANY NAME CURTMAN CONTRACTING, INC.

COMPANY REPRESENTATIVE BRYAN CURTMAN

DATE 10-11-89

(8)

PDM-626-108

PLANT DATA

COMPANY NAME Curtman Contracting, Inc.

COMPANY REP. Bryan Curtman DATE 10-16-89 PHONE # 437-3611

DATA SOURCE Gencontrol II Digital & Ramsey Blending System

PLANT LOCATION Hwy Y. Owensville, Mo.

PLANT MFG. CMI PLANT MODEL # PDM-626 PLANT TYPE Drum

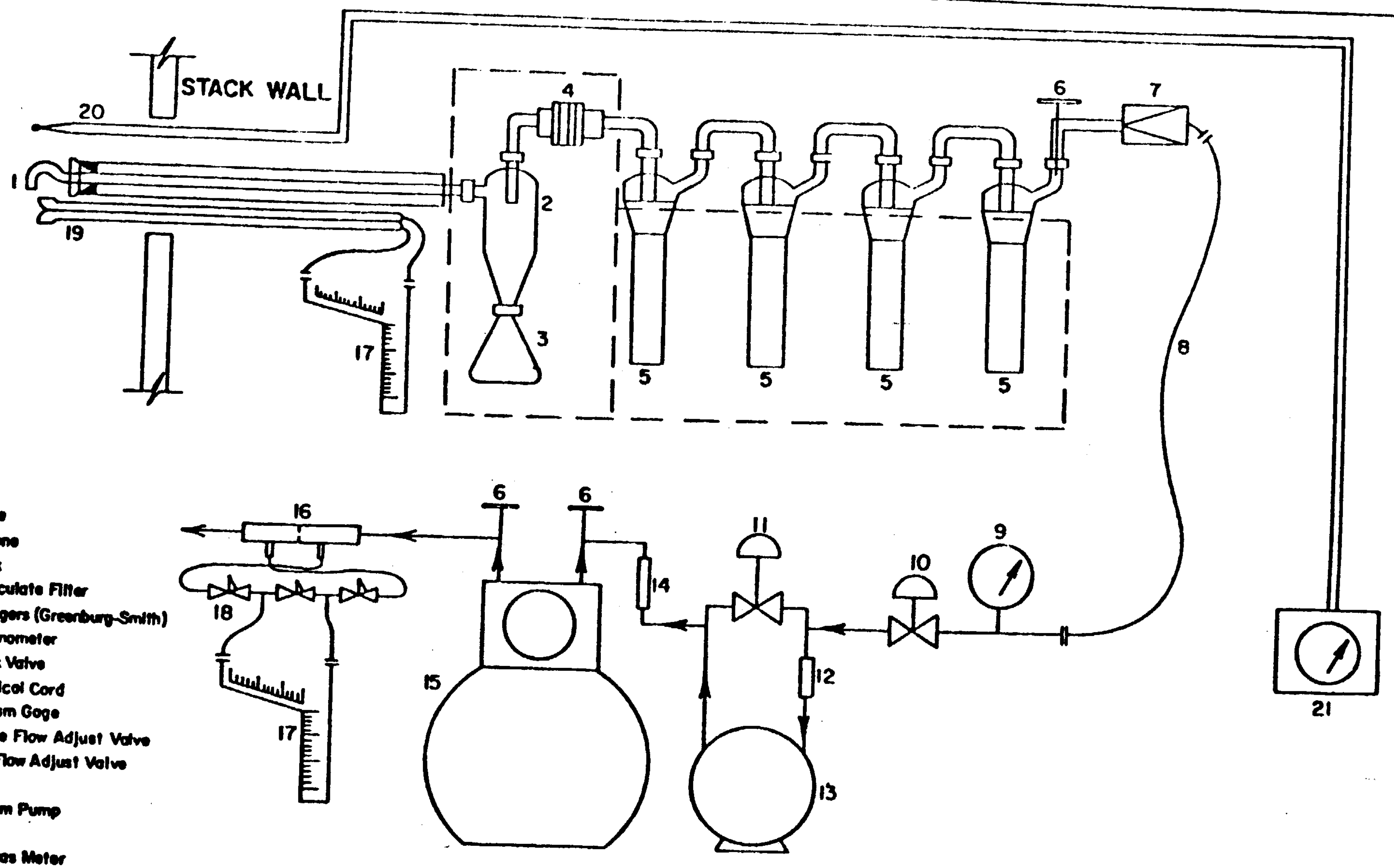
MIX SPECIFICATION # Grade D OIL SPECIFICATION # AC-10

	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
	9:30	Fuel	2.5	75	—	5.3	320	12
TART TEST →	9:45	Pump	2.5	80	—	5.7	300	10
	10:00	Set	2.5	90	—	6.2	275	10.5
	10:15	at	2.75	90	—	6.2	290	9
	10:30	75 psi	2.75	95	—	6.6	280	9
ND TEST →	10:45	at	3	100	—	6.9	295	9
	11:00	Burner	2.75	90	—	6.2	290	9.5
	11:15	Fuel	2.5	75	—	5.2	290	9.5
	11:30	Pressure	2.5	75	—	5.2	290	11
TART TEST →	11:45	Gage.	2.4	70	—	4.8	295	12
	12:00		2.4	70	—	4.8	290	12
	12:15		2.4	70	—	4.8	290	11.5
	12:30		2.5	70	—	4.8	295	12
TOP TEST →	12:45		2.37	70	—	4.8	290	12
TART →	2:45		2.5	95	—	6.5	275	12
	3:00		2.75	95	—	6.6	280	11
	3:15		2.75	95	—	6.6	295	10.5
	3:30		2.75	95	—	6.6	290	11
STOP →	3:45		2.75	95	—	6.5	290	10
				84				
						5.8		

REC #04

Bryan Curtman

V. EQUIPMENT USED



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

SAMPLING TRAIN
USED FOR ISOKINETIC SAMPLING

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 Curtman

Relative humidity in lab 50 %

Sample Location Hot mix asphalt plant

Density of Acetone (pa) .7857 mg/ml

Blank volume (V_a) 175 ml

Date/Time wt. blank 10/19 13:20

Date/Time wt. blank 10/20 13:15

Gross wt. 120.7098 mg

Gross wt. 120.7094 mg

Ave. Gross wt. 120.7096 mg

Tare wt. 120.7081 mg

Weight of blank (m_{ab}) 0.0015 mg

Acetone blank residue concentration (C_a) (C_a) = (M_{ab}) / (V_a) (p_a) = (.0000109 mg/g)

Weight of residue in acetone wash: $W_a = C_a V_{aw} P_a$ = (175)(.7857)( ) = (.0015)

		Run # 1	Run # 2	Run # 3
Acetone rinse volume (V_{aw})	ml	175	175	175
Date/Time of wt 10/19 13:15 Gross wt	g	157.7715	120.3278	129.0224
Date/Time of wt 10/20 13:40 Gross wt	g	157.7707	120.3276	129.0226
Average Gross wt	g	157.7711	120.3277	129.0225
Tare wt	g	157.7070	120.2779	129.0048
Less acetone blank wt (W_a)	g	0.0014	0.0014	0.0014
Wt of particulate in acetone rinse (m_a)	g	0.0627	0.0484	0.0163

Filter Numbers	#	BL-3640	BL-3641	BL-3642
Date/Time of wt 10/19 13:25 Gross wt	g	0.5622	0.5640	0.5577
Date/Time of wt 10/20 13:30 Gross wt	g	0.5623	0.5642	0.5582
Average Gross wt	g	0.5623	0.5641	0.5582
Tare wt	g	0.5305	0.5300	0.5310

Weight of particulate on filters(s) (m_f)	g	0.0318	0.0341	0.0272
Weight of particulate in acetone rinse	g	0.0627	0.0484	0.0163
Total weight of particulate (m_n)	g	0.0945	0.0825	0.0435

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

Signature of reviewer

Certman Const Ins.
Company Name

10-16-89
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: 12.82 = 20.9 - [1.3465 x 6]

RUN #2: 13.72 = 20.9 - [1.3465 x 5.33]

RUN #3 ____ = 20.9 - [1.3465 x ____]

RUN 1:	CO_{2x}	6	CO_{2x}	6	CO_{2x}	6	AVG.	6
	O_{2x}	12.82	O_{2x}	12.82	O_{2x}	12.82	AVG.	12.82
	N_{2x}	81.18	N_{2x}	81.18	N_{2x}	81.18	AVG.	81.18
RUN 2:	CO_{2x}	6	CO_{2x}	5	CO_{2x}	5	AVG.	5.33
	O_{2x}	12.82	O_{2x}	14.17	O_{2x}	14.17	AVG.	13.72
	N_{2x}	81.18	N_{2x}	80.83	N_{2x}	80.83	AVG.	80.95
RUN 3:	CO_{2x}	4	CO_{2x}	4	CO_{2x}	4	AVG.	4
	O_{2x}	15.51	O_{2x}	15.51	O_{2x}	15.51	AVG.	15.51
	N_{2x}	80.49	N_{2x}	80.49	N_{2x}	80.49	AVG.	80.49

VII. CALCULATIONS

SUMMARY OF TEST DATA

		10-16-89 RUN #1	10-16-89 RUN #2	10-16-89 RUN #3
SAMPLING TRAIN DATA				
	start	09:45	11:40	14:38
	finish	10:49	12:44	15:44
1. Sampling time, minutes	θ	60.0	60.0	60.0
2. Sampling nozzle diameter, in.	D_n	.3600	.3600	.3600
3. Sampling nozzle cross-sect. area, ft^2	A_n	.000707	.000707	.000707
4. Isokinetic variation	I	100.2	98.9	98.7
5. Sample gas volume - meter cond., cf.	V_m	42.068	47.107	45.479
6. Average meter temperature, ^oR	T_m	557	562	557
7. Avg. oriface pressure drop, in. H_2O	dH	1.24	1.45	1.36
8. Total particulate collected, mg.	M_n	94.50	82.50	43.50
VELOCITY TRAVERSE DATA				
9. Stack area, ft^2	A	3.74	3.74	3.74
10. Absolute stack gas pressure, in. Hg.	P_s	29.50	29.50	29.50
11. Barometric pressure, in. Hg.	P_{bar}	29.50	29.50	29.50
12. Avg. absolute stack temperature, R^o	T_s	611	610	607
13. Average $-\sqrt{\text{vel. head}}$, (C_p= .81)	$-\sqrt{dP}$	0.39	0.43	0.42
14. Average stack gas velocity, ft./sec.	V_s	23.75	26.11	25.50
STACK MOISTURE CONTENT				
15. Total water collected by train, ml.	V_{ic}	256.70	259.70	259.20
16. Moisture in stack gas, %	B_{ws}	23.45	21.90	22.21
EMISSIONS DATA				
17. Stack gas flow rate, dscf/hr.(000's)	Q_{sd}	208	234	229
18. Stack gas flow rate, cfm	acfm	5330	5859	5722
19. Particulate concentration, gr/dscf	C_s	0.0368	0.0290	0.0157
20. Particulate concentration, lb/hr	E	1.10	0.97	0.51
21. Particulate concentration, lb/mBtu	E'	0.00000	0.00000	0.00000
ORSAT DATA				
22. Percent CO_2 by volume	CO_2	6.00	5.30	4.00
23. Percent O_2 by volume	O_2	12.80	13.70	15.50
24. Percent CO by volume	CO	.00	.00	.00
25. Percent N_2 by volume	N_2	81.20	81.00	80.50

Format: summryR3

Dry Gas Volume

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

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 ^{o}R.

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

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:

$$V_{m(std)} = (17.64)(1.002)(\ 42.068) \left[\frac{(29.50) + \frac{1.24}{13.6}}{557}\right] = 39.503 \text{ dscf}$$

RUN 2:

$$V_{m(std)} = (17.64)(1.002)(\ 47.107) \left[\frac{(29.50) + \frac{1.45}{13.6}}{562}\right] = 43.864 \text{ dscf}$$

RUN 3:

$$V_{m(std)} = (17.64)(1.002)(\ 45.479) \left[\frac{(29.50) + \frac{1.36}{13.6}}{557}\right] = 42.718 \text{ dscf}$$

Particulate concentration C_s' gr./dscf.

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

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:

$$C_s' = \left[0.0154 \frac{\text{gr}}{\text{mg}} \right] \left[\frac{94.50}{39.503} \right] = 0.0368 \text{ gr./dscf.}$$

Run 2:

$$C_s' = \left[0.0154 \frac{\text{gr}}{\text{mg}} \right] \left[\frac{82.50}{43.864} \right] = 0.0290 \text{ gr./dscf.}$$

Run 3:

$$C_s' = \left[0.0154 \frac{\text{gr}}{\text{mg}} \right] \left[\frac{43.50}{42.718} \right] = 0.0157 \text{ gr./dscf.}$$

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:

$$M_d = 0.44(6.00\%) + 0.32(12.80\%) + 0.28(.00\% + 81.20\%) = 29.47 \frac{lb}{lb\text{-}mole}$$

Run 2:

$$M_d = 0.44(5.30\%) + 0.32(13.70\%) + 0.28(.00\% + 81.00\%) = 29.40 \frac{lb}{lb\text{-}mole}$$

Run 3:

$$M_d = 0.44(4.00\%) + 0.32(15.50\%) + 0.28(.00\% + 80.50\%) = 29.26 \frac{lb}{lb\text{-}mole}$$

Water Vapor Condensed

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

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

Where:

0.04707 = Conversion factor, ft.^{3}/ml.

0.04715 = Conversion factor, ft.^{3}/g.

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

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

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

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

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

Run 1:

$V_{wc(std)}$ = (0.04707) (250.0) = 11.8 cu.ft
$V_{wsg(std)}$ = (0.04715) (6.7) = 0.3 cu.ft

Run 2:

$V_{wc(std)}$ = (0.04707) (252.0) = 11.9 cu.ft
$V_{wsg(std)}$ = (0.04715) (7.7) = 0.4 cu.ft

Run 3:

$V_{wc(std)}$ = (0.04707) (252.0) = 11.9 cu.ft
$V_{wsg(std)}$ = (0.04715) (7.2) = 0.3 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:

$$B_{ws} = \frac{11.8 + 0.3}{11.8 + 0.3 + 39.503} \times 100 = 23.45\ \%$$

Run 2:

$$B_{ws} = \frac{11.9 + 0.4}{11.9 + 0.4 + 43.864} \times 100 = 21.90\ \%$$

Run 3:

$$B_{ws} = \frac{11.9 + 0.3}{11.9 + 0.3 + 42.718} \times 100 = 22.21\ \%$$

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 = 29.47 (1 - 23.45) + 18 (23.45) = 26.78 (lb./lb.-mole)

Run 2:

M_s = 29.40 (1 - 21.90) + 18 (21.90) = 26.90 (lb./lb.-mole)

Run 3:

M_s = 29.26 (1 - 22.21) + 18 (22.21) = 26.76 (lb./lb.-mole)

Stack Gas Velocity

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

Where:

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

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

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:

$$V = (85.49)\,(\;.81)\,(\;0.39) \sqrt{\frac{611}{(29.50)(26.78)}} = 23.75 \text{ ft/sec.}$$

Run 2:

$$V = (85.49)\,(\;.81)\,(\;0.43) \sqrt{\frac{610}{(29.50)(26.90)}} = 26.11 \text{ ft/sec.}$$

Run 3:

$$V = (85.49)\,(\;.81)\,(\;0.42) \sqrt{\frac{607}{(29.50)(26.76)}} = 25.50 \text{ ft/sec.}$$

Format: vsR3

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:

$$Q_{sd}=3600(1- .2345)(23.75)(3.74)\left[\frac{528}{611}\right]\left[\frac{29.50}{29.92}\right] = 208562.4 \; \frac{dscf}{hr}$$

Run 2:

$$Q_{sd}=3600(1- .2190)(26.11)(3.74)\left[\frac{528}{610}\right]\left[\frac{29.50}{29.92}\right] = 234313.1 \; \frac{dscf}{hr}$$

Run 3:

$$Q_{sd}=3600(1- .2221)(25.50)(3.74)\left[\frac{528}{607}\right]\left[\frac{29.50}{29.92}\right] = 229057.1 \; \frac{dscf}{hr}$$

Emissions Rate from Stack

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

Where:

E = Emissions rate, lb/hr.

C_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:

$$E = \frac{(0.0368)(208562.4)}{7000} = 1.10 \text{ lb. / hr.}$$

Run 2:

$$E = \frac{(0.0290)(234313.1)}{7000} = 0.97 \text{ lb. / hr.}$$

Run 3:

$$E = \frac{(0.0157)(229057.1)}{7000} = 0.51 \text{ lb. / hr.}$$

Isokinetic Variation

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

Where:

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

$$I = (100)(\;611\;) \left[\frac{(0.002669)(256.70) + \frac{42.068}{557} \left[29.50 + \frac{1.24}{13.6} \right]}{60\;(\;60.0\;)\;(\;23.75\;)\;(\;29.50\;)\;(\;.000707\;)} \right] = 100.2\%$$

Run 2:

$$I = (100)(\;610\;) \left[\frac{(0.002669)(259.70) + \frac{47.107}{562} \left[29.50 + \frac{1.45}{13.6} \right]}{60\;(\;60.0\;)\;(\;26.11\;)\;(\;29.50\;)\;(\;.000707\;)} \right] = 98.9\%$$

Run 3:

$$I = (100)(\;607\;) \left[\frac{(0.002669)(259.20) + \frac{45.479}{557} \left[29.50 + \frac{1.36}{13.6} \right]}{60\;(\;60.0\;)\;(\;25.50\;)\;(\;29.50\;)\;(\;.000707\;)} \right] = 98.7\%$$

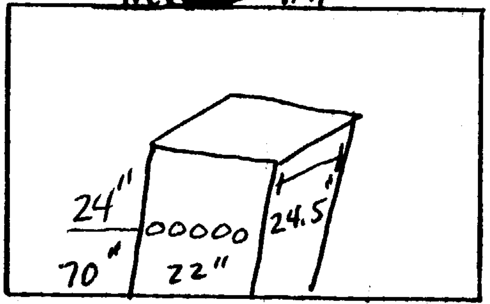
VIII. FIELD DATA

RAMCON ENVIRONMENTAL CORPORATION

Plant Curtman Cont, Inc

Location Owensville, Mo.
Operator F.C. KUHN
Date 10-16-89
Run No. 1
Sample Box No. 3
Meter Box No. 689836 C-100
Meter H @ 1.54
C Factor 1.002
Pitot Tube Coefficient Cp .814

m [illegible] 7.71



Schematic of Stack Cross Section

Ambient Temperature 74°F
Barometric Pressure 29.5
Assumed Moisture, % 20
Probe Length, ft 53
Nozzle Identification No. .000[illegible]
Avg. Calibrated Nozzle Dia., (in.) .360/.360/.360
Probe Heater Setting 5
Leak Rate, m³/min. (cfm) .009 @ 13"
Probe Liner Material 316 STAINLESS
Static Pressure, mm Hg (in. Hg) ±.002
Filter No. BL-3640 .5305

	IMPINGER VOLUME ml	SILICA GEL WEIGHT g
FINAL	450	559.3
INITIAL	200	552.69
DIFFERENCE	250	6.7

TRAV. PT NO.	SAMPLING TIME (θ) min.	VACUUM in. Hg	STACK TEMP (Ts) °F	VELOCITY HEAD (Ps) in H20	PRESSURE DIFF. ORF. MTR in H20	GAS SAMPLE VOLUME ft³	GAS SAMPLE TEMP. AT DRY GAS METER °F Inlet	GAS SAMPLE TEMP. AT DRY GAS METER °F Outlet	FILTER HOLDER TEMP °F	GAS TEMP LVG CONDENSER OR LAST IMPINGER °F
A 1	945 / 947	2	145	.04	.31	696.11 / 696.82	82	80	240	60
2	949	3	150	.10	.77	697.86	94	80	250	60
3	951	3	150	.12	.93	699.15	98	80	250	60
4	953	3.5	150	.15	1.2	700.56	100	80	250	60
5	955	4	150	.18	1.4	702.06	102	80	250	60
6	957	4	155	.18	1.4	703.61	102	80	250	60
B 1	958 / 1000	2	150	.05	.39	704.36	100	82	250	60
2	1002	2.5	150	.10	.77	705.47	104	84	250	60
3	1004	4	150	.18	1.4	706.93	106	84	250	60
4	1006	4.5	150	.21	1.6	708.58	108	84	250	60
5	1008	5	150	.22	1.7	710.26	108	84	250	60
6	1010	5	150	.20	1.5	711.90	108	86	250	60

Form #REC-06

RAMCON emissions test log sheet, cont. DATE 10-6-89 LOCATION Owensville, Mo. 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		
C 1	1011/1013	2.5	150	.09	.69	713.01	106	86	250	60
2	1015	3	150	.13	1.0	714.30	110	88	250	60
3	1017	4	150	.16	1.2	715.72	112	88	250	60
4	1019	4.5	150	.20	1.5	717.32	112	88	250	60
5	1021	5	150	.23	1.8	719.02	112	88	250	60
6	1023	5	150	.23	1.8	720.76	112	90	250	60
D 1	1024/1026	2.5	145	.07	.54	721.74	108	90	250	60
2	1028	3	155	.09	.69	722.84	112	90	250	60
3	1030	4.5	155	.20	1.5	724.35	114	90	250	60
4	1032	6	155	.22	1.7	726.06	112	90	250	60
5	1034	6	155	.25	1.9	727.83	114	90	250	60
6	1036	6	155	.25	1.9	729.63	114	90	250	60
E 1	1037/1039	2.5	145	.06	.46	730.50	110	90	250	60
2	1041	3	155	.10	.77	731.63	114	92	250	60
3	1043	4	155	.17	1.3	733.07	116	92	250	60
4	1045	5	155	.20	1.5	734.66	116	92	250	60
5	1047	5	155	.22	1.7	736.34	114	92	250	60
6	1049	7	155	.26	2.0	738.178	112	92	250	60

RAMCON ENVIRONMENTAL CORPORATION

Plant CURTMAN CONT. INC.

AC 7.71

Location Owensville, Mo.
Operator F. C. KUHN
Date 10-16-89
Run No. 2
Sample Box No. 3
Meter Box No. 689836 C-100
Meter H @ 1.54
C Factor 1.002
Pitot Tube Coefficient Cp .814

Ambient Temperature 79°F
Barometric Pressure 29.5
Assumed Moisture, % 25
Probe Length, ft 5
Nozzle Identification No. .0007[illegible]
Avg. Calibrated Nozzle Dia., (in.) .360/.360/.360
Probe Heater Setting 5
Leak Rate, m3/min, (cfm) .004 @ 10"
Probe Liner Material 316 STAINLESS
Static Pressure, mm Hg (in. Hg) +.002
Filter No. BL-3641 .5300

	IMPINGER VOLUME, ml	SILICA GEL WEIGHT, g
FINAL	452	552.4
INITIAL	200	544.7
DIFFERENCE	252	7.7

Schematic of Stack Cross Section

TRAV. PT NO.	SAMPLING TIME (θ)min.	VACUUM in. Hg	STACK TEMP (Ts) °F	VELOCITY HEAD (Ps) in H20	PRESSURE DIFF. ORF. MTR in H20	GAS SAMPLE VOLUME ft3	GAS SAMPLE TEMP. AT DRY GAS METER °F Inlet	GAS SAMPLE TEMP. AT DRY GAS METER °F Outlet	FILTER HOLDER TEMP °F	GAS TEMP LVG CONDENSER OR LAST IMPINGER °F
A 1	1140 / 1142	2	150	.07	.54	738.41 / 739.38	90	90	230	60
2	1144	2	150	.09	.69	740.47	102	90	235	60
3	1146	2	150	.11	.85	741.68	106	90	250	60
4	1148	2	150	.12	.93	742.95	110	90	250	60
5	1150	2.5	150	.16	1.2	744.40	110	90	250	60
6	1152	3	150	.19	1.5	746.02	110	90	250	60
B 1	1153 / 1155	3	150	.19	1.5	747.62	108	90	250	60
2	1157	2	150	.12	.93	748.90	110	90	250	60
3	1159	3	155	.15	1.2	750.36	114	90	250	60
4	1201	3.5	155	.20	1.5	751.96	114	90	250	60
5	1203	3.5	150	.22	1.7	753.69	114	90	250	60
6	1205	3.5	150	.20	1.5	755.31	114	90	250	60

Form #REC-06

RAMCON emissions test log sheet, cont. DATE 10-16-89 LOCATION Duenweg, Mo 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		
C	1	1206 1208	2.5	150	,13	1.0	756.64	112	90	250	60
	2	1210	3	150	.17	1.3	758.18	114	92	250	60
	3	1212	3.5	150	,22	1.7	759.88	116	92	250	60
	4	1214	4	150	.26	2.0	761.64	116	92	250	60
	5	1216	4	150	,23	1.8	763.53	112	92	250	60
	6	1218	4	150	,24	1.9	765.35	114	92	250	60
D	1	1219 1221	3	150	,14	1.1	766.76	112	92	250	60
	2	1223	3.5	150	,20	1.5	768.38	116	92	250	60
	3	1225	4	150	,23	1.8	770.12	116	92	250	60
	4	1227	4	150	,26	2.0	771.97	114	92	250	60
	5	1229	4	150	,26	2.0	773.82	114	92	250	60
	6	1231	4	150	,26	2.0	775.68	114	94	250	60
E	1	1232 1234	3	150	,14	1.1	777.06	110	94	250	60
	2	1236	3	150	.16	1.2	778.50	116	94	250	60
	3	1238	4	150	.27	2.1	780.33	116	94	250	60
	4	1240	4	150	,21	1.6	782.01	114	94	250	60
	5	1242	4	150	,21	1.6	783.69	114	94	250	60
	6	1244	4	150	,24	1.9	785.517	114	94	250	60

RAMCON ENVIRONMENTAL CORPORATION

Plant CURTMAN CONT. INC.

Location OWENSVILLE, MO.
Operator F. C. KUHN
Date 10-16-89
Run No. 3
Sample Box No. 3
Meter Box No. 689836 C-100
Meter H @ 1.54
C Factor 1.002
Pitot Tube Coefficient Cp .814

M=7.71

Schematic of Stack Cross Section

Ambient Temperature 81°F
Barometric Pressure 29.5
Assumed Moisture, % 25
Probe Length, m(ft) 53

	IMPINGER VOLUME, ml	SILICA GEL WEIGHT, g
FINAL	452	565.2
INITIAL	200	558 g.
DIFFERENCE	252	7.2

Nozzle Identification No. .0007069
Avg. Calibrated Nozzle Dia., (in.) .360/.360/.360
Probe Heater Setting 5
Leak Rate, m³/min. (cfm) .004 @ 11"
Probe Liner Material 316 stainless steel
Static Pressure, mm Hg (in.Hg) ±.002
Filter No. BL-3642 .5310

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	1438 / 1440	2	150	.10	.77	785.65 / 786.80	86	86	250	55
2	1442	3	150	.14	1.1	788.20	98	86	250	55
3	1444	3	150	.14	1.1	789.62	102	86	250	55
4	1446	3	150	.17	1.3	791.09	102	86	250	55
5	1448	3	150	.17	1.3	792.62	104	86	250	55
6	1450	3.5	150	.19	1.5	794.22	106	86	250	55
B 1	1451 / 1453	2.5	150	.012	.93	795.49	102	86	250	55
2	1455	3	150	.17	1.3	797.01	106	86	250	55
3	1457	3.5	150	.20	1.5	798.59	108	86	250	55
4	1459	3.5	150	.18	1.4	800.17	108	86	250	55
5	1501	4	150	.22	1.7	801.86	108	86	250	55
6	1503	4	150	.22	1.7	803.58	108	86	250	55

Form #REC-05

Form #REC-u6

RAMCON emissions test log sheet, cont. DATE 10-16-89 LOCATION Owensville, Mo 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		
C	1	1504 / 1506	2	150	.07	.54	804.57	104	86	250	55
	2	1508	3	150	.17	1.3	806.07	108	86	250	55
	3	1510	3	145	.14	1.1	807.46	110	88	250	55
	4	1512	3	145	.18	1.4	809.02	110	88	250	55
	5	1514	4	~~150~~ 145	.24	1.9	810.83	110	88	250	55
	6	1516	4	145	.24	1.9	812.58	108	88	250	55
D	1	1517 / 1519	2.5	145	.11	.85	813.80	106	88	250	55
	2	1521	3	145	.13	1.0	815.12	110	88	250	55
	3	1523	3	145	.15	1.2	816.58	110	88	250	55
	4	1525	3.5	145	.20	1.5	818.17	112	88	250	55
	5	1527	4	145	.24	1.9	819.95	112	88	250	55
	6	1529	4	145	.25	1.9	821.81	110	88	250	55
E	1	1530 / 1532	2.5	140	.12	.93	823.00	104	88	250	55
	2	1534	2.5	145	.12	.93	824.27	110	88	250	55
	3	1536	3.5	145	.18	1.4	825.84	112	88	250	55
	4	1538	4	145	.22	1.7	827.55	112	88	250	55
	5	1540	4.5	145	.25	1.9	829.33	110	90	250	55
	6	1544	4.5	145	.25	1.9	831.129	110	90	250	55

IX. CALIBRATION

METER BOX CALIBRATION DATA AND CALCULATION FORM

(English units)

c100

Date 3-20-89 Meter box number 689836

Barometric pressure, P_b = 29.90 in. Hg Calibrated by E. Kuhn

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	345.180 350.355	68	94 102	78 78	88	11.78	1.001	1.497	0.439
1.0	5	[illegible]460 344.631	68	94 102	78 78	88	8.33	1.001	1.497	0.620
1.5	10	328.921 339.114	68	99 102	76 78	86.5	13.73	1.002	1.530	0.749
2.0	10	318.001 328.274	68	88 100	[illegible] 76	85	11.92	1.000	1.541	0.862
3.0	10	294.151 304.28	68	86 96	70 72	81	9.8	1.004	1.574	1.034
4.0	10	305.551 315.620	68	84 94	76 76	82.5	8.57	1.006	1.601	1.181
							Avg	1.002	1.540	

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		

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[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

POSTTEST DRY GAS METER CALIBRATION DATA FORM (English units)

Test number ____________ Date 10·17·89 Meter box number C-100 Plant ____________

Barometric pressure, P_b = 30.10 in. Hg Dry gas meter number 689836 Pretest Y 1.007

Orifice manometer setting, (ΔH), in. H_2O	Gas volume		Temperature				Time (θ), min	Vacuum setting, in. Hg	Y_i	Y_i
	Wet test meter (V_w), ft^3	Dry gas meter (V_d), ft^3	Wet test meter (t_w), °F	Dry gas meter						$\frac{V_w P_b (t_d + 460)}{V_d \left(P_b + \frac{\Delta H}{13.6}\right)(t_w + 460)}$
				Inlet (t_{d_i}), °F	Outlet (t_{d_o}), °F	Average (t_d), °F				
1.5	10	837.20 / 847.372	77	96 / 104	78 / 80	89.5	12.77	3	1.002	
1.5	10	847.4[illegible] / 857.68	77	96 / 108	82 / 84	92.5	12.78	3	1.000	
1.5	10	857.68 / 867.989	77	102 / 110	84 / 86	95.5	12.8	3	1.000	
									Y = 1.001	

* If there is only one thermometer on the dry gas meter, record the temperature under t_d

where

V_w = Gas volume passing through the wet test meter, ft^3.

V_d = Gas volume passing through the dry gas meter, ft^3.

t_w = Temperature of the gas in the wet test meter, °F.

t_{d_i} = Temperature of the inlet gas of the dry gas meter, °F.

t_{d_o} = Temperature of the outlet gas of the dry gas meter, °F.

t_d = Average temperature of the gas in the dry gas meter, obtained by the average of t_{d_i} and t_{d_o}, °F.

ΔH = Pressure differential across orifice, in. H_2O.

Y_i = Ratio of accuracy of wet test meter to dry gas meter for each run.

Y = Average ratio of accuracy of wet test meter to dry gas meter for all three runs; tolerance = pretest Y $\pm 0.05Y$.

P_b = Barometric pressure, in. Hg.

θ = Time of calibration run, min.

Quality Assurance Handbook M4-2.4A

1548

STACK TEMPERATURE SENSOR CALIBRATION DATA FORM

Date 5-5-89 Thermocouple number Inlet/Outlet

Ambient temperature 20 °C Barometric pressure 29.88 in. Hg

Calibrator Reference: mercury-in-glass ✓

other

Reference point number	Source[a] (specify)	Reference thermometer temperature, ~~°C~~ °F	Thermocouple potentiometer temperature, ~~°C~~ °F	Temperature difference,[b] %
A	Ice Bath	32	32	0
B	oven	200	200	0
C	oven	350°F	350	0
D	Ambient 10-16-89	74°F	74°F	0

---

[a] Type of calibration system used.

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

STACK TEMPERATURE SENSOR CALIBRATION DATA FORM

Date 5-5-89 Thermocouple number Hotbox

Ambient temperature 20 °C Barometric pressure 29.88 in. Hg

Calibrator S Turner Reference: mercury-in-glass ✓

other

Reference point number	Source[a] (specify)	Reference thermometer temperature, ~~°C~~ F	Thermocouple potentiometer temperature, ~~°C~~ F	Temperature difference,[b] %
A	ice bath	32	32	0
B	oven	200	200	0
C	oven	350	350	0
D	ambient 10-16-89	74	74	0

[a] Type of calibration system used.

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

Quality Assurance Handbook M5-2.5

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. 53 Date 5-6-89

Calibrated by: Sam 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	1,2	1,8	.816	< .01
2	0,80	1.2	.816	< ,01
3	,55	,84	,809	< ,01
		$\bar{C}_p$ (SIDE A)	.814	

"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	1,20	1,80	.816	< ,01
2	0.80	1.2	.816	< ,01
3	0.55	,85	.804	< .01
		$\bar{C}_p$ (SIDE B)	,812	

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

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

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

RAMCON

Lear Siegler Stack Sampler

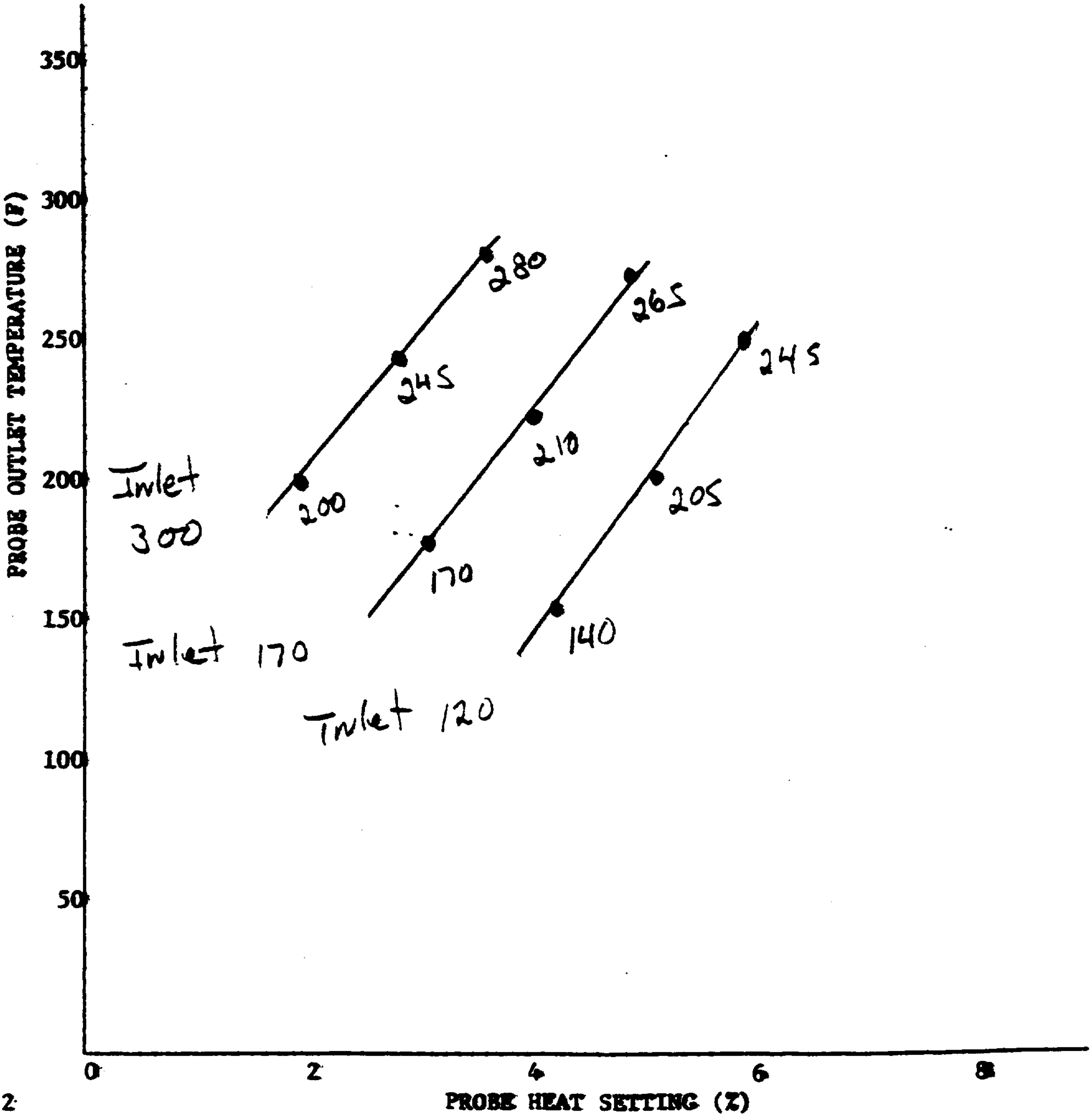
Heating Probe Calibration

Probe No. 53 Probe Length 5'

Date of Calibration 5-7-89 Signature Sam [illegible]

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 6-15-89 Thermocouple number 53

Ambient temperature 22 °C Barometric pressure 29.93 in. Hg

Calibrator E.C.KUHN Reference: mercury-in-glass ✓

other ________

Reference point number	Source[a] (specify)	Reference thermometer temperature, ~~°C~~ F	Thermocouple potentiometer temperature, ~~°C~~ F	Temperature difference,[b] %
A	ICE BATH	32	32	0
B	Boiling H2O	212	212	0
C	Heated oil	345	345	0
D	Ambient 10-16-89	74	74	0

[a] Type of calibration system used.

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

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 olde and a graduate of the University of Mississippi with graduate studies at Memphis State University and State Technical Institute of Memphis.

Frank "Chuck" Kuhn - Team Leader

Chuck Kuhn has been employed by RAMCON for two years. He has undergone extensive training in Method 1 through 9. He is qualified as a team leader and is currently certified as a V.E. reader.