RAMCON
ENVIRONMENTAL CORPORATION

SOURCE SAMPLING
for
PARTICULATE EMISSIONS
F.G. SULLIVAN COMPANY
PORT ALLEN, LOUISIANA
March 6 & 7, 1991

Mr. Steve Strickland
F.G. Sullivan Company

G. Sumner Buck, III
President

Bill Turner
Team Leader

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

RAMCON
ENVIRONMENTAL CORPORATION

March 18, 1991

Mr. Steve Strickland
F.G. Sullivan Company
P.O. Box 15196
Baton Rouge, Louisiana 70895

Re: Particulate Emissions Test: Port Allen, Louisiana

Dear Mr. Strickland:

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 Louisiana. Therefore, the plant is operating in compliance with Federal and State Standards.

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

Mr. Brett Dedual
Air Quality Compliance Division
Louisiana Department of Environmental Quality
11720 Airline Highway
Baton Rouge, LA 70817

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:djb

Enclosures

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TABLE OF CONTENTS

I. INTRODUCTION

On March 6 & 7, 1991 personnel from RAMCON Environmental Corporation conducted a source emissions test for particulate emissions compliance at F.G. Sullivan Company's Astec Double Barrel drum mix asphalt plant located in Port Allen, Louisiana. RAMCON personnel conducting the test were Bill Turner, Team Leader, and Tommy Crook. 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. Turner and Ms. Baldick.

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

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 Louisiana are the same as those set by EPA.

Mr. Brett Dedual of Louisiana Department of Environmental Quality observed the testing conducted by RAMCON Environmental. Tommy Crook of RAMCON Environmental conducted the opacity test which ranged from 0% to 0% on all three runs and therefore meets N.S.P.S. requirements.

TABLE I

SUMMARY OF TEST RESULTS

March 6 & 7, 1991

Test Run	Time	Grain Loading	Isokinetic Variation	Actual Emissions
1	08:19 to 09:23	0.0352 gr/DSCF	91.7%	6.2 lbs/hr
2	12:30 to 13:35	0.0405 gr/DSCF	97.7%	7.2 lbs/hr
3	11:10 to 12:16	0.0158 gr/DSCF	91.8%	3.0 lbs/hr
	Average:	0.0305 gr/DSCF		5.5 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 Louisiana. Therefore, the plant is operating in compliance with State and Federal Standards.

III. TEST PROCEDURES

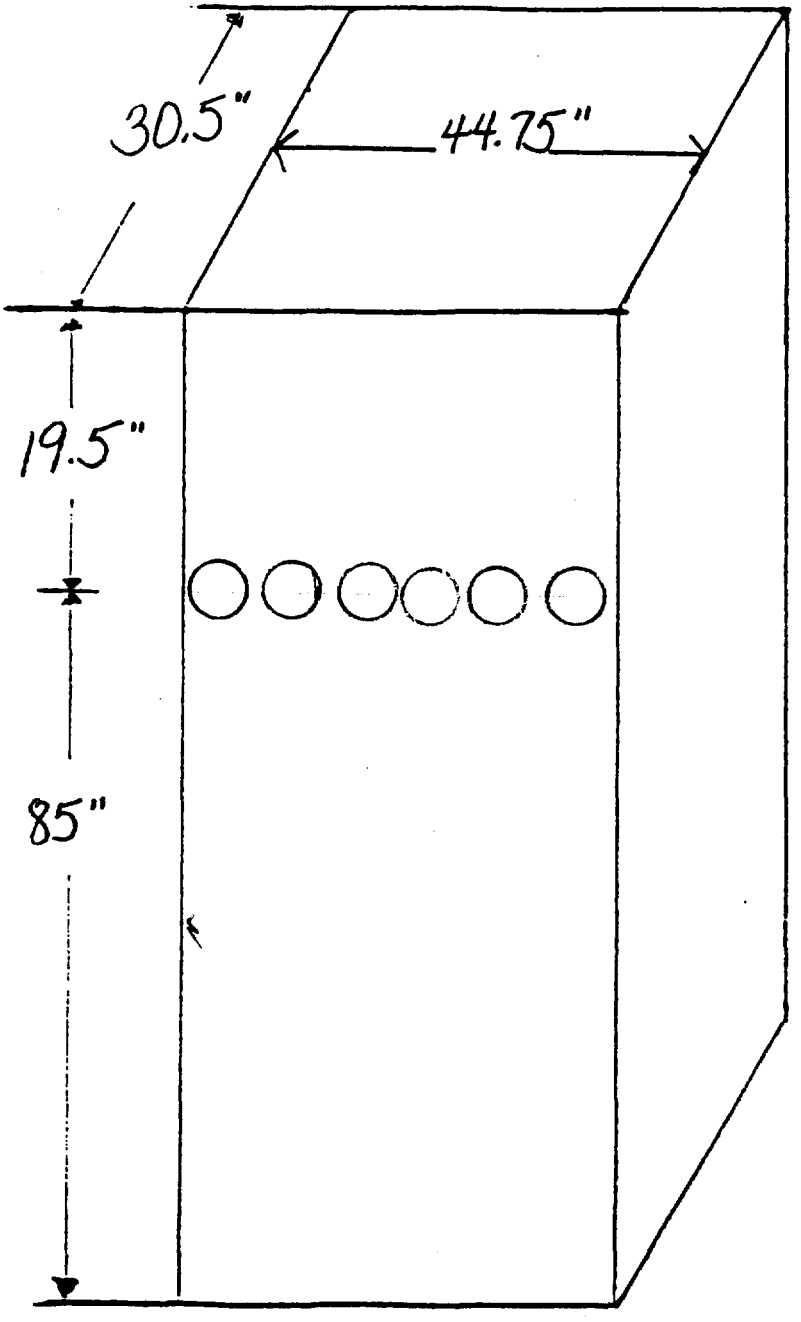
A. Method Used: Method 5 source sampling was conducted in accordance with requirements of the U.S. Environmental Protection Agency as set forth in 39 FR 9314, March 8, 1974, 60.93, as amended.

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

C. Sampling Site: The emissions test was conducted after a baghouse on a rectangular stack measuring 30.5" x 44.75" with an equivalent diameter of 36.3". Six sampling ports were placed 19.5" down (0.5 diameters upstream) from the top of the stack and 85" up (2.3 diameters downstream) from the last flow disturbance. The ports were evenly spaced on 7.5" centers. The two outside ports are 3.75" from the side walls of the stack. Thirty points were sampled, five through each port for two minutes each.

Points on a Diameter	Probe Mark
1	*9.0" 3.6
2	15.2" 9.2
3	21.3" 15.3
4	27.4" 21.4
5	33.5" 27.5

*Measurements include a 6" standoff.



IV. THE SOURCE

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F.G. Sullivan Company employs an Astec double 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 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 temperature ranging from 300°F to 1600°F. When recycled asphalt mix is used, it is added halfway down the drum through a separate conveyor. The hot and dried aggregate moves to an outer shell around the rotating drum where 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 drum mixer uses a burner fired with #4 Fuel Oil to heat air to dry the aggregate, and the motion of the rotating drum to blend the aggregate. The air is drawn into the system via an exhaust fan. After passing through the gas burner and the mixing drum, the air passes through a baghouse. The baghouse is manufactured by Astec. The exhaust gasses are drawn through the baghouse and discharged to the atmosphere through the stack. The design pressure drop across the tube sheet is 2-6 inches of water. The particulate matter, which is removed by the baghouse, is reinjected into the drum mixer.

Form REC#03

DATA ON FACILITY BEING STACK TESTED

COMPANY NAME P. G. SULLIVAN COMPANY REP. _____ PHONE (504) 336-5467

LOCATION OF FACILITY _____ ORIGINAL START-UP DATE _____ DESIGNED CAPACITY _____

OEM _____ MODEL NO. _____ TYPE _____ AC TYPE AC 30

1 Time (24 HR) NOTE: check small box in column when moisture sample is taken		2 Fuel Use (4 #Fuel Oil, Nat. Gas, Propane, Coal, other)	3 Burner Setting	4 Blower Pressure	5 Production Rate: Mix Aggregate TPH	5 Production Rate: RAP TPH	6 Asphalt Cement %	7 Mix Temp. °F	8 Exhaust Gas Temp. °F	9 Venturi Scrubber / X Baghouse: Pressure Drop in w.g.	9 Venturi Scrubber / X Baghouse: Water Pressure psi	10 Ambient Temp. °F	11 Relative Humidity %	12 Exhaust Damper Position
8:16 AM	✓	✓	61	60	180	33	4.6	308	278	10				.20
8:31		✓	45	51	191	32	4.6	318	280	9 3/4				.28
8:46		✓	46.2	70	210.69	33	4.6	313	280	9				.30
9:01		✓	57.5	65	210.34	35	4.6	315	280	8				.28
9:18		✓	48.8	65	194.11	33	4.6	319	290	10 3/4				.23
9:31		✓	52.0	65	213.70	32	4.6	310	280	10				.28
12:22	✓	✓	43.8	50	205.71	31	4.6	309	270	5				.28
12:37		✓	51.5	62 1/2	207.28	34	4.6	315	272	5				.28
12:52		✓	43.8	62	208.80	34	4.6	328	272	4 1/2				.30
1:07		✓	47.4	62	210.70	33	4.6	312	272	6				.20
1:22		✓	49.2	62	211.47	34	4.6	315	290	8				.27
1:37														

(5)

Form REC#04

PAGE ___ OF ___

1 Time (24 HR) NOTE: check small box in column when moisture sample is taken		2 Fuel Use 4 #Fuel Oil ___ Nat. Gas ___ Propane ___ Coal ___ ___ other	3 Burner Setting	4 Blower Pressure	5 Production Rate ___ Mix ___ Aggregate TPH	5 Production Rate ___ RAP TPH	6 Asphalt Cement %	7 Mix Temp. °F	8 Exhaust Gas Temp. °F	9 ___ Venturi Scrubber ___ Baghouse Pressure Drop in w.g.	9 Water Pressure psi	10 Ambient Temp. °F	11 Relative Humidity %	12 Exhaust Damper Position
10:55	✓	✓	40.5	52	193	31	4.6	317	260	4				.22
11:10		✓	39.7	53	206.57	32	4.6	314	270	4				.22
11:25		✓	45.6	53	204.61	33	4.6	314	272	4				.21
11:40		✓	46.7	54	210.62	34	4.6	312	272	5				.22

(9)

DATA SUMMARY ON STACK BEING TESTED

(7)

AGGREGATE

1. Name/type of mix 90 W C with RAP
2. Name/type of 2nd mix (if used) —
3. Type/temperature of Liquid Asphalt /295 °F
4. Sieve/Screening analysis: % Passing:

	1st mix / 2nd mix		1st mix / 2nd mix		1st mix / 2nd mix
1"	100% /	3/8"	87% /	#	/
3/4"	100% /	#200	9% /	#	/
1/2"	98% /	#	/	#	/

CONTROL SYSTEM

Manufacturer ASTEC

A. Baghouse:

1. Type of bags SINGED NOMEX micro-seal # of bags 1024 Sq. ft. of bags 9911
2. Air to cloth ratio 5.5:1 Designed ACFM 55,000
3. Type of cleaning - pulse jet ✓ reverse air ____ plenum pulse ____ other ____
4. Cleaning cycle time 0.15 SEC Interval between cleaning cycle 0.27 SEC
5. Pulse pressure on cleaning cycle 70 psi

B. Scrubber:

1. Type - Venturi ____ Wet Washer ____
   Spray Booth ____ Other ____
2. Gallons per minute through system ____
3. Water source ____ (i.e., pond, lagoon, etc.)
4. Number of spray nozzles ____

Company Name ____ Date ____

Company Representative ____

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

SAMPLE ANALYTICAL DATA FORM

Plant Location Sullivan — Relative humidity in lab 50 %

Sample Location ____ — Density of Acetone (pa) .7843 mg/ml

Blank volume (V_a) 250 ml

Date/Time wt. blank 3-11-91 12:25 — Gross wt. 164.6716 mg

Date/Time wt. blank 3-12-91 12:45 — Gross wt. 164.6720 mg

Ave. Gross wt. 164.6718 mg

Tare wt. 164.6709 mg

Weight of blank (m_{ab}) 0.0009 mg

Acetone blank residue concentration (C_a) (C_a) = (M_{ab}) / (V_a) (P_a) = (4.5$\tilde{7}$-6 mg/g)

Weight of residue in acetone wash: $W_a = C_a V_{aw} P_a$ = ( )( )( ) = (.0014)

		Run # 1	Run # 2	Run # 3
Acetone rinse volume (V_{aw})	ml	380	380	380
Date/Time of wt 3-11-91 12:25 Gross wt	g	155.8001	173.6363	171.1481
Date/Time of wt 3-12-91 12:45 Gross wt	g	155.8002	173.6365	171.1485
Average Gross wt	g	155.8002	173.6364	171.1483
Tare wt	g	155.7299	173.5427	171.1136
Less acetone blank wt (W_a)	g	0.0014	0.0014	0.0014
Wt of particulate in acetone rinse (m_a)	g	0.0689	0.0923	0.0333
Filter Numbers	#	HB4660	RJ4628	RJ4629
Date/Time of wt 3-11-91 12:20 Gross wt	g	0.5684	0.5655	0.5590
Date/Time of wt 3-12-91 12:40 Gross wt	g	0.5684	0.5655	0.5593
Average Gross wt	g	0.5684	0.5655	0.5592
Tare wt	g	0.5520	0.5527	0.5519
Weight of particulate on filters(s) (m_f)	g	0.0164	0.0128	0.0073
Weight of particulate in acetone rinse	g	0.0689	0.0923	0.0333
Total weight of particulate (m_n)	g	0.0853	0.1051	0.0406

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 P Baldwin Signature of reviewer

F.G. Sullivan
Company Name

3-6-91
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 - [____ x ____]

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

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

RUN 1:	CO_{2x}	2.5	CO_{2x}	2.0	CO_{2x}	2.0	AVG. 2.2
	O_{2x}	13.5	O_{2x}	13.5	O_{2x}	13.5	AVG. 13.5
	N_{2x}	____	N_{2x}	____	N_{2x}	____	AVG. 84.3
RUN 2:	CO_{2x}	3.0	CO_{2x}	3.0	CO_{2x}	3.0	AVG. 3.0
	O_{2x}	13.5	O_{2x}	13.5	O_{2x}	13.5	AVG. 13.5
	N_{2x}	____	N_{2x}	____	N_{2x}	____	AVG. 83
RUN 3:	CO_{2x}	3.0	CO_{2x}	____	CO_{2x}	____	AVG. ____
	O_{2x}	14.0	O_{2x}	____	O_{2x}	____	AVG. ____
	N_{2x}	____	N_{2x}	____	N_{2x}	____	AVG. ____

VII. CALCULATIONS

F.G. SULLIVAN COMPANY
PORT ALLEN, LOUISIANA

SUMMARY OF TEST DATA

		3-6-91 RUN #1	3-6-91 RUN #2	3-7-91 RUN #3
SAMPLING TRAIN DATA				
	start	08:19	12:30	11:10
	finish	09:23	13:35	12:16
1. Sampling time, minutes	θ	60.0	60.0	60.0
2. Sampling nozzle diameter, in.	D_n	.2400	.2400	.2400
3. Sampling nozzle cross-sect. area, ft^2	A_n	.000314	.000314	.000314
4. Isokinetic variation	I	91.7	97.7	91.8
5. Sample gas volume - meter cond., cf.	V_m	38.500	42.470	40.630
6. Average meter temperature, ^oR	T_m	554	572	551
7. Avg. oriface pressure drop, in. H_2O	dH	1.47	1.69	1.84
8. Total particulate collected, mg.	M_n	85.30	105.10	40.60
VELOCITY TRAVERSE DATA				
9. Stack area, ft^2	A	9.50	9.50	9.50
10. Absolute stack gas pressure, in. Hg.	P_s	29.77	29.77	29.77
11. Barometric pressure, in. Hg.	P_{bar}	29.77	29.77	29.77
12. Avg. absolute stack temperature, R^o	T_s	745	745	740
13. Average $-\sqrt{\text{vel. head}}$, (C_p= .84)	$-\sqrt{dP}$	0.98	0.98	1.03
14. Average stack gas velocity, ft./sec.	V_s	68.96	68.75	71.95
STACK MOISTURE CONTENT				
15. Total water collected by train, ml.	V_{ic}	277.00	289.00	283.00
16. Moisture in stack gas, %	B_{ws}	25.96	25.40	25.11
EMISSIONS DATA				
17. Stack gas flow rate, dscf/hr.(000's)	Q_{sd}	1231	1236	1308
18. Stack gas flow rate, cfm	acfm	39307	39188	41012
19. Particulate concentration, gr/dscf	C_s	0.0352	0.0405	0.0158
20. Particulate concentration, lb/hr	E	6.19	7.16	2.95
21. Particulate concentration, lb/mBtu	E'	0.00000	0.00000	0.00000
ORSAT DATA				
22. Percent CO_2 by volume	CO_2	2.20	3.00	3.00
23. Percent O_2 by volume	O_2	13.50	13.50	14.00
24. Percent CO by volume	CO	.00	.00	.00
25. Percent N_2 by volume	N_2	84.30	83.50	83.00

Format: summryR3

Dry Gas Volume

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

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:

$$V_{m(std)} = (17.64)(1.020)(38.500)\left[\frac{(29.77) + \frac{1.47}{13.6}}{554}\right] = 37.360 \text{ dscf}$$

RUN 2:

$$V_{m(std)} = (17.64)(1.020)(42.470)\left[\frac{(29.77) + \frac{1.69}{13.6}}{572}\right] = 39.937 \text{ dscf}$$

RUN 3:

$$V_{m(std)} = (17.64)(1.020)(40.630)\left[\frac{(29.77) + \frac{1.84}{13.6}}{551}\right] = 39.677 \text{ dscf}$$

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:

$$C_s' = \left[0.0154 \frac{gr}{mg}\right] \left[\frac{85.30}{37.360}\right] = 0.0352 \text{ gr./dscf.}$$

Run 2:

$$C_s' = \left[0.0154 \frac{gr}{mg}\right] \left[\frac{105.10}{39.937}\right] = 0.0405 \text{ gr./dscf.}$$

Run 3:

$$C_s' = \left[0.0154 \frac{gr}{mg}\right] \left[\frac{40.60}{39.677}\right] = 0.0158 \text{ gr./dscf.}$$

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:

$$M_d = 0.44(\ 2.20\%) + 0.32(13.50\%) + 0.28(\ .00\% + 84.30\%) = 28.89 \ \frac{lb}{lb\text{-mole}}$$

Run 2:

$$M_d = 0.44(\ 3.00\%) + 0.32(13.50\%) + 0.28(\ .00\% + 83.50\%) = 29.02 \ \frac{lb}{lb\text{-mole}}$$

Run 3:

$$M_d = 0.44(\ 3.00\%) + 0.32(14.00\%) + 0.28(\ .00\% + 83.00\%) = 29.04 \ \frac{lb}{lb\text{-mole}}$$

Water Vapor Condensed

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

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

Where:

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

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

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

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

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

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

p_w = Density of water, 0.002201 lb/ml.

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

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

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

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

Run 1:

$V_{wc(std)}$ = (0.04707) (265.0) = 12.5 cu.ft
$V_{wsg(std)}$ = (0.04715) (12.0) = 0.6 cu.ft

Run 2:

$V_{wc(std)}$ = (0.04707) (275.0) = 12.9 cu.ft
$V_{wsg(std)}$ = (0.04715) (14.0) = 0.7 cu.ft

Run 3:

$V_{wc(std)}$ = (0.04707) (270.0) = 12.7 cu.ft
$V_{wsg(std)}$ = (0.04715) (13.0) = 0.6 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:

$$B_{ws} = \frac{12.5 + 0.6}{12.5 + 0.6 + 37.360} \times 100 = 25.96\ \%$$

Run 2:

$$B_{ws} = \frac{12.9 + 0.7}{12.9 + 0.7 + 39.937} \times 100 = 25.40\ \%$$

Run 3:

$$B_{ws} = \frac{12.7 + 0.6}{12.7 + 0.6 + 39.677} \times 100 = 25.11\ \%$$

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 = 28.89 (1 - 25.96) + 18 (25.96) = 26.06 (lb./lb.-mole)

Run 2:

M_s = 29.02 (1 - 25.40) + 18 (25.40) = 26.22 (lb./lb.-mole)

Run 3:

M_s = 29.04 (1 - 25.11) + 18 (25.11) = 26.27 (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 $\left[\frac{(g/g\text{-mole})\text{-(mm Hg)}}{(^oK)(\text{mm } H_2O)}\right]^{1/2}$

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, (^oF).

T_s = Absolute stack temperature, (^oR). = 460 + t_s.

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

Run 1:

$$V = (85.49)\ (\ .84)\ (\ 0.98)\ \sqrt{\frac{745}{(29.77)(26.06)}} = 68.96 \text{ ft/sec.}$$

Run 2:

$$V = (85.49)\ (\ .84)\ (\ 0.98)\ \sqrt{\frac{745}{(29.77)(26.22)}} = 68.75 \text{ ft/sec.}$$

Run 3:

$$V = (85.49)\ (\ .84)\ (\ 1.03)\ \sqrt{\frac{740}{(29.77)(26.27)}} = 71.95 \text{ ft/sec.}$$

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:

$$Q_{sd}=3600(1-\ .2596\ )(\ 68.96)(\ 9.50)\left[\frac{528}{745}\right]\left[\frac{29.77}{29.92}\right] = 1231358.9\ \frac{dscf}{hr}$$

.7404 → 64.46 → 1,151 006.3

Run 2:

$$Q_{sd}=3600(1-\ .2540\ )(\ 68.75)(\ 9.50)\left[\frac{528}{745}\right]\left[\frac{29.77}{29.92}\right] = 1236894.1\ \frac{dscf}{hr}$$

Run 3:

$$Q_{sd}=3600(1-\ .2511\ )(\ 71.95)(\ 9.50)\left[\frac{528}{740}\right]\left[\frac{29.77}{29.92}\right] = 1308278.4\ \frac{dscf}{hr}$$

Emissions Rate from Stack

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

Where:

E = Emissions rate, lb/hr.

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

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

Run 1:

$$E = \frac{(0.0352)\ (1231358.9)}{7000} = 6.19\ lb. / hr.$$

5.08

Run 2:

$$E = \frac{(0.0405)\ (1236894.1)}{7000} = 7.16\ lb. / hr.$$

Run 3:

$$E = \frac{(0.0158)\ (1308278.4)}{7000} = 2.95\ lb. / hr.$$

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, ^oR.
0.002669	=	Conversion factor, Hg - ft^3/ml - ^oR.
V_{ic}	=	Ttl vol of liquid collected in impingers and silica gel, ml.
T_m	=	Absolute average dry gas meter temperature, ^oR.
P_{bar}	=	Barometric pressure at sampling site, (in. Hg).
dH	=	Av pressure differential across the oriface meter, (in.H_2O).
13.6	=	Specific gravity of mercury.
60	=	Conversion seconds to minutes.
Θ	=	Total sampling time, minutes.
V_s	=	Stack gas velocity, ft./sec.
P_s	=	Absolute stack gas pressure, in. Hg.
A_n	=	Cross sectional area of nozzle, ft^2.

Run 1:

$$I = (100)(745)\left[\frac{(0.002669)(277.0) + \frac{38.500}{554}\left[29.77 + \frac{1.47}{13.6}\right]}{60\ (60.0)\ (68.96)\ (29.77)\ (.000314)} \right] = 91.7\%$$

Run 2:

$$I = (100)(745)\left[\frac{(0.002669)(289.0) + \frac{42.470}{572}\left[29.77 + \frac{1.69}{13.6}\right]}{60\ (60.0)\ (68.75)\ (29.77)\ (.000314)} \right] = 97.7\%$$

Run 3:

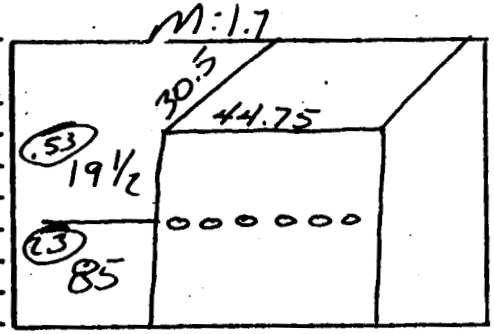
$$I = (100)(740)\left[\frac{(0.002669)(283.0) + \frac{40.630}{551}\left[29.77 + \frac{1.84}{13.6}\right]}{60\ (60.0)\ (71.95)\ (29.77)\ (.000314)} \right] = 91.8\%$$

VIII. FIELD DATA

RAMCON ENVIRONMENTAL CORPORATION

F.G. Sullivan

Location Port Allen, LA.
Operator W.C. Turner
Date 3-6-91
Run No. 1
Sample Box No. 1
Meter Box No. 004
Meter H @ 1.85
C Factor 1.02
Pitot Tube Coefficient Cp .835



			IMPINGER VOLUME, ml	SILICA GEL WEIGHT, g
Ambient Temperature	88			
Barometric Pressure	29.77	FINAL	465	513
Assumed Moisture, %	25	INITIAL	400	501
Probe Length, m(ft)	3'	DIFFERENCE	265	12

Nozzle Identification No. .600 314
Avg. Calibrated Nozzle Dia., (in.) .240/.240/.240
Probe Heater Setting 5
Leak Rate, m^3/min, (cfm) .003@26"
Probe Liner Material 316 SS
Static Pressure, mm Hg (in.Hg) .01 ±
Filter No. HB-46600

O_2: 13.5, 13.5, 15.5 Schematic of Stack Cross Section CO_2: 2.5, 2.0, 2.0

TRAV. PT NO.	SAMPLING TIME (θ) min.	VACUUM in. Hg	STACK TEMP (T_s) °F	VELOCITY HEAD (P_s) in H_2O	PRESSURE DIFF. ORF. MTR in H_2O	GAS SAMPLE VOLUME ft^3	GAS SAMPLE TEMP. AT DRY GAS METER °F Inlet	Outlet	FILTER HOLDER TEMP °F	GAS TEMP LVG CONDENSER OR LAST IMPINGER °F
(A) 1	8:18 / 8:21	3	250	1.8	3.1	173.00 / 174.83	72	72	225	32
2	8:23	3	255	1.5	2.6	176:51	84	74	240	34
3	8:25	3	280	1.0	1.7	177:92	88	76	245	34
4	8:27	3	285	.60	1.0	179:03	92	76	245	34
5	8:29	3	285	.58	.99	180:14	92	76	245	34
(B) 1	8:30 / 8:32	3	285	.75	1.3	181:41	94	78	245	34
2	8:34	3	290	.65	1.1	182:59	98	80	245	34
3	8:36	3	290	1.0	1.7	183:82	100	80	245	34
4	8:38	3	288	.85	1.4	185:16	100	80	245	34
5	8:40	3	285	.92	1.6	186:67	102	80	245	34

(25)

Form #REC-05

Form #REC-06

RAMCON emissions test log sheet, cont. DATE 3-6-91 LOCATION Port Allen, La TEST NO. 1

TRAVERSE POINT	SAMPLING TIME θ (min)	VACUUM mm Hg (in. Hg)	STACK TEMP T_s (°F)	VELOCITY HEAD ΔP_s (in. H_2O)	ORFICE DIFF. PRESSURE ΔH (in. H_2O)	GAS VOLUME Vm (ft^3)	GAS SAMPLE TEMP.(°F)		SAMPLE BOX TEMP. (°F)	IMPINGER TEMP (°F)
							in	out		
C) 1	8:41 8:43	4	285 285	1.6	2.7	188:24	100	84	250	34
2	8:45	4	285	1.2	2.0	189:77	104	84	250	34
3	8:47	4	285	.52	.88	190:74	108	84	250	34
4	8:49	4	285	1.1	1.9	192:11	108	84	250	34
5	8:51	4	285	.68	1.2	193.3	110	84	250	34
D) 1	8:52 8:54	4	292	.85	1.4	194:63	104	86	250	34
2	8:56	4	295	.65	1.1	195: 73	110	86	250	34
3	8:58	4	295	.65	1.1	196: 94	110	86	250	34
4	9:00	4	290	.62	1.1	198: 11	110	86	250	34
5	9:02	4	285	.70	1.2	199: 20	110	86	250	34
E) 1	9:04 9:06	4	285	.54	.92	200:26	112	88	250	34
2	9:08	4	285	.88	1.5	201: 58	112	88	250	34
3	9:10	4	285	.95	1.6	202: 90	114	90	250	34
4	9:12	4	285	1.0	1.7	204: 33	114	90	250	34
5	9:14	4	285	1.0	1.7	205:64	116	90	250	34
F) 1	9:15 9:17	4	290	1.0	1.7	206:98	112	90	250	34
2	9:19	4	290	.58	.99	208:12	114	90	250	34
3	9:21	4	285	.60	1.0	209:24	116	90	250	34
4	9:23	4	285	.62	1.1	210:41	116	90	250	34
5	9:25	4	285	.55	.94	211:51	111			

RAMCON ENVIRONMENTAL CORPORATION

Plant Sullivan

Location Fort Miller, LA
Operator C. L. Tucker
Date 3-6-91
Run No. 2
Sample Box No. 2
Meter Box No. 054
Meter H @ 1.85
C Factor 607
Pitot Tube Coefficient Cp .855

Ambient Temperature 68
Barometric Pressure 29.71
Assumed Moisture, % 25 @
Probe Length, m(ft) 3'

	IMPINGER VOLUME, ml	SILICA GEL WEIGHT, g
FINAL	475	526
INITIAL	200	512
DIFFERENCE	275	14

Nozzle Identification No. 000314
Avg. Calibrated Nozzle Dia., (in.) .214/.214/.210
Probe Heater Setting 3
Leak Rate, m³/min. (cfm) .005
Probe Liner Material 316SS
Static Pressure, mm Hg (in. Hg) .0/T
Filter No. RS-4628

Schematic of Stack Cross Section

TRAV. PT NO.	SAMPLING TIME (θ) min.	VACUUM in. Hg	STACK TEMP (Ts) °F	VELOCITY HEAD (Ps) in H2O	PRESSURE DIFF. ORF. MTR in H2O	GAS SAMPLE VOLUME 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	12:30 / 12:32	3	265	2	3.4	212.734 / 214.6	90	90	255	50
2	12:34	3	272	~~2~~ 1.5	~~3.4~~ 2.6	216.13	98	92	255	50
3	12:36	3	285	1.5	2.6	218.36	104	92	255	50
4	12:38	3	285	.6	1.0	219.42	104	92	255	50
5	12:40	3	285	.62	1.1	220.56	110	94	255	50
B 1	12:41 / 12:43	3	285	.80	1.4	221.75	112	96	255	50
2	12:45	3	285	.75	1.3	223	114	96	255	50
3	12:47	3	285	1.2	2.0	224.47	116	96	255	50
4	12:49	3	285	.95	1.6	225.89	118	96	255	50
5	12:51	3	288	.95	1.6	227.12	118	96	255	50

O2 13.5 % CO2 3 %
O2 13.0 % CO2 3 %

Form #REC-05

(27.)

Form #REC-06

RAMCON emissions test log sheet, cont. DATE 3-6-91 LOCATION Ft Allen, Ld TEST NO. 2

TRAVERSE POINT	SAMPLING TIME θ (min)	VACUUM mm Hg (in. Hg)	STACK TEMP T_s (°F)	VELOCITY HEAD ΔP_s (in. H_2O)	ORFICE DIFF. PRESSURE ΔH (in. H_2O)	GAS VOLUME Vm (ft^3)	GAS SAMPLE TEMP. (°F) in	GAS SAMPLE TEMP. (°F) out	SAMPLE BOX TEMP. (°F)	IMPINGER TEMP (°F)
(0) 1	12:52 / 12:54	3	282	1.7	2.9	229.31	120	100	255	55
2	12:56	3	285	1.5	2.6	230.82	122	100	255	55
3	12:58	3	285	1.0	1.7	232.25	124	102	255	55
4	1:00	3	285	1.1	1.9	233.64	126	102	255	55
5	1:02	3	290	.72	1.2	234.92	126	102	255	55
(0) 1	1:03 / 1:05	3	288	.95	1.6	236.24	122	104	255	55
2	1:07	3	285	.95	1.6	237.64	128	104	255	55
3	1:09	3	285	.75	1.3	238.92	130	104	255	55
4	1:11	3	285	.85	1.4	240.26	132	106	258	55
5	1:13	3	285	.85	1.4	241.65	132	106	255	55
(E) 1	1:14 / 1:16	3	285	.95	1.6	243.14	128	106	255	55
2	1:18	3	285	.92	1.6	244.52	132	106	255	55
3	1:20	3	292	1.0	1.7	246	134	108	255	55
4	1:22	3	292	1.0	1.7	247.38	134	108	255	55
5	1:24	3	295	1.1	1.9	248.94	134	108	255	55
(F) 1	1:25 / 1:27	3	285	.85	1.4	250.45	136	110	255	60
2	1:29	3	285	.85	1.4	251.62	136	110	255	60
3	1:31	3	285	.58	.99	252.69	136	110	255	60
4	1:33	3	293	.62	1.1	253.82	136	110	255	60
5	1:35	3	285	.68	1.7	255.24	136	110	255	60

RAMCON ENVIRONMENTAL CORPORATION

Plant Sullivan

Location Port Allen, La
Operator S. L. Turner
Date 3-10-94
Run No. 3
Sample Box No. 2
Meter Box No. 004
Meter H @ 1.83
C Factor 1.02
Pitot Tube Coefficient Cp .835

Ambient Temperature 55
Barometric Pressure 29.77 FINAL
Assumed Moisture, % 25 INITIAL
Probe Length, m(ft) 3' DIFFERENCE

	IMPINGER VOLUME, ml	SILICA GEL WEIGHT, g
FINAL	470	510
INITIAL	200	493
DIFFERENCE	270	13

Nozzle Identification No. .050314
Avg. Calibrated Nozzle Dia., (in.) .240/.240/.240
Probe Heater Setting 5
Leak Rate, m^3/min, (cfm) .003 05"
Probe Liner Material 316 SS
Static Pressure, mm Hg(in.Hg) .01+
Filter No. RS-4629

Schematic of Stack Cross Section

TRAV. PT NO.	SAMPLING TIME (θ)min.	VACUUM in. Hg	STACK TEMP (Ts) °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	11:10 / 11:12	3	265	1.8	3.1	255.40 / 257.15	72	72	235	40
2	11:14	3	265	1.6	2.7	259	78	72	240	40
3	11:16	3	278	1.6	2.7	260.82	84	72	240	40
4	11:18	3	280	.70	1.2	261.90	88	74	250	40
5	11:20	3	282	.75	1.3	262.85	90	74	250	40
B) 1	11:21 / 11:23	3	265	.88	1.5	263.89	92	74	250	40
2	11:25	3	265	.65	1.1	264.68	94	74	250	40
3	11:27	3	270	1.2	2.0	265.93	94	74	250	40
4	11:29	3	280	.90	1.5	267.48	94	74	250	40
5	11:31	3	283	.90	1.5	268.91	94	74	250	40
										-

O_2 14 %
O_2 14 %

CO_2 3%
CO_2 3%

Form #REC-05

(29)

Form #REC-06

RAMCON emissions test log sheet, cont. DATE 3-7-91 LOCATION Port Allen, La 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		
1	11:32 / 11:34	3	285	1.6	2.7	271:02	100	78	250	40
2	11:36	3	285	1.6	2.7	272:68	104	78	250	40
3	11:38	3	285	1.5	2.6	274:41	106	80	250	40
4	11:40	3	285	1.2	2.0	275:95	108	82	250	40
5	11:42	3	285	.95	1.6	277:07	108	82	250	40
1	11:43 / 11:45	3	282	1.0	1.7	278:5	108	82	250	40
2	11:47	3	282	1.2	2.0	280:00	106	82	250	40
3	11:49	3	285	.90	1.5	281:33	108	82	250	40
4	11:51	3	285	.90	1.5	282:65	110	84	250	40
5	11:53	3	285	.85	1.4	283:88	110	84	250	40
1	11:54 / 11:56	3	285	.90	1.5	284:41	110	84	250	40
2	11:58	3	285	.90	1.5	285:22	110	84	250	40
3	12:00	3	280	1.1	1.9	286:71	110	84	250	40
4	12:02	3	280	1.1	1.9	288:46	112	84	250	40
5	12:04	3	282	1.0	1.7	289:72	112	84	250	40
1	12:06 / 12:08	3	282	.90	1.5	290:95	112	86	250	40
2	12:10	3	285	.95	1.6	292:36	112	86	250	40
3	12:12	3	285	.95	1.6	293:51	114	86	250	40
4	12:14	3	285	1.1	1.9	294:72	114	86	250	40
5	12:16	3	285	1.1	1.9	296:03	114	86	250	40

(30)

IX. CALIBRATION

METER BOX CALIBRATION DATA AND CALCULATION FORM

(English units)

Date 3-1-91 Meter box number 004

Barometric pressure, P_b = 29.58 in. Hg Calibrated by Jea Turner

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	146:00 / 151:07	66.2	90 / 96	68 / 72	81.5	9:15	1.01	1.84
1.5	10								
2.0	10	151:40 / 161:57	66.2	92 / 102	72 / 74	85	13:10	1.01	1.87
3.0	~~10~~ 11	161:80 / 172:85	66.2	92 / 104	74 / 76	86.5	11.7	1.03	1.84
4.0	10								
							Avg	1.02	1.85

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.

POSTTEST DRY GAS METER CALIBRATION DATA FORM (English units)

Test number _____ Date 5-18-91 Meter box number 004 Plant _____

Barometric pressure, P_b = 29.84 in. Hg Dry gas meter number _____ Pretest Y [illegible]

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: Average[a] (t_d), °F	Time (θ), min	Vacuum setting, in. Hg	Y_i	$\frac{Y_i V_w P_b (t_d + 460)}{V_d \left(P_b + \frac{\Delta H}{13.6}\right)(t_w + 460)}$
1	10 5	477.4 / 487.533	66.2	88 / 78	72 / 72	82.5	9.18		1.03	1.83
2	10	487.8 / 497.943	66.2	99 / 82	72 / 74	84.5	13.23		1.02	1.89
3	10	493.1 / 503.[illegible]	66.2	99 / 84	74 / 76	88	11.02		1.02	1.96
		263							Y = 1.01	ΔH@ = 1.89

[a] 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 ±0.05Y.

P_b = Barometric pressure, in. Hg.

θ = Time of calibration run, min.

STACK TEMPERATURE SENSOR CALIBRATION DATA FORM

Date 5-5-90 Thermocouple number Inlet/Outlet

Ambient temperature 20 °C Barometric pressure 29.88 in. Hg

Calibrator Sam Turner Reference: mercury-in-glass 1

other _____

Reference point number	Source[a] (specify)	Reference thermometer temperature, °C	Thermocouple potentiometer temperature, °C	Temperature difference,[b] %
A	Ice Bath	32 °F	32 °F	0
B	Oven	200 °F	200 °F	0
C	Oven	350 °F	350 °F	0
D	Ambient 3-6-91	58 °F	58 °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 ≤ 1.5%.

STACK TEMPERATURE SENSOR CALIBRATION DATA FORM

Date 5-5-90 Thermocouple number Hotbox

Ambient temperature 20 °C Barometric pressure 29.88 in. Hg

Calibrator San Luna Reference: mercury-in-glass V

other _____

Reference point number	Source[a] (specify)	Reference thermometer temperature, °C	Thermocouple potentiometer temperature, °C	Temperature difference,[b] %
A	Ice Bath	32 °F	32 °F	0
B	Oven	200 °F	200 °F	0
C	oven	350 °F	350 °F	0
D	Ambient 3-6-91	58 °F	58 °F	0

[a] Type of calibration system used.

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

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. 33 Date 5-11-90

Calibrated by: S. 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	2.1	3.0	.837	.002
2	1.45	2.1	.831	.004
3	0.91	1.3	.836	.001
		$\bar{C}_p$ (SIDE A)	.835	

"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	2.1	3.0	.837	-.002
2	1.45	2.1	.831	-.004
3	0.91	1.3	.836	.001
		$\bar{C}_p$ (SIDE B)	.835	

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

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

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

Form No. EED-17-1

RAMCON ENVIRONMENTAL CORPORATION

Date 5-8-90 Thermocouple number 33

Ambient temperature 81 °F/°C Barometric pressure 29.96 in. Hg

Calibrator 5 Lines Reference: mercury-in-glass ✓

other _____

Reference point number[a]	Source[b] (specify)	Reference Thermometer Temperature, °C	Thermocouple Potentiometer Temperature, °C	Temperature Difference,[c] %
Boiling H2O		212 °F	212 °F	0
Boiling oil		411 °F	411 °F	0
Ice H2O		32 °F	32 °F	0
Ambient Temp		81 °F	81 °F	0
3-6-91		58 °F	58 °F	0

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

[b]Type of calibration system used.

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

Figure 2.5 stack temperature sensor calibration data form.