M E M O R A N D U M

TO: J.K. TAFT

VIA: J.J. KLIMENT
          R.J. TAGGART

FROM: C.S. KRICK

SUBJECT: WILMINGTON MATERIALS COMPANY STACK TESTS

DATE: JUNE 19, 1987

Attached is the report of the particulate testing at Wilmington Materials Company's Asphalt Plant. The tests were witnessed and the report has been reviewed. The results are considered to be representative of the Plant's emissions at the time of the tests.

The particulate test results are in compliance for the 30% recycle only by rounding the results down to 0.04 grains per dry standard cubic foot. The question becomes whether the operation of the plant during the 30% recycle tests can be considered typical. In order to have a flow distribution suitable for isokinetic sampling, the tester had the plant open the damper more than normal. The effect of this is to increase the flow of gas through the unit. Increased flow causes increased dilution which will understate the results, but it will also increase the velocity through the bags which tends to increase emissions and the additional flow will increase the stripping of hydrocarbons from the RAP and the asphalt. Considering the particulate levels and the opacity, the ability of this plant to stay in compliance when running 30% recycle is certainly suspect.

Attached is a recap of the parameters during the testing. During the recycle testing, there was more dilution air, higher stack temperatures, lower mix temperature, and lower pressure drop across the baghouse.

The hydrocarbon emissions certainly represent a potential for odor problems from this plant.

CSK:blt

Attachment

RAMCON

ENVIRONMENTAL CORPORATION

SOURCE SAMPLING
for
PARTICULATE EMISSIONS
WILMINGTON MATERIALS COMPANY, INC.
NEW CASTLE, DELAWARE
May 12 & 13, 1987

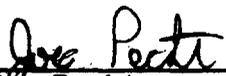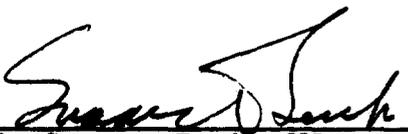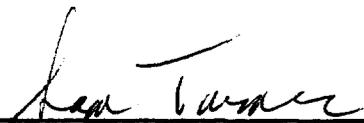# RAMCON ENVIRONMENTAL CORPORATION

SOURCE SAMPLING
for
PARTICULATE EMISSIONS
WILMINGTON MATERIALS COMPANY, INC.
NEW CASTLE, DELAWARE
May 12 & 13, 1987

Joe Pecht
Wilmington Materials Company

G. Sumner Buck, III
President

Sam T. Turner
Field Supervisor

R A M C O N

ENVIRONMENTAL CORPORATION

May 19, 1987

Mr. Joe Pecht
Wilmington Materials Company
301 Marsh Lane
New Castle, DE   19720

Re: Particulate Emissions Test - New Castle, Delaware

Dear Mr. Pecht:

Enclosed are four copies of our report on the particulate emissions test we conducted at your plant. Based on our test results, your plant does pass both EPA New Source Performance Standards and those set by the State of Delaware. The average grain loading of both of the test runs using recycle and virgin mix is in compliance with Federal and State Standards.

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

Mr. Charles Krick
Delaware DNR
P.O. Box 1401
Dover, DE   19903

We certainly have enjoyed working with you and look forward to serving you again in the future.

Sincerely,
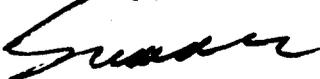
G. Sumner Buck, III
President

GSBIII:kr

Enclosures

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I. INTRODUCTION

On May 12 & 13, 1987, personnel from RAMCON Environmental Corporation (REC) conducted a source emissions test for particulate emissions compliance at Wilmington Materials Company, Inc.'s CMI drum mix asphalt plant located in New Castle, Delaware. RAMCON personnel conducting the test were Sam Turner, Field Supervisor and Bill Turner. Kim Rea was responsible for the final particulate 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. Rea.

The purpose of the test was to determine if the rate of particulate emissions from the plant's baghouse and the total contaminants by weight (grain loading) are below the limits set by EPA and the State of Delaware.

II. TEST RESULTS

Table I summarizes the test results. The grain loading limitation for EPA is specified in 39 FR 9314, March 8, 1974, 60.92 Standards for Particulate Matter (1), as amended. The allowable emissions for the State of Delaware is the same as those set by EPA.

Mr. Charles Krick of Delaware's Department of Natural Resources and Environmental Control observed the testing conducted by RAMCON.

TABLE I

SUMMARY OF TEST RESULTS
May 12 & 13, 1987

VIRGIN MIX

Test Run	Time	Grain Loading	Isokinetic Variation	Actual Emissions
1	12:22 to 13:25	0.014 gr/DSCF	105%	3.5 lbs/hr
2	14:36 to 15:40	0.018 gr/DSCF	103%	4.3 lbs/hr
	Average:	0.016 gr/DSCF		3.9 lbs/hr

RECYCLE MIX

Test Run	Time	Grain Loading	Isokinetic Variation	Actual Emissions
1	14:14 to 15:17	0.04 gr/DSCF	98%	11.7 lbs/hr
2	09:23 to 10:26	0.04 gr/DSCF	100%	10.6 lbs/hr
	Average:	0.04 gr/DSCF		11.2 lbs/hr

ROUNDED OFF

On the basis of these test results, the average grain loading on both of the test runs on recycle and virgin mix was below the .04 gr/DSCF emissions limitation set by US EPA and the State of Delaware. Therefore, the plant is operating in compliance with State and Federal Standards.

III.   TEST PROCEDURES

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

B.   Problems Encountered: There was an electrical storm which forced a shutdown of testing during run one while the plant was producing recycled asphalt pavement mix.   The run time was 59 minutes when the testers were forced off the stack by lightening.   When testing was resumed, only enough RAP production was available for a second test run.   Therefore, the average of two runs was used to determine compliance.

When production resumed with the plant producing virgin material, the testing was again terminated after two runs when the plant shut down with electrical problems.

C. Sampling Site: The emissions test was conducted after a baghouse on a rectangular stack measuring 57.5" x 42.9" with an equivalent diameter of 49.1". Five sampling ports were placed 61.5" down (1.3 diameters upstream) from the top of the stack and 248" up (5.1 diameters downstream) from the last flow disturbance. Twenty points were sampled, four through each port for three minutes each.

Points on a Diameter	Probe Mark
1	7.2"
2	21.6"
3	36.0"
4	50.4"
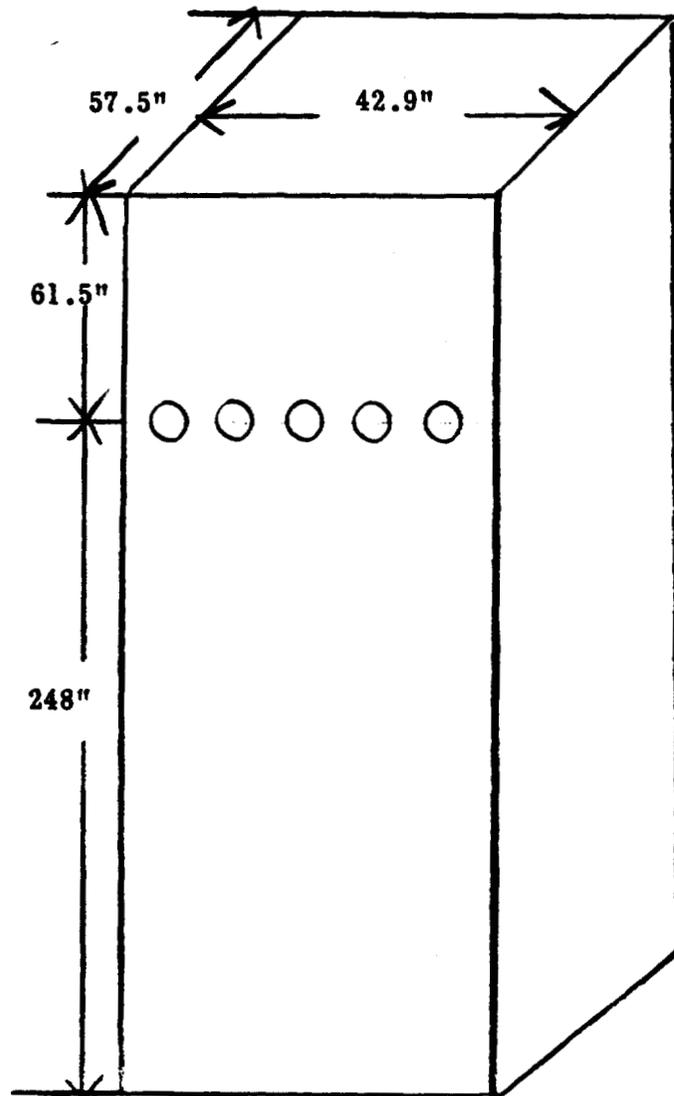
IV. THE SOURCE

IV.   THE SOURCE

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

The following is a general description of the plant's manufacturing process: The cold feed materials (aggregate) are dumped into 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. When recycled mix is used, it is added approximately halfway down the drum through a separate conveyor. 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 conveyor. The hot asphalt mix is then discharged from the storage silo through a slide gate into waiting dump trucks, which transport the material to a final destination for spreading. The rated capacity of the plant will vary with each aggregate mix and moisture content with a 5% surface moisture removal.

The drum mixer uses a burner fired with propane to heat air to dry the aggregate, and the motion of the rotating drum to blend the aggregate and hot asphalt oil thoroughly. The air is drawn into the system via an exhaust fan. After passing through the burner and the mixing drum, the air passes through a baghouse. The baghouse is manufactured by CMI. The exhaust gasses are drawn through the baghouse and discharged to the atmosphere through the stack. The design pressure drop across the tube-sheet is 1 - 6 inches of water. The particulate matter, which is removed by the baghouse, is reinjected into the drum mixer.
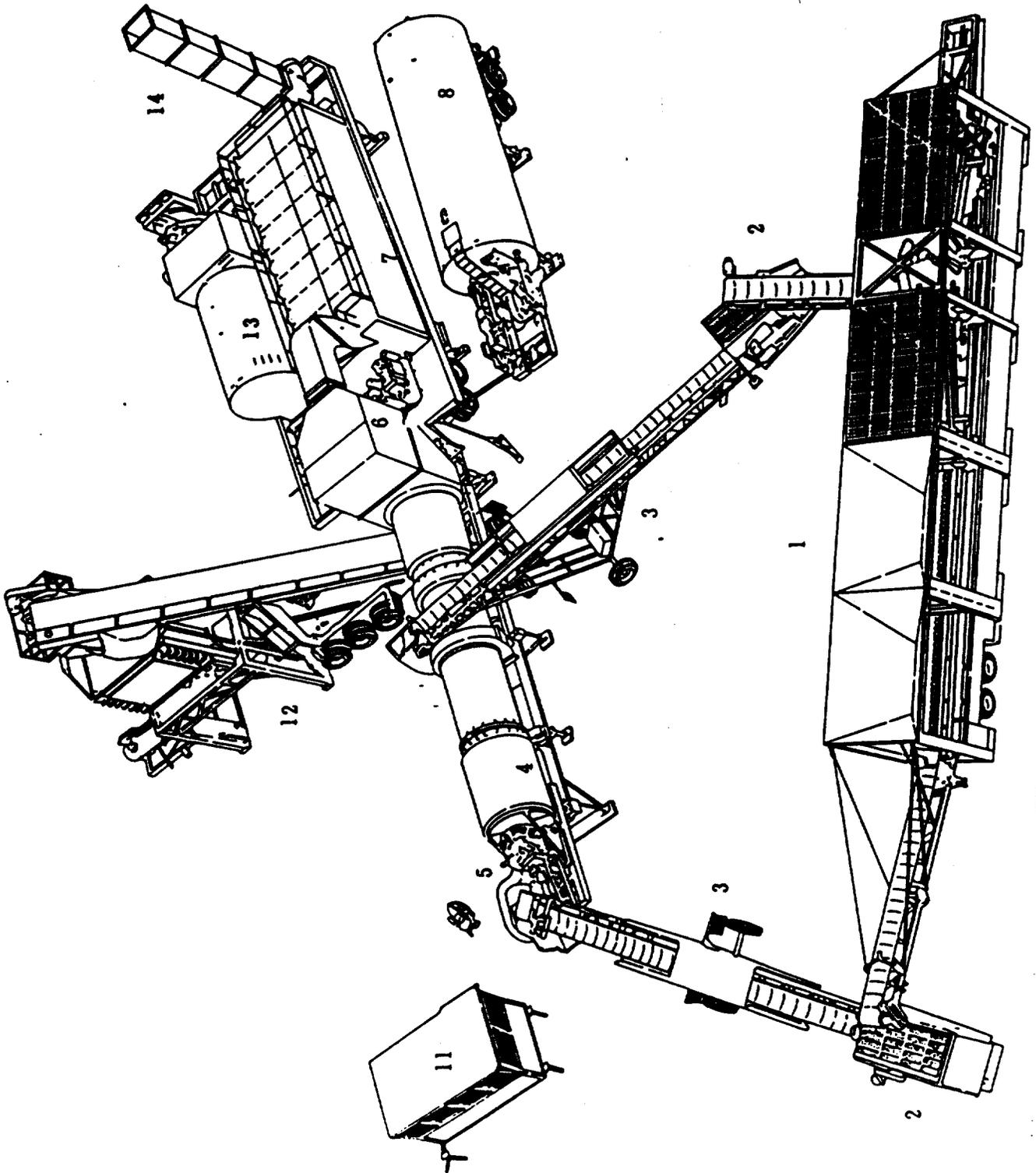
CMI drum mixer plant (baghouse)

1. **Aggregate bins:** Virgin aggregate is fed individually into each of four bins by type. It is metered onto a conveyor belt running under the bins to a shaker screen. The proporation 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 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 provide the flame which drys the aggregate.

6. **Knock off baffleing:** A baffeling plate is inserted in the "dirty" side plenum as a knock out for heavy particles in the air stream. These particles fall to the bottom of the baghouse.

7. **Baghouse:** The hot gases are pulled through the bags into the clean air plenum. The solid particulate matter is trapped on the dust coat buildup on the bags. A bag cleaning cycle consisting of jet burst of air from the inside (or clean air side) of the bags sends a large bubble of air down the inside of the bags shaking loose buildup on the bag surface. This particulate matter is collected at the bottom of the baghouse and reinjected into the drum mixer where it is used as part of the finished project.

8. **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.

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

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

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

12. **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.

13. Fuel Storage

DATA SUMMARY

Plant

1. Manufacturer of plant ___CMI___ .
2. Designed maximum operating capacity __350__ TPH @ __5__ % moisture.
3. Actual operation rate __350__ TPH @ __5__ % moisture.
4. Startup date __4/14/87__ .
5. Type of fuel used in dryer __Liquid Propane__ .
6. Quanity of fuel consumption __2.3 Gal. Per Ton__ .

Aggregate

7. Name/type of mix __Type C__ .
8. Percent asphalt in mix __5.2__ %.
9. Temperature of asphalt __290__ .
10. Sieve/Screening analysis: % Passing;

    | 1" __100__ | 3/8" __95__ | #30 __21.9__ |
    | 3/4" __100__ | #4 __62.9__ | #50 __6.1__ |
    | 1/2" __100__ | #8 __40.9__ | #200 __4.4__ |

    MoisTURE ___ %

Baghouse

11. Manufacturer __CMI__ .
12. No. of bags __770__ . Type of bags __Nomex__ .
13. Air to cloth ratio __5 To 1__ . Designed ACFM __51,500__ .
14. Square feet of bags __10,742__ .
15. Type of cleaning; pulse jet __✓__ , reverse air _____ ,
    plenum pulse _____ , other _____ .
16. Cleaning cycle time __10.5 Seconds__ .
17. Interval between cleaning cycle __16 Seconds__ .
18. Pressure drop across baghouse __3 to 4__ psi.
19. Pulse pressure on cleaning cycle __100__ psi.

COMPANY NAME __Wilmington Materials__ DATE __5/14/87__

PLANT DATA

COMPANY NAME _Wilmington Materials Inc._

COMPANY REP. _____ DATE _5-12-87_ PHONE # _302-659-1910_

DATA SOURCE _____

PLANT LOCATION _200 Marsh Lane New Castle De. 19720_

PLANT MFG. _CMI_ PLANT MODEL # _SMV-2000_ PLANT TYPE _Drum_

MIX SPECIFICATION # _____ OIL SPECIFICATION # _____

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
12:27		49%	355		19.35	300	6.6
12:42		51%	349		19.64	295	6.6
12:57		50%	353		19.19	300	6.6
13:14		50%	355		19.69	300	6.6
14:32		40%	325		12.47	310	6.8
14:47		52%	352.5		19.09	300	6.4
15:02		52%	347		19.06	305	6.4
15:17		50%	349		18.54	300	6.8
15:32		50%	346		18.58	300	6.6

PLANT DATA

COMPANY NAME _Wilmington Materials Inc._

COMPANY REP._____ DATE _5-12-97_ PHONE # _302-899-1510_

DATA SOURCE _____

PLANT LOCATION _200 Marsh Lane New Castle De. 19720_

PLANT MFG. _CMI_ PLANT MODEL # _SMV-2000_ PLANT TYPE _Drum_

MIX SPECIFICATION # _____ OIL SPECIFICATION # _____

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
14:04		50 %	229	106	8.02	285	5
14:20		50 %	230	106	8.03	285	4.4
14:35		50 %	242	108	8.01	290	5
14:50		51 %	234	104	7.99	285	5
15:05		50 %	232	106	7.88	285	4.6
		42 %	233	108	7.77	290	5.4
9:20							
9:35		45 %	226	103	8.05	290	5
9:50		48 %	228	108	8.09	285	5.4
10:07		46 %	236	95	8.05	285	5.5
10:20		40 %	231	109	7.84	290	5.2

V. EQUIPMENT USED

V. EQUIPMENT USED

Equipment used on conducting the particulate emissions test was:

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

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

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

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

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

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

VI. LABORATORY PROCEDURES & RESULTS

LABORATORY PROCEDURES FOR PARTICULATE SAMPLING

I. Field Preparation

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

   Filters are removed from their box and numbered on the back side with a felt pen. The numbering system is continuous from job to job. The filters are placed in a dessicator to dry for at least 24 hours. Clean plastic petri dishes, also numbered, top and bottom, are placed in the dessicator with the filters. After dessication, the filters are removed one at a time and weighed on the Sartorius analytical balance, then placed in the correspondingly numbered petri dish. Weights are then recorded in the lab record book. Three filters are used for each complete particulate source emissions test and there should be several extra filters included as spares.

   B. SILICA GEL: Silica Gel used for the test is prepared as follows:

   Approximately 200 g of silica gel is placed in a wide mouth "Mason" type jar and dried in an oven (175°C for two hours). The open jars are removed and placed in a dessicator until cool (2 hours) and then tightly sealed. The jars are then numbered and weighed on the triple beam balance to the closest tenth of a gram, and this weight is recorded for each sealed jar. The number of silica gel jars used is the same as the number of filters. Silica gel should be indicating type, 6-16 mesh.

II. Post-Testing Lab Analysis

   A. FILTERS: The filters are returned to the lab in their sealed glass filter holder which was used in field sampling. In the lab these holders are opened. The filter is placed in its petri dish with the lid off and returned to the dessicator for at least 24 hours. The top half of the filter holder is washed into the corresponding probe wash bottle and the bottom half of the filter holder is washed into the corresponding impinger catch bottle. (See II, C and D). After dessication, the filters are reweighed. The final weight is recorded in the lab record book. The filter pick up weight is calculated and recorded also. This procedure is repeated for all filters used in the field.

   Alternately, the test team may opt to oven dry the filters at 220°F for two to three hours, weigh the sample, and use this weight as a final weight.

   B. SILICA GEL: The sealed silica gel jars should be reweighed on the triple-beam balance and their weights recorded as shown on previous page.

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 "zero" position. The beam arrest lever (on the lower left hand side toward the rear of the balance) is then slowly pressed downward to full release position. The lighted vernier scale on the front of the cabinet should align the "zero" with the mark on the cabinet. If it is not so aligned, the adjustment knob on the right hand side (near the rear of the cabinet) should be turned carefully until the marks align. Now return the beam arrest to horizontal arrest position. The balance is now "zeroed".

To weigh an item, it is first placed on the pan. And the sliding doors are closed to avoid air current disturbance. The weight adjustment knob on the right hand side must be at "zero". The beam arrest is then slowly turned upward. The lighted scale at the front of the cabinet will now indicate the weight of the item in grams. If the scale goes past the divided area, the item then exceeds 100 g weight (about 3-1/2 ounces) and it is necessary to arrest the balance (beam arrest lever) and move the lever for 100 g weight away from you. It is located on the left hand side of the cabinet near the front, and is the knob closest to the side of the cabinet. The balance 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 the fractional weight in grams (the decimal would appear before the lighted digits) and the whole number of grams weight is the amount "dialed in" on the left.

In general, be sure that the beam is in "arrest" position before placing weight on or taking weight off of the pan. Don't "dial in" weight unless the beam is arrested. The balance is sensitive to even a hand on the table near the balance, so be careful and painstaking in every movement while weighing.

C.   PROBE RINSINGS: In all tests, a probe wash-out analysis will be necessary. These samples are returned in sealed Mason jars and consist of A.R. Acetone with an unknown solid content. Clean 250 ml beakers are used to make this analysis. These should be immaculately washed and rinsed with deionized water, then oven dried at 105°C for about one hour. The beakers should be moved to the dessicator to cool for ninety (90) minutes, then labeled with a pencil and weighed on the Sartorius analytical balance. Any variance from this procedure should be duplicated exactly when reweighing, as this procedure has been found to be quite sensitive. After preparing the necessary number of beakers (one for each probe wash and one blank) the Mason jars should be opened, poured into the beaker, and any material remaining on the jar walls rinsed with an acetone wash bottle into the beaker. The amount of liquid in the beaker should be noted on the analysis form. The acetone rinsings are evaporated on a warming plate. The liquid is kept swirled with an air sweep to prevent "bumping". When the acetone is evaporated the beakers are weighed as in Section II A.

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

E.   ACETONE: Conduct a blank analysis of acetone in the 1 gallon glass container. This acetone will be used in the field for rinsing the probe, nozzle, and top half of the filter holder. Performing such a blank analysis prior to testing will insure that the quality of the acetone to be used will not exceed the .001% residual purity standard.

SPECIAL NOTE

When sampling sources high in moisture content, (such as asphalt plants) the filter paper sometimes sticks to the filter holder. When removing the filter it may tear. In order to maintain control of any small pieces of filter paper which may be easily lost, they are washed with acetone into the probe washing. This makes the filter weight light (sometimes negative) and the probe wash correspondingly heavier. The net weight is the same and no particulate is lost. This laboratory procedure is taught by EPA in the Quality Assurance for Source Emissions Workshop at Research Triangle Park and is approved by EPA.

SAMPLE ANALYTICAL DATA FORM (15)

Virgin Mix

Plant Location **Wilmington Materials** Relative humidity in lab **45** %

Sample Location **Hot mix asphalt plant** Density of Acetone (pa) **.7853** mg/ml

Blank volume (V_a) **200** ml

Date/Time wt. blank **5-15-87**	Gross wt.	**95.0698** mg
Date/Time wt. blank **5-18-87**	Gross wt.	**95.0698** mg
	Ave. Gross wt.	**95.0698** mg
	Tare wt.	**95.0698** mg
	Weight of blank (m_{ab})	**.0000** mg

Acetone blank residue concentration (C_a) $\quad (C_a) = (M_{ab}) / (V_a)(p_a) = ($ **0** $\quad$ mg/g$)$

Weight of residue in acetone wash: $\quad \underline{W_a = C_a\, V_{aw}\, p_a} = ($ **0** $)($ **200** $)($ **.7853** $) = ($ **0** $)$

			(Run 3)	(Run 4)	
			Run # **1**	Run # **2**	Run #
Acetone rinse volume (V_{aw})		ml	**200**	**200**	
Date/Time of wt **5-15-87**	Gross wt	g	**99.8179**	**100.7665**	
Date/Time of wt **5-18-87**	Gross wt	g	**99.8180**	**100.7662**	
	Average Gross wt	g	**99.8180**	**100.7663**	
	Tare wt	g	**99.7983**	**100.7455**	
	Less acetone blank wt (W_a)	g	**.0000**	**.0000**	
Wt of particulate in acetone rinse (m_a)		g	**.0197**	**.0208**	
Filter Numbers		#	**SG-1905**	**SG-1906**	
Date/Time of wt **5-15-87**	Gross wt	g	**.5424**	**.5512**	
Date/Time of wt **5-18-87**	Gross wt	g	**.5424**	**.5510**	
	Average Gross wt	g	**.5424**	**.5511**	
	Tare wt	g	**.5284**	**.5310**	

Weight of particulate on filters(s) (m_f)	g		**.0140**	**.0201**	
Weight of particulate in acetone rinse	g		**.0197**	**.0208**	
Total weight of particulate (m_n)	g		**.0337**	**.0409**	

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 **Kim Roa** Signature of reviewer _____

Form REC#8   **SAMPLE ANALYTICAL DATA FORM**   *Recycle Mix*

Plant Location *Wilmington Materials* Relative humidity in lab __45__ %

Sample Location *hot mix asphalt stack* Density of Acetone (pa) .7853 mg/ml

Blank volume (V_a) _____ 200 _____ ml

Date/Time wt. blank 5-15-87		Gross wt.	100.1014 mg
Date/Time wt. blank 5-16-87		Gross wt.	100.1007 mg
		Ave. Gross wt.	100.1011 mg
		Tare wt.	100.1012 mg
		Weight of blank (m_{ab})	.0000 mg

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

Weight of residue in acetone wash: $W_a = C_a V_{aw} P_a$ = (0)(200)(.7853) = (0)

		Run #1	Run #2	Run #
Acetone rinse volume (V_{aw})	ml	.200	200	
Date/Time of wt 5-15-87 Gross wt g		94.8700	96.5302	
Date/Time of wt 5-18-87 Gross wt g		94.8698	96.5301	
Average Gross wt g		94.8699	96.5302	
Tare wt g		94.8140	96.4712	
Less acetone blank wt (W_a) g		.0000	.0000	
Wt of particulate in acetone rinse (m_a) g		.0559	.0590	

Filter Numbers	#	SG-1928	SG-1904	
Date/Time of wt 5-18-87 Gross wt g		.5539	.5703	
Date/Time of wt 5-18-87 Gross wt g		.5539	.5701	
Average Gross wt g		.5539	.5702	
Tare wt g		.5053	.5303	

Weight of particulate on filters(s) (m_f) g		.0486	.0399	
Weight of particulate in acetone rinse g		.0559	.0590	
Total weight of particulate (m_n) g		.1045	.0989	

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 *Kim Roa*   Signature of reviewer _____

ASH TEST
Filters

DATE Wilmington
PLANT 5-18-87

BEFORE ASHING

RUN #	1 RAP	2 RAP	3 virgin
Gross Weight	.5548	.5727	.5436
-tare weight	.5053	.5303	.5284
Net Weight of Particulate	.0495	.0424	.0152

AFTER ASHING

RUN #	1	2	3
Gross wt. after ash	.5300	.5448	.5416
-tare weight	.5053	.5303	.5284
Weight of non-volatiles	.0247	.0145	.0132

CALCULATIONS NON-VOLATILES

RUN #	1	2	3
Weight of Non-volatiles	.0247	.0145	.0132
÷ Net weight of Particulate	.0495	.0424	.0152
X 100%	100%	100%	100%
Weight percent of non-volatiles	49.9 %	34.2 %	86.8

CALCULATIONS VOLATILES

RUN #	1	2	3
100%	100%	100%	100%
-Weight percent of non-volatiles	49.9 %	34.2 %	86.8 %
-Weight percent of volatiles	50.1 %	65.8 %	13.2 %

Analyst_____ Checked_____ Approval _____
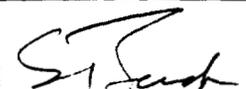
ASH TEST

Filters

DATE Wilmington

PLANT 5-18-87

BEFORE ASHING

RUN #	4 Virgin	∄	∄
Gross Weight	.5522		
-tare weight	.5310		
Net Weight of Particulate	.0212		

AFTER ASHING

RUN #	1	2	3
Gross wt. after ash	.5490		
-tare weight	.5310		
Weight of non-volatiles	.0180		

CALCULATIONS NON-VOLATILES

RUN #	1	2	3
Weight of Non-volatiles	.0180		
÷ Net weight of Particulate	.0212		
X 100%	100%	100%	100%
Weight percent of non-volatiles	84.9%		

CALCULATIONS VOLATILES

RUN #	1	2	3
100%	100%	100%	100%
-Weight percent of non-volatiles	84.9%		
-Weight percent of volatiles	15.1%		

Analyst   Checked   Approval
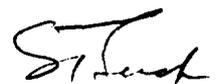
VII. CALCULATIONS

NAME: WILMINGTON MATERIALS - RECYCLE

LOCATION: NEW CASTLE, DELAWARE

date 5/12/87 5/13/87

SUMMARY OF TEST DATA		RUN # 1	RUN # 2	RUN #
SAMPLING TRAIN DATA	start	14:14	09:23	0
	finish	15:17	10:26	0

			RUN # 1	RUN # 2	RUN #
1	Sampling time, minutes	θ	59	60	0
2	Sampling nozzle diameter, in.	Dn	.255	.255	.000
3	Sampling nozzle cross-sectional area, ft^2.	An	.000355	.000355	.000000
4	Isokinetic variation	I	98	100	0
5	Sample gas volume - meter conditions, cf.	Vm	39.06	35.90	.00
6	Average meter temperature, $^\circ$R	Tm	563	532	0
7	Average oriface pressure drop, in.H$_2$O	ΔH	1.62	1.39	.00
8	Total particulate collected mg.	Mn	104.5	98.9	.0

VELOCITY TRAVERSE DATA

9	Stack area, ft^2.	A	17.2	17.2	.0
10	Absolute stack gas pressure, in. Hg.	Ps	30.16	30.45	.00
11	Barometric pressure, in. Hg.	Pbar	30.16	30.45	.00
12	Average absolute stack temperature, $^\circ$R	Ts	747	736	0
13	Average $\overline{\sqrt{velocity\ head}}$, (Cp= .80)	$\overline{\sqrt{\Delta P}}$	.82	.76	.00
14	Average stack gas velocity ft. / sec.	Vs	54	49	0

STACK MOISTURE CONTENT

15	Total water collected by train, ml.	Vic	219.0	206.0	.0
16	Moisture in stack gas, %	Bws	22.0	21.3	.0

EMISSIONS DATA:

17	Stack gas flow rate, dscf/hr. (000's)	Qsd	1,862	1,758	0
18	Total particulate concentration, gr/dscf	Cs	(.0440)	(.0424)	.0000
19	Total particulate concentration, lbs/hr	E	11.7	10.6	.0
20	Total particulate concentration, lbs/mbtu	E^1	.0000	.0000	.0000

ORSAT DATA

21	Percent CO2 by volume	CO2	2.5	3.5	.0
22	Percent O2 by volume	O2	17.5	15.9	.0
23	Percent CO by volume	CO	.0	.0	.0
24	Percent N2 by volume	N2	80.0	80.6	.0

> .04 GR/DSCF

Buzzycalc

Dry Gas Volume :

$$V_{m(std)} = V_m \left| \frac{T_{(std)}}{T_m} \right| \left| \frac{P_{bar} + \frac{\Delta H}{13.6}}{P_{(std)}} \right| = 17.64 \frac{^\circ R}{in.Hg.} Y V_m \left| \frac{P_{bar} + \frac{\Delta H}{13.6}}{T_m} \right|$$

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 $^\circ R$

T_{std} = Standard absolute temperature (528$^\circ R$)

ΔH = Average pressure drop across oriface meter,in.$H_2 0$

Y = Dry gas meter calibration factor

13.6 = Inches water per inches Hg.

Run # 1 $V_{m(std)}$ = 17.64 (.99)(39.06) $\left| \frac{(30.16) + \frac{1.62}{13.6}}{563} \right|$ = 36.58 dsc

Run # 2 $V_{m(std)}$ = 17.64 (.99)(35.90) $\left| \frac{(30.45) + \frac{1.39}{13.6}}{532} \right|$ = 35.90 dsc

Run # 3 $V_{m(std)}$ = 17.64 (.00)(.00) $\left| \frac{(.00) + \frac{.00}{13.6}}{0} \right|$ = .00 dsc

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: $C_s' = \left[0.0154 \; \frac{gr}{mg} \right] \left[\frac{104.5}{36.58} \right] = .0440$ gr./dscf.

Run # 2: $C_s' = \left[0.0154 \; \frac{gr}{mg} \right] \left[\frac{98.9}{35.90} \right] = .0424$ gr./dscf.

Run # 3: $C_s' = \left[0.0154 \; \frac{gr}{mg} \right] \left[\frac{0}{.00} \right] = .0000$ 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(2.5%) + 0.32(17.5%) + 0.28(.0% + 80.0%) = 29.1
                                                                   lb./lb.-mol

Run # 2: M_d = 0.44(3.5%) + 0.32(15.9%) + 0.28(.0% + 80.6%) = 29.2
                                                                     lb./lb.-mol

Run # 3: M_d = 0.44(.0%) + 0.32(.0%) + 0.28(.0% + .0%) = .0
                                                                     lb./lb.-mol

Water vapor condensed :

$$V_{wc_{std}} = \left| V_f - V_i \right| \left| \frac{P_w}{M_w} \frac{R\ T_{(std)}}{P_{(std)}} \right| = 0.04707 \left| V_f - V_i \right|$$

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

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)

V_f = Final volume of impinger contents, ml.

V_i = Initial volume of impinger contents

p = 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) (210.0) = 9.9 cu.ft
               $V_{wsg(std)}$ = (0.04715) (9.0) = .4 cu.ft

Run # 2: $V_{wc(std)}$ = (0.04707) (196.0) = 9.2 cu.ft
               $V_{wsg(std)}$ = (0.04715) (10.0) = .5 cu.ft

Run # 3: $V_{wc(std)}$ = (0.04707) (.0) = .0 cu.ft
               $V_{wsg(std)}$ = (0.04715) (.0) = .0 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: $B_{ws} = \dfrac{9.9 + .4}{9.9 + .4 + 36.58} \times 100 = 22.0\ \%$

Run # 2: $B_{ws} = \dfrac{9.2 + .5}{9.2 + .5 + 35.90} \times 100 = 21.3\ \%$

Run # 3: $B_{ws} = \dfrac{.0 + .0}{.0 + .0 + .00} \times 100 = .0\ \%$

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: $M_s = 29.1 (1- .220) + 18 (.220) = 26.7$ (lb./lb.-mole).

Run # 2: $M_s = 29.2 (1- .213) + 18 (.213) = 26.8$ (lb./lb.-mole).

Run # 3: $M_s = .0 (1- .000) + 18 (.000) = .0$ (lb./lb.-mole).

Stack gas velocity:

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

Where:

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

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

C_p = Pitot tube coefficient,(dimensionless).

ΔP = Velocity head of stack gas, in. H_2O.

P_{bar} = Barometric pressure at measurement site, (in.Hg).

P_g = 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, ($^\circ$f).

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

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

Run # 1: $V = (85.49)\ (\ .80)\ (\ .82)\ \sqrt{\dfrac{747}{(30.16)(26.66)}} = 54.12$ ft/se

Run # 2: $V = (85.49)\ (\ .80)\ (\ .76)\ \sqrt{\dfrac{736}{(30.45)(26.81)}} = 49.41$ ft/se

Run # 3: $V = (85.49)\ (\ .00)\ (\ .00)\ \sqrt{\dfrac{0}{(\ .00)(\ .00)}} = .00$ ft/se

Emissions rate from stack:

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

Where:

E = Emissions rate, lb./hr.

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

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

Run # 1: $\quad E = \dfrac{(.0440)(1862372)}{7000} = \quad 11.7 \text{ lb. / hr.}$

Run # 2: $\quad E = \dfrac{(.0424)(1757933)}{7000} = \quad 10.6 \text{ lb. / hr.}$

Run # 3: $\quad E = \dfrac{(.0000)(0)}{7000} = \quad .0 \text{ lb. / hr.}$

Stack gas flow rate:

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

Where:

Q_{sd}	=	Dry volumetric stack gas flow rate corrected to standard conditions, (dscf/hr).
A	=	Cross sectional area of stack (ft.)^2
3600	=	Conversion factor, sec./hr.
t_s	=	Stack temperature (°f).
T_s	=	Absolute stack temperature, (°R).
T_{std}	=	Standard absolute temperature, (528°R).
P_{bar}	=	Barometric pressure at measurement site, (in.Hg.).
P_g	=	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:

$$Q_{sd} = 3600 \ (1-.220) \ (54.12) \ (17.2) \left| \frac{528}{747} \right| \left| \frac{30.16}{29.92} \right| = 1862372 \ dscf.$$

Run # 2:

$$Q_{sd} = 3600 \ (1-.213) \ (49.41) \ (17.2) \left| \frac{528}{736} \right| \left| \frac{30.45}{29.92} \right| = 1757933 \ dscf.$$

Run # 3:

$$Q_{sd} = 3600 \ (1-.000) \ (.00) \ (.0) \left| \frac{528}{0} \right| \left| \frac{.00}{29.92} \right| = 0 \ dscf.$$

(28)

$$\text{Isokinetic variation}: I = 100\ T_s \left[\frac{0.002669\ V_{ic} + (V_m/T_m)(P_{bar} + \Delta H/13.6)}{.60\ \ 0\ \ V_s\ \ P_s\ \ A_n} \right]$$

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}	=	Total volume of liquid collected in impingers and silica gel, m
T_m	=	Absolute average dry gas meter temperature, °R.
P_{bar}	=	Barometric pressure at sampling site, (in.Hg).
ΔH	=	Average pressure differential across the oriface meter, (in.H_2O
13.6	=	Specific gravity of mercury.
60	=	Conversion seconds to minutes
0	=	Total sampling time, minutes.
V_s	=	Stack gas velocity, ft./sec.
P_s	=	Absolute stack gas pressure, in.Hg.
A_n	=	Cross sectional area of nozzle, ft^2.

Run # 1:

$$I = 100 \times 747 \left[\frac{(0.002669)(219.0) + \dfrac{39.1}{563}\left[30.16 + \dfrac{1.62}{13.6}\right]}{60\ (\ 59\ )\ (\ 54.12\ )\ (30.16\ )\ (\ .000355\ )} \right] = 98\ \%$$

Run # 2:

$$I = 100 \times 736 \left[\frac{(0.002669)(206.0) + \dfrac{35.9}{532}\left[30.45 + \dfrac{1.39}{13.6}\right]}{60\ (\ 60\ )\ (\ 49.41\ )\ (30.45\ )\ (\ .000355\ )} \right] = 100\ \%$$

Run # 3:

$$I = 100 \times 0 \left[\frac{(0.002669)(\ \ .0) + \dfrac{.0}{0}\left[.00 + \dfrac{.00}{13.6}\right]}{60\ (\ \ 0\ )\ (\ \ .00\ )\ (\ \ .00\ )\ (\ .000000\ )} \right] = 0\ \%$$

NAME: WILMINGTON MATERIALS — VIRGIN

LOCATION: NEW CASTLE, DELAWARE   date   5/13/87   5/13/87

SUMMARY OF TEST DATA			RUN # 1	RUN # 2	RUN #
SAMPLING TRAIN DATA		start	12:22	14:36	0
		finish	13:25	15:40	0
1	Sampling time, minutes	θ	60	60	0
2	Sampling nozzle diameter, in.	Dn	.255	.255	.000
3	Sampling nozzle cross-sectional area, ft^2.	An	.000355	.000355	.000000
4	Isokinetic variation	I	105	103	0
5	Sample gas volume — meter conditions, cf.	Vm	37.51	36.12	.00
6	Average meter temperature, °R	Tm	535	537	0
7	Average oriface pressure drop, in.H_2O	ΔH	1.44	1.36	.00
8	Total particulate collected mg.	Mn	33.7	40.9	.0
VELOCITY TRAVERSE DATA					
9	Stack area, ft^2.	A	17.2	17.2	.0
10	Absolute stack gas pressure, in. Hg.	Ps	30.54	30.54	.00
11	Barometric pressure, in. Hg.	Pbar	30.54	30.54	.00
12	Average absolute stack temperature, °R	Ts	721	715	0
13	Average $\overline{\sqrt{velocity\ head}}$, (Cp= .80)	$\overline{\sqrt{\Delta P}}$	.79	.77	.00
14	Average stack gas velocity ft. / sec.	Vs	51	50	0
STACK MOISTURE CONTENT					
15	Total water collected by train, ml.	Vic	281.0	271.0	.0
16	Moisture in stack gas, %	Bws	26.1	26.1	.0
EMISSIONS DATA:					
17	Stack gas flow rate, dscf/hr. (000's)	Qsd	1,752	1,715	0
18	Total particulate concentration, gr/dscf	Cs	.0139	.0176	.0000
19	Total particulate concentration, lbs/hr	E	3.5	4.3	.0
20	Total particulate concentration, lbs/mbtu	E'	.0000	.0000	.0000
ORSAT DATA					
21	Percent CO2 by volume	CO2	4.0	4.0	.0
22	Percent O2 by volume	O2	15.1	15.1	.0
23	Percent CO by volume	CO	.0	.0	.0
24	Percent N2 by volume	N2	80.9	80.9	.0

Buzzycalc

Dry Gas Volume :

$$V_{m(std)} = V_m \left| \begin{array}{c} T_{(std)} \\ \hline T_m \end{array} \right| \left| \frac{P_{bar} + \dfrac{\Delta H}{13.6}}{P_{(std)}} \right| = 17.64 \frac{^\circ R}{in.Hg.} Y V_m \left| \frac{P_{bar} + \dfrac{\Delta H}{13.6}}{T_m} \right|$$

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 $^\circ R$

T_{std} = Standard absolute temperature (528$^\circ R$)

ΔH = 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 (.99)(37.51) $\left| \dfrac{(30.54) + \dfrac{1.44}{13.6}}{535} \right|$ = 37.41 dsc

Run # 2 $V_{m(std)}$ = 17.64 (.99)(36.12) $\left| \dfrac{(30.54) + \dfrac{1.36}{13.6}}{537} \right|$ = 35.88 dsc

Run # 3 $V_{m(std)}$ = 17.64 (.00)(.00) $\left| \dfrac{(.00) + \dfrac{.00}{13.6}}{0} \right|$ = .00 dsc

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: $C_s' = \left| 0.0154 \ \frac{gr}{mg} \right| \left| \frac{33.7}{37.41} \right| = .0139$ gr./dscf.

Run # 2: $C_s' = \left| 0.0154 \ \frac{gr}{mg} \right| \left| \frac{40.9}{35.88} \right| = .0176$ gr./dscf.

Run # 3: $C_s' = \left| 0.0154 \ \frac{gr}{mg} \right| \left| \frac{.0}{.00} \right| = .0000$ 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: $M_d = 0.44(\ 4.0\%\ ) + 0.32(15.1\%\ ) + 0.28(\ \ .0\% + 80.9\%\ ) = \ 29.2$
                                                                        lb./lb.-mol.

Run # 2: $M_d = 0.44(\ 4.0\%\ ) + 0.32(15.1\%\ ) + 0.28(\ \ .0\% + 80.9\%\ ) = \ 29.2$
                                                                        lb./lb.-mol.

Run # 3: $M_d = 0.44(\ \ .0\%\ ) + 0.32(\ \ .0\%\ ) + 0.28(\ \ .0\% + \ \ .0\%\ ) = \ \ .0$
                                                                        lb./lb.-mol.

Water vapor condensed :

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

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

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)

V_f = Final volume of impinger contents, ml.

V_i = Initial volume of impinger contents

p = 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) (272.0) = 12.8 cu.ft
        $V_{wsg(std)}$ = (0.04715) (9.0) = .4 cu.ft

Run # 2: $V_{wc(std)}$ = (0.04707) (266.0) = 12.5 cu.ft
        $V_{wsg(std)}$ = (0.04715) (5.0) = .2 cu.ft

Run # 3: $V_{wc(std)}$ = (0.04707) (.0) = .0 cu.ft
        $V_{wsg(std)}$ = (0.04715) (.0) = .0 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: $B_{ws} = \dfrac{12.8 + .4}{12.8 + .4 + 37.41} \times 100 = 26.1\%$

Run # 2: $B_{ws} = \dfrac{12.5 + .2}{12.5 + .2 + 35.88} \times 100 = 26.1\%$

Run # 3: $B_{ws} = \dfrac{.0 + .0}{.0 + .0 + .00} \times 100 = .0\%$

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: $M_s = 29.2 (1- .261) + 18 (.261) = 26.3$ (lb./lb.-mole).

Run # 2: $M_s = 29.2 (1- .261) + 18 (.261) = 26.3$ (lb./lb.-mole).

Run # 3: $M_s = .0 (1- .000) + 18 (.000) = .0$ (lb./lb.-mole).

Stack gas velocity:

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

Where:

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

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

C_p = Pitot tube coefficient,(dimensionless).

ΔP = Velocity head of stack gas, in. H_2O.

P_{bar} = Barometric pressure at measurement site, (in.Hg).

P_g = 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, ($^\circ$f).

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

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

Run # 1: $V = (85.49)\,(\,.80)\,(\,.79)\sqrt{\dfrac{721}{(30.54)(26.28)}} \;=\; 51.21\ ft/se$

Run # 2: $V = (85.49)\,(\,.80)\,(\,.77)\sqrt{\dfrac{715}{(30.54)(26.28)}} \;=\; 49.71\ ft/se$

Run # 3: $V = (85.49)\,(\,.00)\,(\,.00)\sqrt{\dfrac{0}{(\,.00)(\,.00)}} \;=\; .00\ ft/se$

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 ($^{\circ}$f).

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

T_{std} = Standard absolute temperature, (528°R).

P_{bar} = Barometric pressure at measurement site, (in.Hg.).

P_g = Stack static pressure, (in.Hg.).

P_s = Absolute stack gas pressure, (in.Hg.); = P_{bar} + P_g

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

Run # 1:

$$Q_{sd} = 3600 \ (1-.261) \ (\ 51.21) \ (\ 17.2) \left[\frac{528}{721} \right] \left[\frac{30.54}{29.92} \right] = \ 1751605 \ dscf$$

Run # 2:

$$Q_{sd} = 3600 \ (1-.261) \ (\ 49.71) \ (\ 17.2) \left[\frac{528}{715} \right] \left[\frac{30.54}{29.92} \right] = \ 1714567 \ dscf$$

Run # 3:

$$Q_{sd} = 3600 \ (1-.000) \ (\ \ .00) \ (\ \ .0) \left[\frac{528}{0} \right] \left[\frac{.00}{29.92} \right] = \ 0 \ dscf$$

Emissions rate from stack:

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

Where:

E = Emissions rate, lb./hr.

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

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

Run # 1: $E = \dfrac{(.0139)(1751605)}{7000} = 3.5$ lb. / hr.

Run # 2: $E = \dfrac{(.0176)(1714567)}{7000} = 4.3$ lb. / hr.

Run # 3: $E = \dfrac{(.0000)(0)}{7000} = .0$ lb. / hr.

(38)

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

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}	=	Total volume of liquid collected in impingers and silica gel, m
T_m	=	Absolute average dry gas meter temperature, °R.
P_{bar}	=	Barometric pressure at sampling site, (in.Hg).
ΔH	=	Average pressure differential across the oriface meter, (in.H_2C
13.6	=	Specific gravity of mercury.
60	=	Conversion seconds to minutes
O	=	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:

$I \; = \; 100 \; X \; 721 \left[\dfrac{(0.002669)(281.0) + \dfrac{37.5}{535} \left[30.54 + \dfrac{1.44}{13.6} \right]}{60 \; (\; 60 \;) \; (\; 51.21 \;) \; (30.54 \;) \; (\; .000355 \;)} \right] = 105 \; \%$

Run # 2:

$I \; = \; 100 \; X \; 715 \left[\dfrac{(0.002669)(271.0) + \dfrac{36.1}{537} \left[30.54 + \dfrac{1.36}{13.6} \right]}{60 \; (\; 60 \;) \; (\; 49.71 \;) \; (30.54 \;) \; (\; .000355 \;)} \right] = 103 \; \%$

Run # 3:

$I \; = \; 100 \; X \; 0 \left[\dfrac{(0.002669)(\; .0) + \dfrac{.0}{0} \left[.00 + \dfrac{.00}{13.6} \right]}{60 \; (\; 0 \;) \; (\; .00 \;) \; (\; .00 \;) \; (\; .000000 \;)} \right] = 0 \; \%$

VIII. FIELD DATA

RAMCON ENVIRONMENTAL CORPORATION

Plant __Wilmington Materials Company__

Location __Wilmington De__
Operator __Sam Lubner__
Date __5-14-87__
Run No. __1 Ass'y.__
Sample Box No. _____
Meter Box No. __670775__
Meter H θ __.95__
C Factor __.989__
Pitot Tube Coefficient Cp __.84__

pp = .82
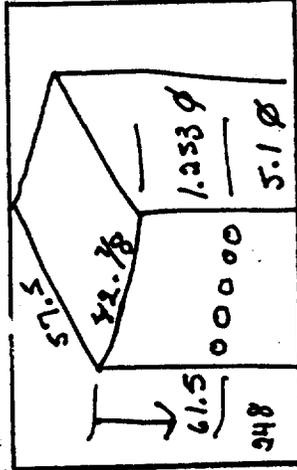
Ambient Temperature __78__
Barometric Pressure __30.16__
Assumed Moisture, % __25__
Probe Length, m(ft) __5'__
Nozzle Identification No. __00__
Avg. Calibrated Nozzle Dia., (in.) __.255/.255/.255__
Probe Heater Setting __5__
Leak Rate, m³/min.(cfm) __.015 at 7.5 "Vac__
Probe Liner Material __Stainless Steel__
Static Pressure, mm Hg (in. Hg) __.35/416__
Filter No. __56-1978__

Initial 416 Final 416
Initial .00 Outmost 2.10

Nuclear Volume 709
Nuclear Weight 709
400
.9

57.5
48.78
1,253 ø
61.5
00000
348   5.1 ø

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	Outlet	FILTER HOLDER TEMP °F	GAS TEMP LVG CONDENSER OR LAST IMPINGER °F
A 1	14:14:30 / 14:17:30	0	260	.20	.45	360.50 / 361.80	90	88	250	60
2	14:20:30	1	277	.30	.68	363.20	100	90	250	60
3	14:23:30	3	287	.60	1.4	364.80	104	90	250	60
4	14:26:30	5	291	.90	2.0	367.178	106	90	250	60
B 1	14:27:30 / 14:30:30	1	285	.30	.68	368.90	106	92	260	60
2	14:33:30	2	274	.40	.90	370.20	111	94	260	60
3	14:36:30	5	284	.90	2.0	372.40	113	94	260	60
4	14:39:30	7	286	1.2	2.7	374.98	114	95	260	60
C 1	14:40:15 / 14:43:15	1	275	.30	.68	376.50	112	96	260	68
2	14:46:15	3	284	.60	1.4	378.70	114	96	260	60
3	14:49:15	5	290	.90	2.0	380.80	116	98	250	60
4	14:52:15	7	296	1.2	2.7	383.20	118	98	250	60

Co2: 2.5 %
O2: 17.1 %

Co2: 2.5 %
O2: 17.1 %

co2 2.0 %
o2 17.9 %

RAMCON ENVIRONMENTAL CORPORATION

Plant __Wilmington Material__

Location __Wilmington De__
Operator __San Juaner__
Date __5-13-87__
Run No. __2 Recy__
Sample Box No. __2__
Meter Box No. __620-225__
Meter H θ __1.95__
C Factor __.987__
Pitot Tube Coefficient Cp __.801__

Ambient Temperature __55__
Barometric Pressure __30.95__
Assumed Moisture, % __15__
Probe Length, m(ft) __5'__
Nozzle Identification No. __000.3549__
Avg. Calibrated Nozzle Dia., (in.) __.155/.155/.155__
Probe Heater Setting __5__
Leak Rate, m³/min. (cfm) __.007 at 5" Vac.__
Probe Liner Material __Stainless Steel__
Static Pressure, mm Hg (in.Hg) __.35/13.6__
Filter No. __56-1907__

	SAMPLE VOLUME	SILICA GEL WEIGHT
FINAL	396	9.22
INITIAL	300	4/2
DIFFERENCE	196	.10

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	Outlet	FILTER HOLDER TEMP °F	GAS TEMP LVG CONDENSER OR LAST IMPINGER °F
A 1	9:23 / 9:26	0	263	.30	.68	399.232 / 401.10	60	58	240	50
A 2	9:29	0	264	.50	1.1	402.80	68	58	240	50
A 3	9:32	1	268	.70	1.6	404.80	74	60	240	40
A 4	9:35	2	266	1.0	2.2	406.73	78	60	240	40
B 1	9:35:30 / 9:38:30	0	267	.40	.90	408.20	78	61	240	40
B 2	9:41:30	2	272	.80	1.8	410.00	80	62	240	40
B 3	9:44:30	3	282	1.1	2.5	412.50	82	62	240	40
B 4	9:47:30	2	282	.90	2.0	414.80	84	62	240	40
C 1	9:48 / 9:51	1	276	.30	.68	416.20	82	63	240	40
C 2	9:54	1	289	.50	1.1	417.70	83	63	230	40
C 3	9:57	2.5	300	1.1	2.5	420.20	85	64	230	40
C 4	10:00	2.5	281	1.1	2.5	423.00	86	64	230	40

$CO_2 = 3.5$ % / $N_2 = 15.6$
$CO_2 = 3.0$ % / $A = 11.4$
$CO_2 = 3.5$ / $O_2 = 15.6$

Form #REC-06

RAMCON emissions test log sheet, cont. DATE 5-13-89 LOCATION Wilmington & TEST NO. 2 Aug.

TRAVERSE POINT	SAMPLING TIME θ (min)	VACUUM mm Hg (in. Hg)	STACK TEMP Ts (°F)	VELOCITY HEAD ΔP_s (in. H2O)	ORFICE DIFF. PRESSURE ΔH (in. H2O)	GAS VOLUME V_m (ft3)	GAS SAMPLE TEMP.(°F) in	out	SAMPLE BOX TEMP. (°F)	IMPINGER TEMP (°F)
0 1	10:0 / 10:04	6	274	.30	.68	424.30	82	64	240	45
2	10:07	0	274	.30	.68	425.60	84	64	225	45
3	10:10	0	270	.50	1.1	427.50	85	65	230	45
4	10:13	2	283	.90	2.0	429.60	86	65	230	45
(2) 1	10:14 / 10:17	0	266	.26	.45	430.70	82	65	230	45
2	10:20	0	273	.30	.68	431.90	84	65	230	50
3	10:23	0	278	.50	1.1	433.80	85	65	230	50
4	10:26	2	286	.70	1.6	435.632	86	66	230	50

RAMCON ENVIRONMENTAL CORPORATION

Plant _Wilmington Materials_

Location _Wilmington De,_
Operator _Sam Turner_
Date _5-13-90_
Run No. _3 Viasin_
Sample Box No. _1_
Meter Box No. _620.205_
Meter H @ _1.95_
C Factor _.982_
Pitot Tube Coefficient Cp _.801_

Ambient Temperature _65_
Barometric Pressure _30.54_
Assumed Moisture, % _25_
Probe Length, m(ft) _5_
Nozzle Identification No. _000 351_
Avg. Calibrated Nozzle Dia., (In.) _.255/.255/.255_
Probe Heater Setting _5_
Leak Rate, m³/min. (cfm) _.004_ at _6" Vac_
Probe Liner Material _Stainless Steel_
Static Pressure, mm Hg (In. Hg) _.35/13.6_
Filter No. _56-1905_

							METERED VOLUME ml	METERED VOLUME ml
							472	420
							260	41
							272	

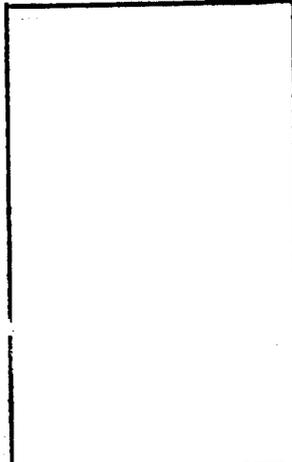## Schematic of Stack Cross Section

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	12:22:30 / 12:25:30	1	242	.30	.68	435.760 / 410.20	69	60	230	50
2	12:28:30	3	242	.60	1.4	439.00	74	62	230	50
3	12:31:30	4	246	.00	1.6	441.10	80	62	230	50
4	12:34:30	4	250	.30	1.6	442.54	82	64	235	50
B) 1	12:35 / 12:38	3	256	.60	1.4	444.50	82	64	235	50
2	12:41	4	257	.60	1.4	446.30	84	64	235	50
3	12:44	4	259	.60	1.4	448.10	86	66	230	50
4	12:47	4	260	.60	1.4	449.96	86	66	230	50
C) 1	12:47:30 / 12:50:30	4	265	.70	1.6	452.70	84	66	230	60
2	12:53:36	4	265	.70	1.6	454.30	86	66	230	50
3	12:56:30	4	265	.70	1.6	456.00	88	67	240	50
4	12:59:30	4	265	.70	1.6	457.90	88	68	240	50

$CO_2 = 4.0$ $CO_2 = 3.5$ $CO_2 = 4.0$
$O_2 = 14.9$ $O_2 = 15.6$ $O_2 = 14.9$

RAMCON emissions test log sheet, cont. DATE 5-13-87 LOCATION Wilmington De. TEST NO. 3 Virgin

TRAVERSE POINT	SAMPLING TIME θ (min)	VACUUM ㎜ Hg (in. Hg)	STACK TEMP T_s (°F)	VELOCITY HEAD ΔP_s (in. H2O)	ORFICE DIFF. PRESSURE ΔH (in. H2O)	GAS VOLUME V_m (ft.³)	GAS SAMPLE TEMP.(°F) in	out	SAMPLE BOX TEMP. (°F)	IMPINGER TEMP (°F)
D) 1	13:00:00 13:03:30	3	260	.60	1.4	459.80	84	68	230	50
2	13:06:30	4	270	.60	1,4	461.70	88	68	230	50
3	13:09:30	4	271	.70	1.6	463.70	88	68	230	50
4	13:12:30	4	270	.70	1.6	465.70	90	68	235	50
E) 1	13:13 13:16	4	265	.60	1,4	467.70	86	68	235	50
2	13:19	4	269	.60	1.4	469.40	90	69	230	50
3	13:22	4	268	.60	1.4	471.30	90	70	230	50
4	13:25	4	271	.60	1.4	473.269	90	70	230	50

RAMCON ENVIRONMENTAL CORPORATION

	FINAL	INITIAL	DIFFERENCE	BEGIN GAS VOLUME
	466	200	266	414
				5

Plant: Wilmington Materials
Location: Wilmington De.
Operator: Sam Weaver
Date: 5-13-87
Run No.: 2
Sample Box No.: 4 Weaver
Meter Box No.: 2
Meter H θ: 670225
Meter H @: 1.95
C Factor: .987
Pitot Tube Coefficient Cp: .80

Ambient Temperature: 65
Barometric Pressure: 30.54
Assumed Moisture, %: 25
Probe Length, m(ft): 5
Nozzle Identification No.: 00354?
Avg. Calibrated Nozzle Dia., (in.): .255/.255/.255
Probe Heater Setting: 5
Leak Rate, m³/min. (cfm): .005 at 7" Vac
Probe Liner Material: Stainless Steel
Static Pressure, mm Hg (in.Hg): .35/13.6
Filter No.: SG-1506

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	Outlet	FILTER HOLDER TEMP °F	GAS TEMP LVG CONDENSER OR LAST IMPINGER °F
A) 1	14:36 / 14:39	0	233	.40	.90	473.40 / 474.80	64	64	230	50
2	14:42	0	233	.50	1.1	472.08	76	66	230	50
3	14:45	2	235	.60	1.4	477.90	80	68	(60) 230	50
4	14:48	2	235	.60	1.4	479.30	78	66	240	50
B) 1	14:49 / 14:52	2	241	.50	1.1	481.10	78	66	240	50
2	14:55	4	243	.50	1.1	482.50	84	68	240	50
3	14:58	5	247	.60	1.4	484.60	84	68	240	50
4	15:01	4	256	(B) <0.50	1.1	486.34	86	68	240	50
C) 1	15:02 / 15:05	2	254	.60	1.4	488.10	84	68	260	50
2	15:08	2	260	.60	1.4	490.10	90	70	250	50
3	15:11	2	260	.60	1.4	492.60	90	70	260	50
4	15:14	2	262	.60	1.4	493.90	92	70	250	50

Co2 = 4.0 %   Co2 = 3.5 %   Co2 4.0 %
O2 14.9   O2 13.6   O2 14.9 %

TRAVERSE POINT	SAMPLING TIME θ (min)	VACUUM mm Hg (in. Hg)	STACK TEMP T_s (°F)	VELOCITY HEAD ΔP_s (in. H2O)	ORIFICE DIFF. PRESSURE ΔH (in. H2O)	GAS VOLUME V_m (ft³)	GAS SAMPLE TEMP (°F) in	out	SAMPLE BOX TEMP (°F)	IMPINGER TEMP (°F)
1 0	15:15/15:18	2	262	.90	1.6	495.80	86	70	250	55
2	15:21	2	367	.60	1.4	498.80	90	70	250	55
3	15:24	2	370	.60	1.4	499.90	93	70	250	60
4	15:27	2	370	.60	1.4	501.58	93	70	250	60
E 1	15:28/15:31	2	361	.90	3.0	504.20	86	71	250	60
2	15:34	2	364	.55	1.3	505.70	93	72	250	60
3	15:37	2	370	.60	1.4	501.60	91	72	240	50
4	15:40	2	370	.70	1.6	509.521	92	72	240	52

IX. CALIBRATIONS

METER BOX CALIBRATION DATA AND CALCULATION FORM

(English units)

Date **5-18-87**   Meter box number **670775**

Barometric pressure, P_b = **29.98** in. Hg   Calibrated by **Sam Tuna**

Vac.

| Orifice manometer setting (ΔH), in. H_2O | Gas volume | | Temperature | | | | Time (θ), min | Y_i | ΔH@$_i$ in. H_2O |
| | Wet test meter (V_w), ft^3 | Dry gas meter (V_d), ft^3 | Wet test meter (t_w), °F | Dry gas meter | | | | | |
				Inlet (t_{d_i}), °F	Outlet (t_{d_o}), °F	Avg[a] (t_d), °F			
3 0.5	5	544.62 / 549.60	77	81 / 81	78 / 78	79.5	12.43	.999	1.75
5 1.0	7	549.91 / 542.40	77	82 / 82	78 / 77	79.75	12.68	1.00	1.85
1.5	10								
2.0	10								
6 3.0	10	544.98 / 532.00	77	86 / 90	75 / 77	82	10.48	1.01	1.85
4.0	10								
							Avg	1.003	1.82

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

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

Quality Assurance Handbook M4-2.3A (front side)

Form #REC-02

METER BOX CALIBRATION DATA AND CALCULATION FORM

(English units)

Date __5-4-87__   Meter box number __670775__

Barometric pressure, P_b = __30.14__ in. Hg   Calibrated by __Sam T. Turner__

Orifice manometer setting (ΔH), in. H₂O	Gas volume		Temperature				Time (θ), min	Y_i	$\Delta H@_i$ in. H₂O
	Wet test meter (V_w), ft³	Dry gas meter (V_d), ft³	Wet test meter (t_w), °F	Dry gas meter					
				Inlet (t_{d_i}), °F	Outlet (t_{d_o}), °F	Avg[a] (t_d), °F			
0.5	5	895.00 / 900.115	72	78 78	76 76	77	13.07	.986	1.89
1.0	10	900.90 / 911.128	72	78 82	76 76	78	18.85	.986	1.97
1.5	10								
2.0	10								
3.0	8	914.90 / 920.c1	72	86 88	76 76	81.5	5.5	.989	2.0
4.0	10								
							Avg	.987	1.95

Left margin handwritten: Vac. 4" 4" 6"

ΔH, in. H₂O	$\dfrac{\Delta H}{13.6}$	$Y_i = \dfrac{V_w\, P_b\,(t_d + 460)}{V_d\left(P_b + \dfrac{\Delta H}{13.6}\right)(t + 460)}$	$\Delta H@_i = \dfrac{0.0317\,\Delta H}{P_b\,(t_d + 460)}\left[\dfrac{(t_w + 460)\,\theta}{V_w}\right]^2$
0.5	0.0368		
1.0	0.0737		
1.5	0.110		
2.0	0.147		
3.0	0.221		
4.0	0.294		

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

Quality Assurance Handbook M4-2.3A (front side)

Form #REC-02

STACK TEMPERATURE SENSOR CALIBRATION DATA FORM

Date ___6-17-86___ Thermocouple number _inlet/outlet_

Ambient temperature __24__ °C Barometric pressure __29.95__ in. Hg

Calibrator _S Turner_ Reference: mercury-in-glass ___✓___

other _____

Reference point number	Source[a] (specify)	Reference thermometer temperature, °C	Thermocouple potentiometer temperature, °C	Temperature difference,[b] %
A	inlet, ambient	24 °C	24 °C	0
B	outlet inlet	211 °C	211 °C	0
C.	ambient 5-12-87	78 °F	78 °F	0 %

[a]Type of calibration system used.

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

Quality Assurance Handbook M5-2.5

STACK TEMPERATURE SENSOR CALIBRATION DATA FORM

Date _6-17 - 86_   Thermocouple number _Hot bay_

Ambient temperature _24_ °C   Barometric pressure _29.95_ in. Hg

Calibrator _Sam Tune_   Reference: mercury-in-glass ___✓___

other _____

Reference point number	Source[a] (specify)	Reference thermometer temperature, °C	Thermocouple potentiometer temperature, °C	Temperature difference,[b] %
A	boiling water	100 °C	100 °C	0
B	Ambient	24°C	23.9	<.1 %
C	ambient 5-12-87	78°F	78°F	0%

[a] Type of calibration system used.

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

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PITOT TUBE CALIBRATION DATA

Calibration pitot tube: type ___S___ size (OD) ___3/8___ ID number ___51___

Type S pitot tube ID number ___51___ $C_{p(std)}$ = ___1___

Calibration: date ___1-9-87___ performed by ___Sam Turner___

A-Side Calibration

$\Delta p_{std'}$ cm (in.) H_2O	$\Delta p_{s'}$ cm (in.) H_2O	$C_{p(S)}$ [a]	DEV. [b]
.97	1.50	.80	.01
.74	1.10	.82	.01
.82	1.25	.81	.00
Average		.81	

B-Side Calibration

$\Delta p_{std'}$ cm (in.) H_2O	$\Delta p_{s'}$ cm (in.) H_2O	$C_{p(S)}$ [a]	DEV. [b]
.97	1.50	.80	.003
.74	1.15	.80	.003
.82	1.25	.81	.007
Average		.803	

[a] $C_{p(S)} = C_{p(std)} \sqrt{\dfrac{\Delta p_{std}}{\Delta p_s}}$ = _____

[b] DEV = $C_{p(S)} - \bar{C}_p$, (must be ≤ 0.01)

$\bar{C}_p(A) - \bar{C}_p(B)$ = _____ (must be ≤ 0.01).

Quality Assurance Handbook M2-2.5

STACK TEMPERATURE SENSOR CALIBRATION DATA FORM

Date __11/09/87__ Thermocouple number __51__

Ambient temperature __55°F__ °C Barometric pressure __29.86__ in. Hg

Calibrator __Shawn Greenwood__ Reference: mercury-in-glass __✓__

other _____

Reference point number[a]	Source[b] (specify)	Reference thermometer temperature, °C	Thermocouple potentiometer temperature, °C	Temperature difference,[c] %
A	Ice Water	32°F	32°F	0%
B	Boiling Water	212°F	211°F	.005%
C	Oil	380°F	382°F	.005%
D	Ambient	55°F	56°F	.02%
	3-12-87	78°F	78°F	0%

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

[b] Type of calibration system used.

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

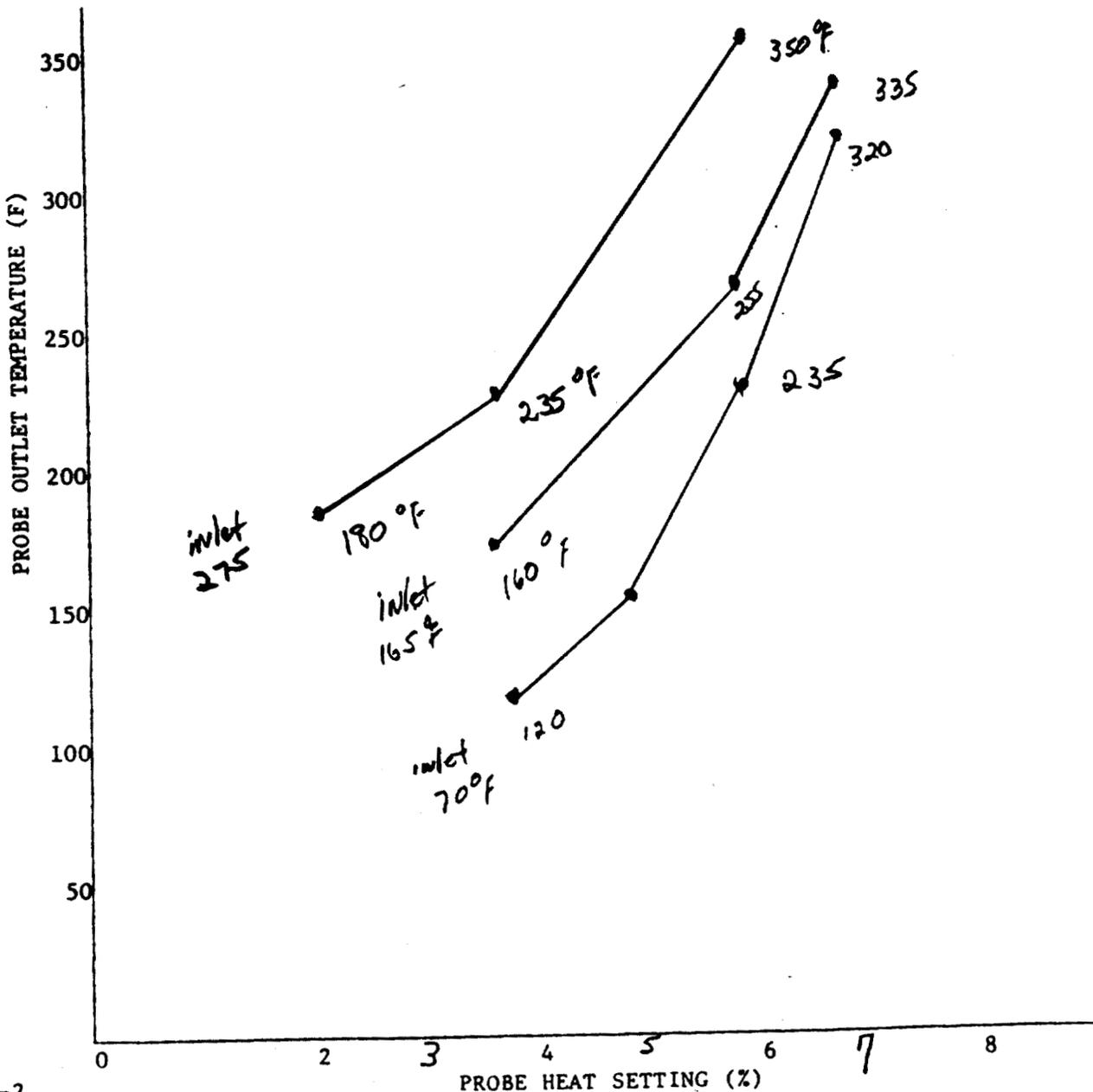Quality Assurance Handbook M2-2.10

RAMCON

Lear Siegler Stack Sampler

Heating Probe Calibration

Probe No. ___51___   Probe Length ___5'___

Date of Calibration _4-3-86_   Signature _Sam T. Tessay_

Name of Company to be tested _____

Note: 3 ft. probe - 5 min. warmup
        6 ft. probe - 15 min. warmup
        10 ft. probe - 30 min. warmup
        Calibration flow rate = .75 CFM

X. RAMCON PERSONNEL

RAMCON Environmental Stack Test Team

Sumner Buck - President

Sumner Buck is the President of RAMCON Environmental. He is a graduate of the EPA 450 "Source Sampling for Particulate Pollutants" course and the 474 "Continuous Emissions Monitoring" course all given at RTP. Mr. Buck is a qualified V.E. reader with current certification. Mr. Buck has personally sampled over 400 stacks including over 300 asphalt plants. He is 42 years old and a graduate of the University of Mississippi with graduate studies at Memphis State University and State Technical Institute of Memphis.

Sam Turner - Field Supervisor

Sam Turner has five years experience in the Air Division and is our field supervisor. He has sampled over 30 large boiler stacks and approximately 200 asphalt plants. He is a graduate of State Technical Institute of Memphis, and holds an Associate Degree in Environmental Engineering. He also has current certification as a V.E. reader.