RAMCON
ENVIRONMENTAL CORPORATION

SOURCE SAMPLING
for
PARTICULATE EMISSIONS
GENSTAR STONE PRODUCTS COMPANY
FREDERICK, MARYLAND
July 29 & 30, 1987

Rick Cole
Genstar Stone Products

G. Sumner Buck, III
President

Cameron Mitchell
Team Leader

RAMCON
ENVIRONMENTAL CORPORATION

August 7, 1987

Mr. Rick Cole
Genstar Stone Products Company
11350 McCormick Road
Hunt Valley, MD 21031

Re: Particulate Emissions Test - Frederick, Maryland

Dear Mr. Cole:

Enclosed you will find 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 Maryland. The average grain loading of the three test runs is in compliance with Federal and State Standards.

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

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

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

TABLE OF CONTENTS

I. INTRODUCTION

On July 29 & 30, 1987, personnel from RAMCON Environmental Corporation (REC) conducted a source emissions test for particulate emissions compliance at Genstar Stone Products Company's Astec drum mix asphalt plant located in Frederick, Maryland. RAMCON personnel conducting the test were Cameron Mitchell, Team Leader and Shawn Greenwood. 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. Mitchell 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 N.S.P.S. limits set by EPA and the State of Maryland.

II. TEST RESULTS

Table I summarizes the test results. The grain loading limitation for EPA is .04 gr/DSCF and 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 Maryland is .03 gr/dscf as cited in C.O.M.A.R. 101803.03.

Mr. Craig Holdefer of Maryland's Office of Environmental Affairs observed the testing conducted by RAMCON and conducted the opacity test (Reference Method 9).

TABLE I

SUMMARY OF TEST RESULTS
July 29 & 30, 1987

Test Run	Time	Grain Loading	Isokinetic Variation	Actual Emissions
1	10:52 to 12:10	0.0110 gr/DSCF	96%	2.4 lbs/hr
2	14:57 to 16:13	0.0174 gr/DSCF	102%	3.6 lbs/hr
3	08:03 to 09:24	0.0137 gr/DSCF	103%	3.0 lbs/hr
	Average:	0.0140 gr/DSCF		3.0 lbs/hr

On the basis of these test results, the average grain loading of the three test runs was below the .03 gr/DSCF emissions limitation set by the State of Maryland. Therefore, the plant is operating in compliance with State Standards.

III. TEST PROCEDURES

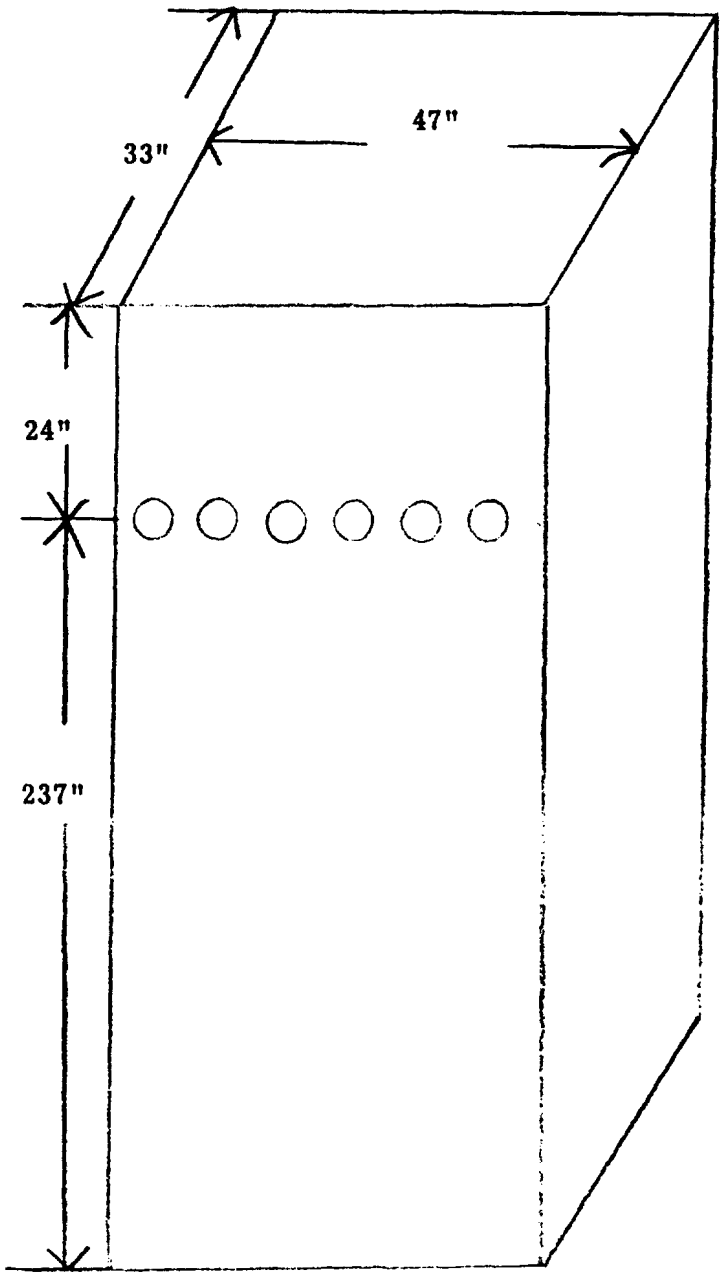
A. Method Used: The source sampling was conducted in accordance with requirements of the U.S. Environmental Protection Agency as set forth in 39 FR 9314, March 8, 1974, 60.93, as amended.

B. Problems Encountered: A leak check was conducted at the end of run two and a leak rate of .024 ft^3/min. was detected. The sample gas volume on run two was corrected according to Method 5, paragraph 6.3 of the Code of Federal Regulations Manual.

C. Sampling Site: The emissions test was conducted after a baghouse on a rectangular stack measuring 47" x 33" with an equivalent diameter of 38.8". Six sampling ports were placed 24" down (0.6 diameters upstream) from the top of the stack and 237" up (6.1 diameters downstream) from the last flow disturbance. Twenty four points were sampled, four through each port for three minutes each.

Points on a Diameter	Probe Mark
1	*11.6"
2	19.9"
3	28.1"
4	36.4"

*Measurements include a 7.5" standoff.



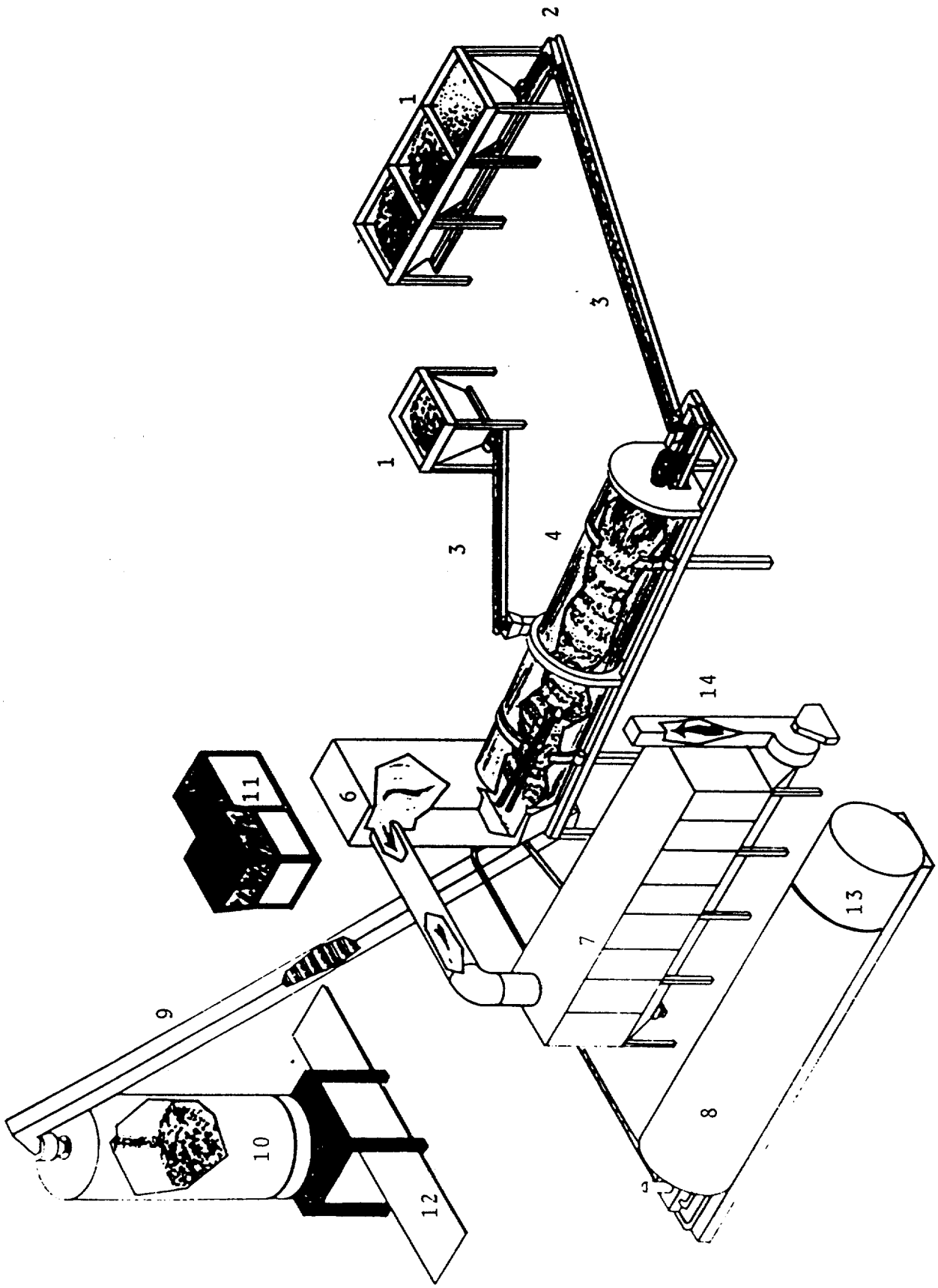
IV. THE SOURCE

IV. THE SOURCE

Genstar Stone Products employs an Astec 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^{o}F. The required amount of hot asphalt oil is then injected onto and mixed into the dried aggregate. Further mixing is conducted in a separate contained call a coater situated at the end of the drum. 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 coal or a mixture of 10% gas and and 90% coal 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 exhaust gasses pass through a baghouse. The baghouse is manufactured by Astec. The exhaust gasses are drawn through the baghouse and discharged to the atmosphere through a 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.



ASTEC - DRUM MIX 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 into the drum where it is blended with the aggregate. Mixing continues in a coater located at the end of the drum.

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

14. Stack

DATA SUMMARY

Plant

1. Manufacturer of plant Astec.
2. Designed maximum operating capacity 410 TPH @ 5 % moisture.
3. Actual operation rate 395 TPH @ 1.9/2.4 % moisture.
4. Startup date Apr. 30 1987.
5. Type of fuel used in dryer Coal/Gas/Oil.
6. Quanity of fuel consumption 2,400 CF Gas. 24F 43B Meters

Aggregate

7. Name/type of mix SN Surface / BI Base.
8. Percent asphalt in mix 5.5 / 4.5 %.
9. Temperature of asphalt 325°F AC.
10. Sieve/Screening analysis: % Passing; Base = State Mix Surface = Private Work/NA

1½"	100	3/8"	68.4	#16	26.3
3/4"	87.2	#4	50.5	#50	10.9
1/2"	N/A	#8	36.0	#200	5.0

BASE Screening

Baghouse

11. Manufacturer Astec BH-63.
12. No. of bags 1,024. Type of bags Nomex 5½D 10' Long.
13. Air to cloth ratio 5.0 - 1. Designed ACFM 74,000.
14. Square feet of bags _____.
15. Type of cleaning; pulse jet X, reverse air _____, plenum pulse _____, other _____.
16. Cleaning cycle time 200 minimum.
17. Interval between cleaning cycle 8.79 sec.
18. Pressure drop across baghouse 2.5 W.C. psi.
19. Pulse pressure on cleaning cycle _____ psi.

COMPANY NAME Ecosta DATE 7.30.87

PLANT DATA

COMPANY NAME Fenstar Stone Products Company

COMPANY REP. Larry Carty DATE July 29, 1987 PHONE # 301-695-7161

DATA SOURCE Plant Blending Comp.

PLANT LOCATION E. South St PO Box 696 Frederick Maryland

PLANT MFG. Astec PLANT MODEL # 86-176 PLANT TYPE Drum Mix Coater

MIX SPECIFICATION # SN Surface / BI Base OIL SPECIFICATION # AC-20

Time 24 Hour	___ Fuel Oil ___ Nat. Gas X Propane ___ Coal X Split test	Burner Setting Panel Display Setting	Aggregate TPH SN Surface	Recycle TPH Mix	Liquid Asphalt TPH	Mix Temp. °F	___ Venturi X Baghouse Pressure Drop Inches Water
Start # 1 10:50	10.35 100% Nat Gas	24.0	162	-0-	8.9	310	3"
	10:50 "	29.1	186	-0-	10.7	315	2"
	11:05 "	23.5	232	-0-	13.1	309	2.5"
	11:20 "	30.6	256	-0-	15.0	309	2.5"
	11:35 "	32.5	372	-0-	20.5	288	2.5"
	11:50 "	31.8	365	-0-	20.7	303	2.5"
End 1 12:10	12:05 "	31.7	290	-0-	16.5	310	2"
	Break in Plant Production		Restricted	at		14:50	
	Gas 100% Coal 0%		BI Mix	Base			
Start 2 14:57	14:55 "	22	169	-0-	7.48	321	2.25"
	15:10 "	20	256	-0-	11.3	285	1.5"
	15:25 "	24.6	338	-0-	14.7	290	1.5"
	15:40 "	31.8	409	-0-	19.0	296	2.25"
	15:55 "	31.8	410	-0-	19.2	312	2.50"
	16:10 "	31.8	411	-0-	19.3	311	2.50"
End 2 16:13	16:25 "	31.8	403	-0-	19.3	304	2.50"
	16:40 "	19.6	338	-0-	16.0	265	1.75"
	16:55 "	26.9	336	-0-	15.9	311	2.00"
	17:10 "	30.3	340	-0-	16.0	312	2.25"

PLANT DATA

COMPANY NAME _____

COMPANY REP. _____ DATE July 30, 1987 PHONE # _____

DATA SOURCE _____

PLANT LOCATION _____

PLANT MFG. _____ PLANT MODEL # _____ PLANT TYPE _____

MIX SPECIFICATION # SN Surface OIL SPECIFICATION # AC20

Time 24 Hour	___ Fuel Oil 0 Nat. Gas 10 Propane 0 Coal 90 _____	Burner Setting _____	Aggregate TPH SN Surface	Recycle TPH	Liquid Asphalt TPH	Mix Temp. °F	___ Venturi X Baghouse Pressure Drop Inches Water
Start 3 8:03 → 8:05	90% Coal 10% Gas	19.3	167	-0-	9.83	313	3.00"
8:20	"	20.5	194	-0-	9.92	328	1.75"
8:35	"	25.3	262	-0-	15.3	316	2.00"
8:50	"	25.3	370	-0-	18.1	295	2.00"
9:05	"	27.6	358	-0-	19.1	307	2.25"
9:20	"	29.9	361	-0-	20.9	306	2.75"
9:21 → 9:35 End 3	"	29.9	365	-0-	21.1	307	2.75"
	" End of SN Run		9:37	0-0			
	"			-0-			
	"			-0-			
	"			-0-			
	"			-0-			

V. EQUIPMENT USED

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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.

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.

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.

Form REC#8

(14)

SAMPLE ANALYTICAL DATA FORM

Plant Location Heinstar Stone Products Relative humidity in lab 49 %

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

Blank volume (V_a) 200 ml

Date/Time wt. blank 8/4/87 Gross wt. 98.7659 mg

Date/Time wt. blank 8/5/87 Gross wt. 98.7658 mg

Ave. Gross wt. 98.7659 mg

Tare wt. 98.7657 mg

Weight of blank (m_{ab}) .0002 mg

Acetone blank residue concentration (C_a) (C_a) = (M_{ab}) / (V_a) (P_a) = (.000003 mg/g)

Weight of residue in acetone wash: $W_a = C_a V_{aw} P_a$ = (.000003)(200)(.7853) = (.0002)

		Run # 1	Run # 2	Run # 3
Acetone rinse volume (V_{aw})	ml	200	200	200
Date/Time of wt 8/4/87 12:30 pm Gross wt	g	158.7705	147.5859	163.0376
Date/Time of wt 8/5/87 8:30 am Gross wt	g	158.7701	147.5857	163.0373
Average Gross wt	g	158.7703	147.5858	163.0375
Tare wt	g	158.7402	147.5424	163.0151
Less acetone blank wt (W_a)	g	.0002	.0002	.0002
Wt of particulate in acetone rinse (m_a)	g	.0299	.0432	.0222

		KP-2163	KP-2164	KP-2165
Filter Numbers	#			
Date/Time of wt 8/4 12:30 pm Gross wt	g	.5347	.5468	.5560
Date/Time of wt 8/5 8:30 Am Gross wt	g	.5345	.5464	.5558
Average Gross wt	g	.5346	.5466	.5559
Tare wt	g	.5234	.5238	.5229

Weight of particulate on filters(s) (m_f)	g	.0112	.0228	.0330
Weight of particulate in acetone rinse	g	.0299	.0432	.0222
Total weight of particulate (m_n)	g	.0411	.0660	.0552

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 Rea Signature of reviewer

COMPANY NAME Gunstar Stone Products

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

Relative humidity in lab 49%

Density of chloroform and ethyl ether 1.473 / .712 g/ml

			RUN 1	RUN 2	RUN 3
Chloroform and ethyl ether rinse volume		ml	348	401	395
Date/time of wt 8/4/87	Gross wt.	g	133.1361	145.7657	157.2027
Date/time of wt 8/5/87	Gross wt.	g	133.1359	145.7654	157.2023
	Avg. Gross wt.	g	133.1360	145.7656	157.2025
	Tare wt.	g	133.1282	145.7601	157.2014
Wt. of particulate in chloroform ethyl ether rinse		g	.0078	.0055	.0011
Water evaporation		#	Imp 1	Imp 2	Imp 3
Date/time of wt. 8/4/87	Gross wt.	g	142.2566	132.9083	153.6652
Date/time of wt. 8/5/87	Gross wt.	g	142.2563	132.9081	153.6650
	Avg. Gross wt.	g	142.2565	132.9082	153.6651
	Tare wt.	g	142.2017	132.7590	153.6406
Less chloroform & ehtyl either blank wt.		g	.0000	.0000	.0000
Weight of particulate from water (m_f)		g	.0548	.1492	.0244
Wt. of particulate in chloroform ethyl ether rinse		g	.0078	.0055	.0011
Total weight of particulate (m_n)		g	.0626	.1547	.0255

Note: In no case should a blank residue 0.02 mg/g or 0.001% of the weight of chloroform ethyl ether used be subtracted from the sample weight.

Remarks _____

Signature of Analyst Kim Rea

Signature of Reviewer S Buck

VII. CALCULATIONS

NAME: GENSTAR STONE PRODUCTS

LOCATION: FREDERICK, MARYLAND		date	7/29/87	7/29/87	7/30/8
	SUMMARY OF TEST DATA		RUN # 1	RUN # 2	RUN #
	SAMPLING TRAIN DATA	start	10:52	14:57	08:03
		finish	12:10	16:13	09:24
1	Sampling time, minutes	θ	72	72	72
2	Sampling nozzle diameter, in.	Dn	.255	.255	.255
3	Sampling nozzle cross-sectional area, ft^2	An	.000355	.000355	.000355
4	Isokinetic variation	I	96	102	103
5	Sample gas volume - meter conditions, cf.	Vm	59.76	61.56	63.87
6	Average meter temperature, °R	Tm	564	570	556
7	Average oriface pressure drop, in.H_2O	ΔH	2.40	2.60	2.78
8	Total particulate collected mg.	Mn	41.1	66.0	55.2
	VELOCITY TRAVERSE DATA				
9	Stack area, ft^2	A	10.8	10.8	10.8
10	Absolute stack gas pressure, in. Hg.	Ps	30.44	30.44	30.36
11	Barometric pressure, in. Hg.	Pbar	30.44	30.44	30.36
12	Average absolute stack temperature, °R	Ts	732	731	729
13	Average $\sqrt{\text{velocity head}}$, (Cp= .81)	$\sqrt{\Delta P}$	1.05	1.03	1.06
14	Average stack gas velocity ft. / sec.	Vs	69	68	70
	STACK MOISTURE CONTENT				
15	Total water collected by train, ml.	Vic	373.0	416.0	404.0
16	Moisture in stack gas, %	Bws	23.5	25.1	23.4
	EMISSIONS DATA:				
17	Stack gas flow rate, dscf/hr. (000's)	Qsd	1,510	1,458	1,529
18	Total particulate concentration, gr/dscf	Cs	.0110	.0174	.0137
19	Total particulate concentration, lbs/hr	E	2.4	3.6	3.0
20	Total particulate concentration, lbs/mbtu	E^1	.0000	.0000	.0000
	ORSAT DATA				
21	Percent CO2 by volume	CO2	3.5	3.0	3.0
22	Percent O2 by volume	O2	14.8	14.5	14.5
23	Percent CO by volume	CO	.0	.0	.0
24	Percent N2 by volume	N2	81.7	82.5	82.5

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_2O

Y = Dry gas meter calibration factor

13.6 = Inches water per inches Hg.

Run # 1 $V_{m(std)} = 17.64 \quad (1.00)(\ 59.76) \left[\frac{(30.44) + \frac{2.40}{13.6}}{564} \right] = 57.40$ dsc

Run # 2 $V_{m(std)} = 17.64 \quad (1.00)(\ 61.56) \left[\frac{(30.44) + \frac{2.60}{13.6}}{570} \right] = 58.53$ dsc

Run # 3 $V_{m(std)} = 17.64 \quad (1.00)(\ 63.87) \left[\frac{(30.36) + \frac{2.78}{13.6}}{556} \right] = 62.12$ 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: $C_s' = \left[0.0154 \frac{gr}{mg} \right] \left[\frac{41.1}{57.40} \right] = .0110$ gr./dscf.

Run # 2: $C_s' = \left[0.0154 \frac{gr}{mg} \right] \left[\frac{66.0}{58.53} \right] = .0174$ gr./dscf.

Run # 3: $C_s' = \left[0.0154 \frac{gr}{mg} \right] \left[\frac{55.2}{62.12} \right] = .0137$ gr./dscf.

Dry molecular weight:

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

Where:

M_d	= Dry molecular weight, lb./lb.-mole.
$\%CO_2$	= Percent carbon dioxide by volume (dry basis).
$\%O_2$	= Percent oxygen by volume (dry basis).
$\%N_2$	= Percent nitrogen by volume (dry basis).
%CO	= Percent carbon monoxide by volume (dry basis).
0.264	= Ratio of O_2 to N_2 in air, v/v.
0.28	= Molecular weight of N_2 or CO, divided by 100.
0.32	= Molecular weight of O_2 divided by 100.
0.44	= Molecular weight of CO_2 divided by 100.

Run # 1: $M_d = 0.44(3.5\%) + 0.32(14.8\%) + 0.28(\ \ .0\% + 81.7\%) =$ 29.2 lb./lb.-mol

Run # 2: $M_d = 0.44(3.0\%) + 0.32(14.5\%) + 0.28(\ \ .0\% + 82.5\%) =$ 29.1 lb./lb.-mol

Run # 3: $M_d = 0.44(3.0\%) + 0.32(14.5\%) + 0.28(\ \ .0\% + 82.5\%) =$ 29.1 lb./lb.-mol

Water vapor condensed :

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

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

Where:

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

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

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

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

V_f = Final volume of impinger contents, ml.

V_i = Initial volume of impinger contents

ρ = 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) (348.0) = 16.4 cu.ft

$V_{wsg(std)}$ = (0.04715) (25.0) = 1.2 cu.ft

Run # 2: $V_{wc(std)}$ = (0.04707) (401.0) = 18.9 cu.ft

$V_{wsg(std)}$ = (0.04715) (15.0) = .7 cu.ft

Run # 3: $V_{wc(std)}$ = (0.04707) (395.0) = 18.6 cu.ft

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

Moisture content of stack gases: $$B_{ws} = \frac{V_{wc_{std}} + V_{wsg_{std}}}{V_{wc_{std}} + V_{wsg_{std}} + V_{m\ std}} \times 100$$

Where:

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

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

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

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

Run # 1: $$B_{ws} = \frac{16.4 + 1.2}{16.4 + 1.2 + 57.40} \times 100 = 23.5\ \%$$

Run # 2: $$B_{ws} = \frac{18.9 + .7}{18.9 + .7 + 58.53} \times 100 = 25.1\ \%$$

Run # 3: $$B_{ws} = \frac{18.6 + .4}{18.6 + .4 + 62.12} \times 100 = 23.4\ \%$$

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: $M_s = 29.2\ (1-\ .235\ ) + 18\ (\ .235\ ) = 26.6$ (lb./lb.-mole).

Run # 2: $M_s = 29.1\ (1-\ .251\ ) + 18\ (\ .251\ ) = 26.3$ (lb./lb.-mole).

Run # 3: $M_s = 29.1\ (1-\ .234\ ) + 18\ (\ .234\ ) = 26.5$ (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 $\left[\text{(g/g-mole)-(mm Hg) / ($^\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: $V = (85.49)(.81)(1.05)\sqrt{\frac{732}{(30.44)(26.57)}} = 69.17$ ft/s

Run # 2: $V = (85.49)(.81)(1.03)\sqrt{\frac{731}{(30.44)(26.31)}} = 68.14$ ft/s

Run # 3: $V = (85.49)(.81)(1.06)\sqrt{\frac{729}{(30.36)(26.50)}} = 69.87$ ft/s

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:

$$Q_{sd} = 3600\ (1-.235)\ (\ 69.17)\ (\ \ 10.8) \left[\frac{528}{732}\right] \left[\frac{30.44}{29.92}\right] = 1509772 \text{ dscf/}$$

Run # 2:

$$Q_{sd} = 3600\ (1-.251)\ (\ 68.14)\ (\ \ 10.8) \left[\frac{528}{731}\right] \left[\frac{30.44}{29.92}\right] = 1458176 \text{ dscf/}$$

Run # 3:

$$Q_{sd} = 3600\ (1-.234)\ (\ 69.87)\ (\ \ 10.8) \left[\frac{528}{729}\right] \left[\frac{30.36}{29.92}\right] = 1529299 \text{ dscf/}$$

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: $E = \frac{(.0110)(1509772)}{7000} = 2.4$ lb. / hr.

Run # 2: $E = \frac{(.0174)(1458176)}{7000} = 3.6$ lb. / hr.

Run # 3: $E = \frac{(.0137)(1529299)}{7000} = 3.0$ lb. / hr.

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

Where:

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

$$I = 100 \times 732 \left| \frac{(0.002669)(373.0) + \frac{59.8}{564} \left| 30.44 + \frac{2.40}{13.6} \right|}{60\ (\ 72\ )\ (\ 69.17\ )\ (30.44\ )\ (\ .000355\ )} \right| = 96\ \%$$

Run # 2:

$$I = 100 \times 731 \left| \frac{(0.002669)(416.0) + \frac{61.6}{570} \left| 30.44 + \frac{2.60}{13.6} \right|}{60\ (\ 72\ )\ (\ 68.14\ )\ (30.44\ )\ (\ .000355\ )} \right| = 102\ \%$$

Run # 3:

$$I = 100 \times 729 \left| \frac{(0.002669)(404.0) + \frac{63.9}{556} \left| 30.36 + \frac{2.78}{13.6} \right|}{60\ (\ 72\ )\ (\ 69.87\ )\ (30.36\ )\ (\ .000355\ )} \right| = 103\ \%$$

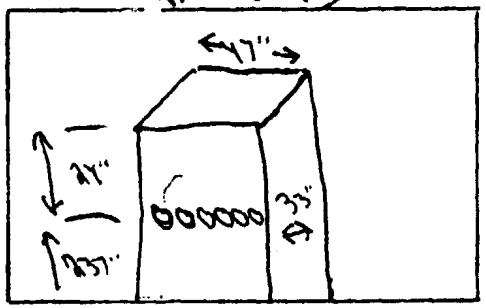
VIII. FIELD DATA

RAMCON ENVIRONMENTAL CORPORATION

Plant Gerstar

Location Frederick, Maryland
Operator Shawn Isenwood
Date 7/29/87
Run No. 1
Sample Box No.
Meter Box No. 670775
Meter H @ 1.99
C Factor 1.003
Pitot Tube Coefficient Cp 0.81

n = 2.13



		IMPINGER VOLUME, ml	SILICA GEL WEIGHT, g
Ambient Temperature	85°		
Barometric Pressure	30.44 FINAL	548	526
Assumed Moisture, %	30% INITIAL	300	501
Probe Length, m(ft)	4.5 DIFFERENCE	342	25
Nozzle Identification No.	0.0003347		
Avg. Calibrated Nozzle Dia., (in.)	.359	.359	.345
Probe Heater Setting	5		
Leak Rate, m^3/min. (cfm)	0.011		
Probe Liner Material	316 Stainless Steel		
Static Pressure, mm Hg (in. Hg)	0.09	13.5	
Filter No.	AP-2163		

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 ft^3	GAS SAMPLE TEMP. AT DRY GAS METER °F Inlet	GAS SAMPLE TEMP. AT DRY GAS METER °F Outlet	FILTER HOLDER TEMP °F	GAS TEMP LVG CONDENSER OR LAST IMPINGER °F
A 1	10:32 / 10:55	3	245	1.0	2.15	709.57 / 167.98	90	80	235	55
2	10:58	5	280	1.4	3.00	710.77	95	80	240	55
3	11:01	6	269	1.6	3.40	713.84	100	80	240	55
4	11:04	5	271	1.6	3.40	716.89	105	85	245	55
B 1	11:07 / 11:08	4	275	1.2	2.55	719.53	105	85	245	55
2	11:11	4	274	1.4	3.00	722.63	110	85	245	55
3	11:14	5	278	1.6	3.40	725.51	110	90	250	55
4	11:17	6	281	1.8	3.85	728.82	115	90	250	55
C 1	11:19 / 11:22	2	272	0.80	1.70	731.11	110	90	250	55
2	11:25	4	277	1.2	2.55	733.65	115	95	250	55
3	11:28	4	280	1.4	3.00	736.52	120	95	245	60
4	11:31	4	277	1.4	3.00	739.04	120	95	245	60
D 1	11:33 / 11:35	2	265	0.60	1.30	740.87	115	95	245	60

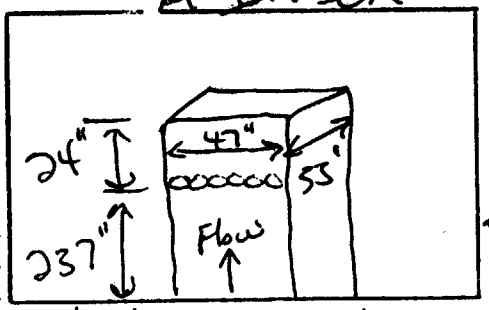
O_2 = 15.0% CO_2 = 3.5%

RAMCON ENVIRONMENTAL CORPORATION

Plant Genstar

Location Frederick Md
Operator C. Mitchell
Date 7-29-87
Run No. 2
Sample Box No. 2
Meter Box No. 670775
Meter H @ 1.98
C Factor 1.003
Pitot Tube Coefficient Cp 0.81

M=2.45CM2.4



Ambient Temperature	95°F	IMPINGER VOLUME, ml	SILICA GEL WEIGHT, g
Barometric Pressure	30.44 FINAL	600	478
Assumed Moisture, %	25 INITIAL	200	463
Probe Length, m(ft)	4ft DIFFERENCE	401	15
Nozzle Identification No.	0.000354		
Avg. Calibrated Nozzle Dia., (in.)	~~0.000354~~		0.25" 0.25" 0.25
Probe Heater Setting	5		
Leak Rate, m³/min. (cfm)	0.024		
Probe Liner Material	316 Stainless		
Static Pressure, mm Hg (in. Hg)	+0.02/13.6		
Filter No.	KP-2164		

* Vm corrected = 61.85 (.024-.02) 72 = 61.562

Schematic of Stack Cross Section

TRAV. PT NO.	SAMPLING TIME (θ) min.	VACUUM in. Hg	STACK TEMP (Ts) °F	VELOCITY HEAD (Ps) in H20	PRESSURE DIFF. ORF. MTR in H20	GAS SAMPLE VOLUME ft³	GAS SAMPLE TEMP. AT DRY GAS METER °F Inlet	GAS SAMPLE TEMP. AT DRY GAS METER °F Outlet	FILTER HOLDER TEMP °F	GAS TEMP LVG CONDENSER OR LAST IMPINGER °F
A) 1	14:57 / 15:00	10	225	1.0	2.4	765.164 / 768.60	105	105	170	62
2	15:03	~~10~~ 13	255	1.2	2.9	772.65	110	100	225	58
3	15:06	10	280	1.2	2.9	774.91	110	100	260	55
4	15:09	10	280	1.2	2.9	775.76	110	100	250	52
B) 1	15:10 / 15:13	14	265	1.2	2.9	779.36	110	100	255	55
2	15:16	16	270	1.8	4.3	782.60	115	100	240	55
3	15:19	16	275	1.4	3.4	785.89	110	100	245	53
4	15:22	16	270	1.4	3.4	787.58	110	100	230	53
C) 1	15:22 30 / 15:25 39	16	265	1.4	3.4	791.88	110	100	235	57
2	15:28 39	8	275	1.0	2.4	793.81	115	100	250	55
3	15:31 39	10	275	1.2	2.9	796.50	120	100	235	55
4	15:34 30	10	270	1.2	2.9	798.88	120	100	235	55
D) 1	15:35 / 15:38	10	270	1.2	2.9	803.15	120	100	265	60

Mo = 3.0% O2 = 14.5%

Form #REC-06

RAMCON emissions test log sheet, cont. DATE 7-29-87 LOCATION Frederick, Md TEST NO. 2

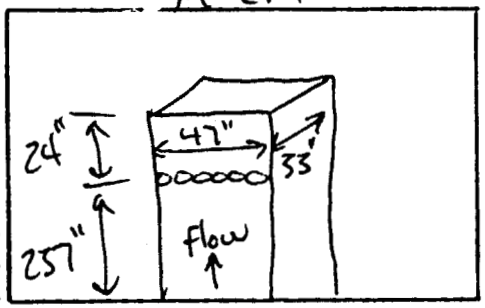
TRAVERSE POINT	SAMPLING TIME θ (min)	VACUUM mm Hg (in. Hg)	STACK TEMP T_s (°F)	VELOCITY HEAD ΔP_s (in. H_2O)	ORFICE DIFF. PRESSURE ΔH (in. H_2O)	GAS VOLUME Vm (ft^3)	GAS SAMPLE TEMP. (°F)		SAMPLE BOX TEMP. (°F)	IMPINGER TEMP (°F)
							in	out		
2	15:41	10	270	1.2	2.9	805.13	120	100	250	58
3	15:44	8	270	1.0	2.4	807.31	120	100	240	58
4	15:47	8	270	1.0	2.4	809.95	125	100	245	56
E) 1	~~15:48~~ 15:51	6	270	0.80	1.9	812.25	120	105	235	58
2	15:54	10	275	1.2	2.9	815.30	125	105	220	57
3	15:57	8	280	1.0	2.4	817.76	125	105	225	55
4	16:00	6	280	0.80	1.9	819.37	125	105	235	55
F) 1	~~16:01~~ 16:04	4	270	0.60	1.4	822.86	120	105	250	58
2	16:07	6	280	0.80	1.9	824.01	CM 0125	105	255	60
3	16:10	5	280	0.60	1.4	825.85	125	105	240	62
4	16:13	5	280	0.60	1.4	827.49	125	105	230	63

RAMCON ENVIRONMENTAL CORPORATION

Plant Genstar

Location Frederick Md
Operator C. Mitchell
Date 7-30-87
Run No. 3
Sample Box No. 1
Meter Box No. 670775
Meter H @ 1.98
C Factor 1.003
Pitot Tube Coefficient Cp 0.81

M=2.4



Schematic of Stack Cross Section

	IMPINGER VOLUME ml	SILICA GEL WEIGHT g
FINAL	595	507
INITIAL	200	498
DIFFERENCE	395	9

Ambient Temperature 75°F
Barometric Pressure 30.36
Assumed Moisture, % 25
Probe Length, m(ft) 4 ft
Nozzle Identification No. 0.0003547
Avg. Calibrated Nozzle Dia., (in.) 0.255/0.255/0.255
Probe Heater Setting 5
Leak Rate, m^3/min. (cfm) 0.011
Probe Liner Material 316 stainless
Static Pressure, mm Hg (in. Hg) to.02/13.6
Filter No. KP-2165

TRAV. PT NO.	SAMPLING TIME (θ) min.	VACUUM in. Hg	STACK TEMP (Ts) °F	VELOCITY HEAD (Ps) in H_2O	PRESSURE DIFF. ORF. MTR in H_2O	GAS SAMPLE VOLUME ft^3	GAS SAMPLE TEMP. AT DRY GAS METER °F Inlet	GAS SAMPLE TEMP. AT DRY GAS METER °F Outlet	FILTER HOLDER TEMP °F	GAS TEMP LVG CONDENSER OR LAST IMPINGER °F
A) 1	8:03 / 8:06	3	200	0.80	1.9	827.88 / 830.91	75	75	270	63
2	8:09	4	230	1.2	2.9	832.80	90	75	260	58
3	8:14:30 / 8:17:30	5	240	1.2	2.9	836.05	85	80	230	62
4	8:20:30	5	275	1.2	2.9	838.30	95	80	230	60
B) 1	8:21:30 / 8:24:30	5	275	1.2	2.9	841.90	95	80	245	55
2	8:27:30	8	285	1.6	3.8	844.72	100	80	250	53
3	8:30:30	8	285	1.8	4.3	848.30	105	80	250	53
4	8:33:30	7	275	1.4	3.4	850.36	105	85	255	52
C) 1	8:34:30 / 8:37:30	6	275	1.4	3.4	855.01	100	85	230	52
2	8:40:30	7	280	1.6	3.8	857.00	110	85	220	54
3	8:43:30	7	280	1.6	3.8	860.30	110	85	225	55
4	8:46:30	8	280	1.6	3.8	862.80	110	90	240	57
D) 1	8:47:30 / 8:50:30	4	270	1.0	2.4	866.10	105	90	245	53

* Plotted

RAMCON emissions test log sheet, cont. DATE 7-30-87 LOCATION Frederick, Md TEST NO. 3

TRAVERSE POINT	SAMPLING TIME θ (min)	VACUUM mm Hg (in. Hg)	STACK TEMP T_s (°F)	VELOCITY HEAD ΔP_s (in. H_2O)	ORFICE DIFF. PRESSURE ΔH (in. H_2O)	GAS VOLUME V_m (ft^3)	GAS SAMPLE TEMP. (°F)		SAMPLE BOX TEMP. (°F)	IMPINGER TEMP (°F)
							in	out		
2	8:53 30	6	275	1.4	3.4	868.80	110	90	255	54
3	8:56 30	5	270	1.2	2.9	871.52	110	90	250	57
4	8:59 30	4	275	1.0	2.4	873.54	115	90	240	58
E) 1	9:00 / 9:03	4	270	0.80	1.9	876.31	110	90	245	58
2	9:06	5	280	1.0	2.4	878.79	115	90	255	57
3	9:09	5	280	1.0	2.4	881.30	115	90	240	60
4	9:12	4	275	0.80	1.9	883.08	115	95	250	60
F) 1	9:12 30 / 9:15 30	2	265	0.40	0.96	885.10	110	95	235	61
2	9:18 30	3	270	0.80	1.9	887.33	115	95	240	63
3	9:21 30	4	275	0.80	1.9	889.60	115	95	240	62
4	9:24 30	5	275	1.0	2.4	891.75	115	95	220	64

IX. CALIBRATIONS

METER BOX CALIBRATION DATA AND CALCULATION FORM

(English units)

Date 8-3-87 Meter box number 670775

Barometric pressure, P_b = 30.33 in. Hg Calibrated by Sam 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	10	96.80 / 100.97	75	88 / 86	82 / 82	84.50	18.70	.998	1.92
1.5	10								
2.0	10	96.30 / 96.422	75	88 / 90	93 / 83	86	13.03	1.003	1.86
3.0	10	75.50 / 85.96	75	90 / 93	82 / 82	86.75	10.72	1.005	1.89
4.0	10								
							Avg	1.002	1.89

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

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

Quality Assurance Handbook M4-2.3A (front side)

Form #REC-02

METER BOX CALIBRATION DATA AND CALCULATION FORM

(English units)

Date 7-10-87 Meter box number 670775

Barometric pressure, P_b = 29.38 in. Hg Calibrated by Sam 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	634.000 / 639.067	76	88 / 86	81 / 80	83.75	9.25	.999	1.95
1.5	10								
2.0	10	623.40 / 633.49	76	89 / 90	81 / 81	85.25	13.25	1.003	1.996
3.0	10	612.80 / 622.84	76	92 / 92	80 / 81	86.25	10.82	1.007	1.993
4.0	10								
							Avg	1.003	1.98

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.

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 Tunney Reference: mercury-in-glass U

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	211 °C	211 °C	0
C	Barrett			
	7-29-87	85°F	85°F	0%

[a] Type of calibration system used.

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

STACK TEMPERATURE SENSOR CALIBRATION DATA FORM

Date 6-17-86 Thermocouple number Hotbox

Ambient temperature 24 °C Barometric pressure 29.95 in. Hg

Calibrator Sam Turney 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	0.1 %
C	ambient 7-29-87	85 °F	85 °F	0 %

[a] Type of calibration system used.

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

STACK TEMPERATURE SENSOR CALIBRATION DATA FORM

Date 11/09/87 Thermocouple number 41

Ambient temperature 54 °C Barometric pressure 29.86 in. Hg

Calibrator Shawn Dearmond 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	31°F	.03%
B	Boiling Water	212°F	211°F	.005%
C	Oil	380°F	377°F	.008%
D	Ambient	54°F	53°F	.02%
	7-29-87	85°F	85°F	0%

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

[b] Type of calibration system used.

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

RAMCON

Lear Siegler Stack Sampler

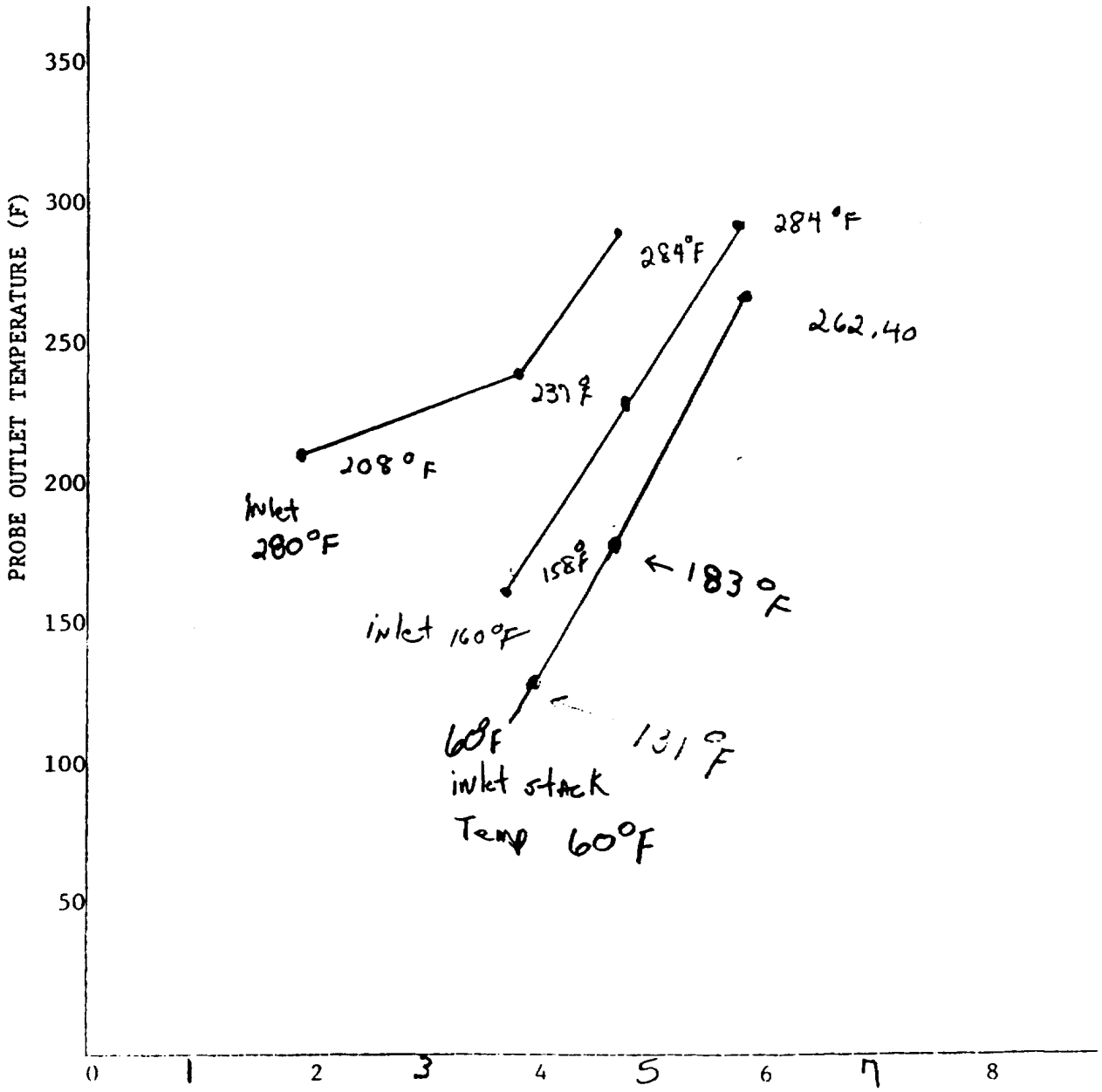
Heating Probe Calibration

Probe No. 41 Probe Length 4'

Date of Calibration 3-21-86 Signature Sam T. Turner

Name of Company to be tested _____

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



PITOT TUBE CALIBRATION DATA

Calibration pitot tube: type S size (OD) 3/8 ID number 41

Type S pitot tube ID number 41 $C_{p(std)}$ = 1

Calibration: date 1-9-87 performed by _____

A-Side Calibration

Δp_{std}, cm (in.) H_2O	Δp_s, cm (in.) H_2O	$C_{p(S)}$ [a]	DEV. [b]
.95	1.45	.81	.01
.74	1.2	.81	.01
.52	1.3	.80	.01
Average		.81	

B-Side Calibration

Δp_{std}, cm (in.) H_2O	Δp_s, cm (in.) H_2O	$C_{p(S)}$ [a]	DEV. [b]
.95	1.45	.81	.01
.74	1.2	.81	.01
.52	1.3	.80	.01
Average		.81	

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

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

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

X. RAMCON PERSONNEL