

Note: This is a reference cited in AP 42, *Compilation of Air Pollutant Emission Factors, Volume I Stationary Point and Area Sources*. AP42 is located on the EPA web site at [www.epa.gov/ttn/chief/ap42/](http://www.epa.gov/ttn/chief/ap42/)

The file name refers to the reference number, the AP42 chapter and section. The file name "ref02\_c01s02.pdf" would mean the reference is from AP42 chapter 1 section 2. The reference may be from a previous version of the section and no longer cited. The primary source should always be checked.

# RAMCON

## ENVIRONMENTAL CORPORATION

RAMCON BUILDING

223 SCOTT STREET

MEMPHIS, TENNESSEE 38112

TELEPHONE 901 / 458-7000

800 / 458-4567

RECEIVED

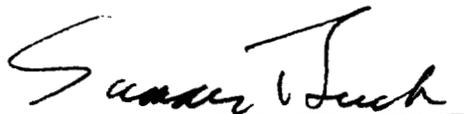
JUN 5 1986

SOURCE SAMPLING  
for  
PARTICULATE EMISSIONS  
**BITUMINOUS CONSTRUCTION COMPANY**  
CROFTON, MARYLAND  
May 2 & 3, 1986

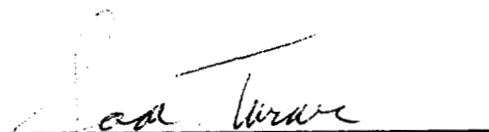
AIR MANAGEMENT  
ADMINISTRATION



John Sherwood  
Bituminous Construction Co.



G. Sumner Buck, III  
President



Sam T. Turner  
Field Supervisor

## TABLE OF CONTENTS

I.	INTRODUCTION	1
II.	TEST RESULTS	1
III.	TEST PROCEDURES	2
IV.	THE SOURCE	4
V.	EQUIPMENT USED	10
VI.	LABORATORY PROCEDURES & RESULTS	11
VII.	CALCULATIONS	19
VIII.	FIELD DATA	33
IX.	CALIBRATIONS	39
X.	RAMCON PERSONNEL	46

I. INTRODUCTION

On May 2 & 3, 1986, personnel from RAMCON Environmental Corporation (REC) conducted a source emissions test for particulate, SO<sub>2</sub> and SO<sub>3</sub> emissions compliance at Bituminous Construction Company's Astec drum mix asphalt plant located in Crofton, Maryland. RAMCON personnel conducting the test were Sam Turner, Field Supervisor and Allen Turner. Kim Rea was responsible for the laboratory analysis including taring the beakers and filters and recording final data in the laboratory record books. Lewis Duckworth was responsible for the laboratory analysis on SO<sub>2</sub> and SO<sub>3</sub>. Custody of the samples were limited to Mr. Turner, Mr. Duckworth and Ms. Rea.

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

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 Maryland for particulates are .03 gr/dscf. The SO<sub>2</sub> and SO<sub>3</sub> allowable emissions are 500 ppm for SO<sub>2</sub> and 35 mg/m<sup>3</sup> for SO<sub>3</sub>.

Mr. Craig Holdefer of Maryland's Department of Environmental Quality Engineering observed the testing conducted by RAMCON and conducted the visible emissions test (Method 9).

TABLE I  
SUMMARY OF TEST RESULTS  
May 2 & 3, 1986

<u>Test Run</u>	<u>Grain Loading</u>	<u>Actual Emissions</u>	<u>SO<sub>2</sub> Emissions</u>	<u>SO<sub>3</sub> Emissions</u>
1	0.0668 gr/dscf	23.0 lbs/hr	3.249 ppm	53.41 mg/m <sup>3</sup>
2	0.0557 gr/dscf	19.2 lbs/hr	10.289 ppm	40.24 mg/m <sup>3</sup>
Ave.	0.0612 gr/dscf	21.1 lbs/hr	6.769 ppm	46.83 mg/m <sup>3</sup>

On the basis of these test results, the average grain loading of both of the test runs was not below the .04 gr/dscf emissions limitation set by US EPA or the .03 gr/dscf emissions limitation set by the State of Maryland. Nor is the plant below the 35 mg/m<sup>3</sup> SO<sub>3</sub> emissions limitation set by State of Maryland. However, the plant is below the 500 ppm SO<sub>2</sub> emissions standard. Therefore, the plant is not operating in compliance with State or Federal Standards for particulates or SO<sub>3</sub>, but is in compliance with State Standards for SO<sub>2</sub>.

### III. TEST PROCEDURES

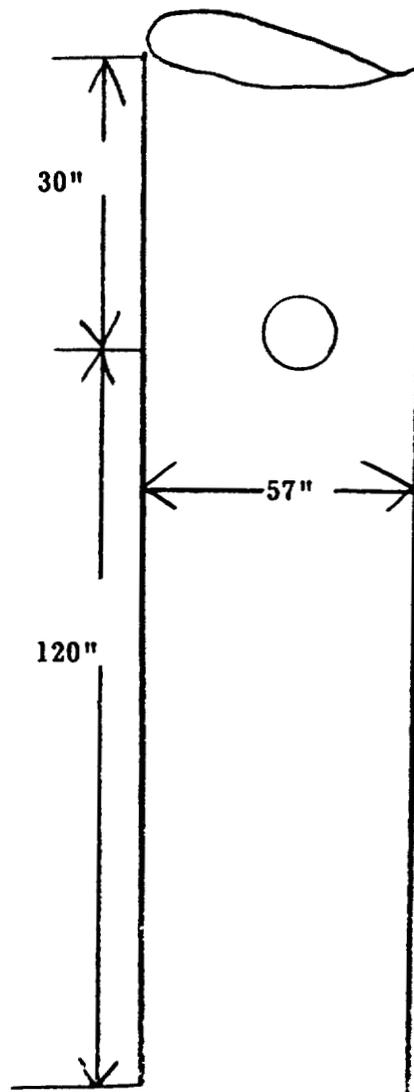
A. Method Used: The source sampling was conducted in accordance with requirements of the U.S. Environmental Protection Agency as set forth in 39 FR 9314, March 8, 1974, 60.93, as amended.

B. Problems Encountered: The filter from test run three was inadvertently contaminated and the final weight cannot be reported. The test results of runs one and two have been reported accurately.

C. Sampling Site: The emissions test was conducted after a scrubber on a round stack with a diameter of 57". The sampling ports were placed 30" down (0.5 diameters upstream) from the top of the stack and 120" up (4.0 diameters downstream) from the last flow disturbance. Twenty four points were sampled, twelve through each traverse for three minutes each.

<u>Points on a Diameter</u>	<u>Probe Mark</u>
1	*7.2"
2	9.8"
3	12.7"
4	16.1"
5	20.3"
6	26.2"
7	42.8"
8	48.8"
9	52.9"
10	56.3"
11	59.2"
12	61.8"

\* Measurements include a 6" standoff.



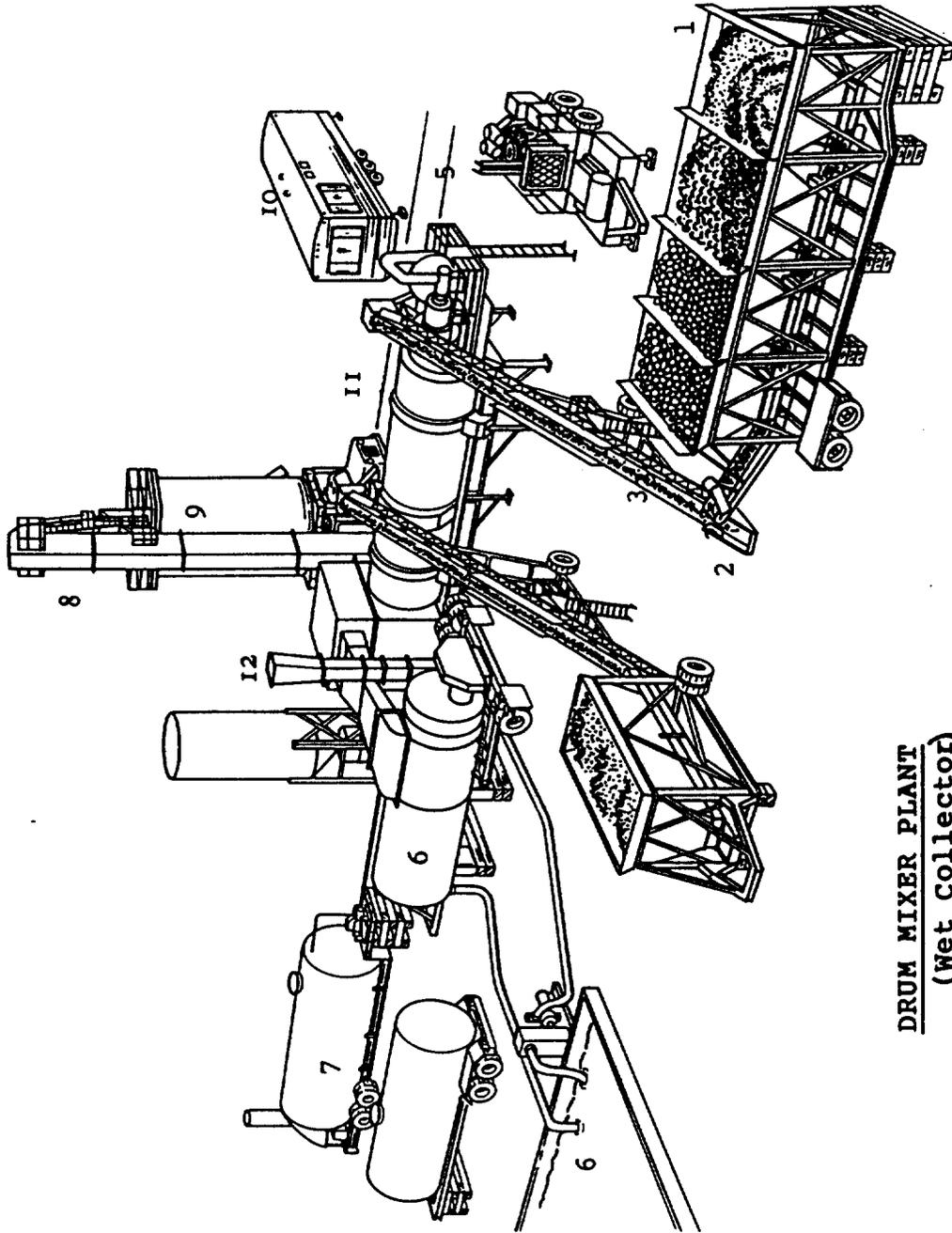
**IV. THE SOURCE**

#### IV. THE SOURCE

Bituminous Construction Company 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°F. When recycled asphalt mix is used, it is added approximately halfway down the drum through a separate weigh 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 coal and fuel oil 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 high efficiency scrubber. The scrubber was manufactured by Astec. The exhaust gasses are drawn through the scrubber and discharged to the atmosphere through the stack. The design pressure drop across the venturi is in excess of 15 inches of water. The particulate matter, which is removed by the scrubber is fed into the scrubber pond where it drops out of suspension.



DRUM MIXER PLANT  
(Wet Collector)

1. Aggregate bins: Virgin and recycled aggregate is fed individually into each of the bins by type. It is metered onto a conveyor belt running under the bins to a shaker screen. The proportion of each aggregate type is determined by the job mix formula and pre-set to be metered out to meet these specifications.
2. Preliminary oversize screen: The aggregate is fed through a shaker screen where oversize rocks and foreign material is screened out of the mix.
3. Weigh conveyor belt: The aggregate is conveyed to the rotary drum dryer on a conveyor belt which weighs the material. The production rate is determined by this weight reading.
4. Rotary drum dryer/mixer: The aggregate is fed into the rotary drum dryer where it is tumbled by flinging into a veil in front of a gas flame which drives off the moisture. Further mixing is also accomplished in this drum. Hot liquid asphalt is injected approximately one-third of the way down the inclined drum where it is mixed with the aggregate.
5. Burner: The fuel fired burner is used to dry the rough aggregate and sand in the rotating drum as well as reheat recycled asphalt when it is part of the mix.
6. Wet scrubbing system: A system of cyclonic action, spray nozzles and a venturi removes 99% of particulates in the gas stream.
7. Liquid asphalt storage: The liquid asphalt is stored in this heated tank until it is needed in the mixer. The amount of asphalt content and its temperature are pre-set for each different type job.
8. Conveyor to surge/storage bin: The finished product of aggregate mixed with liquid asphalt is conveyed to a surge bin.
9. Surge/storage bin: The asphaltic cement is dumped into this surge bin and metered out to dump trucks which pull underneath the slide gate at the bottom of the bin.
10. Control/operators house: The entire plant operation is controlled from this operator's house.
11. Truck loading scale: As the trucks receive the asphalt from the storage/surge bin they are weighed on the loading scale which tells the plant operator the amount of asphalt that is being trucked on each individual load.
12. Stack

DATA SUMMARY

Plant

- 1. Manufacturer of plant Astec
- 2. Designed maximum operating capacity 500 TPH @ 1.5 % moisture.
- 3. Actual operation rate 300 TPH @ 4.5 % moisture.
- 4. Startup date \_\_\_\_\_.
- 5. Type of fuel used in dryer Gas, Oil, Coal
- 6. Quantity of fuel consumption \_\_\_\_\_.

Aggregate

- 7. Name/type of mix SN-SURFACE
  - 8. Percent asphalt in mix 5.7 %.
  - 9. Temperature of asphalt 300°
  - 10. Sieve/Screening analysis:                      % Passing;
- |      |             |      |            |      |            |
|------|-------------|------|------------|------|------------|
| 1"   | <u>100%</u> | 3/8" | <u>94%</u> | #16  | <u>42%</u> |
| 3/4" | <u>100%</u> | #4   | <u>62%</u> | #30  | <u>33%</u> |
| 1/2" | <u>100%</u> | #8   | <u>51%</u> | #50  | <u>20%</u> |
|      |             |      |            | #100 | <u>9%</u>  |
|      |             |      |            | #200 | <u>4%</u>  |

Scrubber Control System

- 11. Manufacturer Astec
- 12. Type; Venturi ; Wet Washer \_\_\_\_\_;  
Spray Booth \_\_\_\_\_; Other \_\_\_\_\_.
- 13. Water line pressure 30 psi.
- 14. Pressure drop across system 16" to 21"
- 15. Gallons per minute through system \_\_\_\_\_.
- 16. Water source well (i.e., lagoon, pond, etc.)
- 17. Number of spray ~~nozzles~~ <sup>bats</sup> 2

COMPANY NAME Bituminous Const. Inc  
 COMPANY REPRESENTATIVE John Sherwood  
 DATE 5-51-9393





**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.

- 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.

**LABORATORY PROCEDURES FOR SO<sub>2</sub>**

Pour the catch from impingers two and three into a 1000 ml volumetric flask. Bring the solution in the flask up to the required 1000 ml volume by mixing it with deionized distilled water, then mix thoroughly. Pipette a 10 ml aliquot of sample into a 250 ml Erlenmeyer flask. Add 40 ml of isopropanol, 2 to 4 drops of thorin indicator and titrate to a pink endpoint using 0.0100 N barium perchlorate. Repeat the titration with a second aliquot of sample and average the titration values. Replicate titrations must agree within 1 percent or 0.2 ml, whichever is greater.

Prepare the blanks by adding 2 to 4 drops of thorin indicator to 100 ml of 80 percent isopropanol. Titrate the blanks in the same manner as the samples.

**LABORATORY PROCEDURES FOR H<sub>2</sub>SO<sub>4</sub>**

Pour the contents of the first impinger into a 250 ml graduated cylinder and bring the volume up to 250 ml with 80% isopropanol. Transfer the contents to a storage container and add the filter. Shake the container to coat the isopropanol solution on the filter. If the filter tears, allow the fragments to settle before taking a sample. Pipette a 25 ml aliquot (100 ml aliquot is too large for these particular samples because of the strength of the solution) of this solution into a 250 ml Erlenmeyer flask, add 2 to 4 drops of thorin indicator and titrate to a pink endpoint using 0.0100 N barium perchlorate. Repeat the titration with a second aliquot and average the titration values.

Plant Location BCI Cooper Rd Relative humidity in lab 45 %

Sample Location lyflet plant stack Density of Acetone (pa) .7853 mg/ml

Blank volume (Va) 200 ml

Date/Time wt. blank 5/8

Date/Time wt. blank 5/9

Gross wt. 93.3841 mg

Gross wt. 93.3841 mg

Ave. Gross wt. 93.3841 mg

Tare wt. 93.3791 mg

Weight of blank (m<sub>ab</sub>) .0050 mg

Acetone blank residue concentration (C<sub>a</sub>) (C<sub>a</sub>) = (M<sub>ab</sub>) / (V<sub>a</sub>) (p<sub>a</sub>) = (,000052 mg/g)

Weight of residue in acetone wash: W<sub>a</sub> = C<sub>a</sub> V<sub>aw</sub> p<sub>a</sub> = (,000052)(200)(,7857) = (,0050)

	Run # 1	Run # 2	Run # 3
Acetone rinse volume (V <sub>aw</sub> ) ml			
Date/Time of wt <u>5/8</u> Gross wt g	139.9662	149.5570	157.3053
Date/Time of wt <u>5/9</u> Gross wt g	139.9660	149.5569	157.3052
Average Gross wt g	139.9661	149.5570	157.3053
Tare wt g	139.7918	149.4568	157.2137
Less acetone blank wt (W <sub>a</sub> ) g	.0015	.0015	.0015
Wt of particulate in acetone rinse (m <sub>a</sub> ) g	.1743	.1002	.0916

	SG-1350	SG-1349	
Filter Numbers #			
Date/Time of wt <u>5/8</u> Gross wt g			
Date/Time of wt <u>5/9</u> Gross wt g			
Average Gross wt g	.7357	.7657	
Tare wt g	.6850	.6791	.7006

Weight of particulate on filters(s) (m <sub>f</sub> ) g	.0507	.0866	
Weight of particulate in acetone rinse g	.1743	.1002	.0916
Total weight of particulate (m <sub>T</sub> ) g	.2250	.1868	

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 The filter from run 3 was contaminated

Signature of analyst [Signature] Signature of reviewer STS

**H<sub>2</sub>SO<sub>4</sub> ANALYSIS**  
(Method 8)

Plant BCIDate 5/14/86

## Audit Samples

Audit Number	Known 7056		Known 9014		A	B	A	B
	A	B	A	B				
V <sub>soln</sub> (ml)	100	100	100	100				
V <sub>a</sub> (ml)	20	20	20	20				
N (N)	0.0100	0.0100	0.0100	0.0100				
V <sub>t</sub> (ml)	17.8	17.7	15.7	15.7				
V <sub>m</sub> (std) (dscm)	21x10 <sup>-3</sup>	21x10 <sup>-3</sup>	21x10 <sup>-3</sup>	21x10 <sup>-3</sup>				
C <sub>SO<sub>2</sub></sub> (mg/dscm)	884.6	892.3	1197.3	1197.3				
Actual C <sub>SO<sub>2</sub></sub> (mg/dscm)	899.9	899.9	1197.3	1197.3				

$$K_2 = 32.03 \text{ mg/meq}$$

H<sub>2</sub>SO<sub>4</sub> Analysis for Impinger <sup>1</sup> ~~Combined~~.

Run Number	1		2		3		Blank	
	A	B	A	B	A	B	A	B
V <sub>soln</sub> (ml)	250	250	250	250			1000	1000
V <sub>a</sub> (ml)	<del>100</del> 25	<del>100</del> 25	<del>100</del> 25	<del>100</del> 25			10	10
N (N)	0.0100	0.0100	0.0100	0.0100			0.0100	0.0100
V <sub>t</sub> (ml)	16	16	12	12			0	0
V <sub>m</sub> (std) (dscf)								
C <sub>SO<sub>2</sub></sub> (lb/dscf)								

$$K_3 = 7.061 \times 10^{-5} \text{ lb/meq}$$

Analysis performed by: Lewis ZuckworthApproved by: John P. Boyer

(17)

SO<sub>2</sub> ANALYSIS

(Method 8)

Plant BCI

Date 5-9-86

Audit Samples

Audit Number								
	A	B	A	B	A	B	A	B
V <sub>soln</sub> (ml)								
V <sub>a</sub> (ml)								
N (N)								
V <sub>t</sub> (ml)								
V <sub>m(std)</sub> (dscm)								
C <sub>SO<sub>2</sub></sub> (mg/dscm)								

K<sub>2</sub> = 32.03 mg/meq

SO<sub>2</sub> Analysis for Impinger 2 ~~and Combined~~

Run Number	1		2		<del>2</del>		Blank	
	A	B	A	B	<del>A</del>	<del>B</del>	A	B
V <sub>soln</sub> (ml)	1000	1000	1000	1000	1000	1000		
V <sub>a</sub> (ml)	10	10	10	10	10	10		
N (N)	0.0100	0.0100	0.0100	0.0100	0.	0.0100		
V <sub>t</sub> (ml)	.4	.4	1.2	1.3				
V <sub>m(std)</sub> (dscf)								
C <sub>SO<sub>2</sub></sub> (lb/dscf)								

K<sub>3</sub> = 7.061 x 10<sup>-5</sup> lb/meq

Analysis performed by: Lewis Rickwald

Approved by: [Signature]

SO<sub>2</sub> ANALYSIS

(Method 8)

Plant BCIDate 5/9/86

## Audit Samples

Audit Number								
	A	B	A	B	A	B	A	B
V <sub>soln</sub> (ml)								
V <sub>a</sub> (ml)								
N (N)								
V <sub>t</sub> (ml)								
V <sub>m(std)</sub> (dscm)								
C <sub>SO<sub>2</sub></sub> (mg/dscm)								

$$K_2 = 32.03 \text{ mg/meq}$$

SO<sub>2</sub> Analysis for Impinger ~~3~~ ~~Standard~~.

Run Number	1		2		3		Blank	
	A	B	A	B	A	B	A	B
V <sub>soln</sub> (ml)	1000	1000	1000	1000				
V <sub>a</sub> (ml)	10	10	10	10				
N (N)	0.0100	0.0100	0.0100	0.0100				
V <sub>t</sub> (ml)	0	0	0	0				
V <sub>m(std)</sub> (dscf)								
C <sub>SO<sub>2</sub></sub> (lb/dscf)								

$$K_3 = 7.061 \times 10^{-5} \text{ lb/meq}$$

Analysis performed by: Lewis TuckworthApproved by: John R. Biggs

---

**VII. CALCULATIONS**

NAME: BITUMINOUS CONSTRUCTION, INC.

LOCATION: CROFTON, MARYLAND

date 5/02/86 5/02/86 5/03/86

## SUMMARY OF TEST DATA

RUN # 1 RUN # 2 RUN # 3

## SAMPLING TRAIN DATA

start 09:55 14:20 08:04  
finish 11:13 15:38 08:22

1	Sampling time, minutes	θ	72	72	72
2	Sampling nozzle diameter, in.	Dn	.250	.250	.250
3	Sampling nozzle cross-sectional area, ft. <sup>2</sup>	An	.000341	.000341	.000341
4	Isokinetic variation	I	91	91	97
5	Sample gas volume - meter conditions, cf.	Vm	51.21	52.10	47.86
6	Average meter temperature, °R	Tm	546	558	538
7	Average orifice pressure drop, in.H <sub>2</sub> O	ΔH	1.85	1.84	1.63
8	Total particulate collected mg.	Mn	225.0	186.8	.0

## VELOCITY TRAVERSE DATA

9	Stack area, ft. <sup>2</sup>	A	17.7	17.7	17.7
10	Absolute stack gas pressure, in. Hg.	Ps	30.46	30.46	30.40
11	Barometric pressure, in. Hg.	Pbar	30.46	30.46	30.40
12	Average absolute stack temperature, °R	Ts	613	613	617
13	Average $\sqrt{\text{velocity head}}$ , (Cp = .81)	$\sqrt{\Delta P}$	.91	.91	.85
14	Average stack gas velocity ft. / sec.	Vs	54	55	52

## STACK MOISTURE CONTENT

15	Total water collected by train, ml.	Vic	286.0	289.0	337.0
16	Moisture in stack gas, %	Bws	20.6	20.8	24.3

## EMISSIONS DATA:

17	Stack gas flow rate, dscf/hr. (000's)	Qsd	2,409	2,414	2,162
18	Total particulate concentration, gr/dscf	Cs	.0668	.0557	.0000
19	Total particulate concentration, lbs/hr	E	23.0	19.2	.0
20	Total particulate concentration, lbs/mbtu	E <sup>1</sup>	.0000	.0000	.0000

## ORSAT DATA

21	Percent CO <sub>2</sub> by volume	CO <sub>2</sub>	4.7	2.2	2.2
22	Percent O <sub>2</sub> by volume	O <sub>2</sub>	12.8	16.3	16.3
23	Percent CO by volume	CO	.0	.0	.0
24	Percent N <sub>2</sub> by volume	N <sub>2</sub>	82.5	81.5	81.5

Dry Gas Volume :

$$V_{m(\text{std})} = V_m \left[ \frac{T_{(\text{std})}}{T_m} \right] \left[ \frac{P_{\text{bar}} + \Delta H}{13.6} \right] = 17.64 \frac{^{\circ}\text{R}}{\text{in. Hg.}} Y V_m \left[ \frac{P_{\text{bar}} + \Delta H}{13.6} \right] \left[ \frac{1}{T_m} \right]$$

Where:

- $V_{m(\text{std})}$  = Dry Gas Volume through meter at standard conditions, cu.ft.  
 $V_m$  = Dry Gas Volume measured by meter, cu.ft.  
 $P_{\text{bar}}$  = Barometric pressure at orifice meter, in. Hg.  
 $P_{\text{std}}$  = Standard absolute pressure, (29.92 in. Hg.)  
 $T_m$  = Absolute temperature at meter  $^{\circ}\text{R}$   
 $T_{\text{std}}$  = Standard absolute temperature ( 528 $^{\circ}\text{R}$ )  
 $\Delta H$  = Average pressure drop across orifice meter, in. H<sub>2</sub>O  
 $Y$  = Dry gas meter calibration factor  
 13.6 = Inches water per inches Hg.

$$\text{Run \# 1 } V_{m(\text{std})} = 17.64 (1.03) ( 51.20) \left[ \frac{(30.46) + \frac{1.85}{13.6}}{546} \right] = 51.88 \text{ dscf}$$

$$\text{Run \# 2 } V_{m(\text{std})} = 17.64 (1.03) ( 52.09) \left[ \frac{(30.46) + \frac{1.84}{13.6}}{558} \right] = 51.64 \text{ dscf}$$

$$\text{Run \# 3 } V_{m(\text{std})} = 17.64 (1.03) ( 47.86) \left[ \frac{(30.40) + \frac{1.63}{13.6}}{538} \right] = 49.09 \text{ dscf}$$

Total contaminants by weight: 'GRAIN LOADING'

Particulate concentration  $C_s$  gr./dscf.

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

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.

$V_m(\text{std})$  = Dry gas volume through meter at standard conditions, cu.ft.

$$\text{Run \# 1: } C_s = \left[ 0.0154 \frac{\text{gr}}{\text{mg}} \right] \left[ \frac{225.0}{51.88} \right] = .0668 \text{ gr./dscf.}$$

$$\text{Run \# 2: } C_s = \left[ 0.0154 \frac{\text{gr}}{\text{mg}} \right] \left[ \frac{186.8}{51.64} \right] = .0557 \text{ gr./dscf.}$$

$$\text{Run \# 3: } C_s = \left[ 0.0154 \frac{\text{gr}}{\text{mg}} \right] \left[ \frac{.0}{49.09} \right] = .0000 \text{ gr./dscf.}$$

Dry molecular weight:

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

Where:

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

Run # 1:  $M_d = 0.44(4.7\%) + 0.32(12.8\%) + 0.28(.0\% + 82.5\%) = 29.3$   
lb./lb.-mole

Run # 2:  $M_d = 0.44(2.2\%) + 0.32(16.3\%) + 0.28(.0\% + 81.5\%) = 29.0$   
lb./lb.-mole

Run # 3:  $M_d = 0.44(2.2\%) + 0.32(16.3\%) + 0.28(.0\% + 81.5\%) = 29.0$   
lb./lb.-mole

Water vapor condensed :

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

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

Where:

0.04707 = Conversion factor  $\text{ft}^3/\text{ml}$ .

0.04715 = Conversion factor  $\text{ft}^3/\text{g}$ .

$V_{wc\_std}$  = 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 $^{\circ}$ R.

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

Run # 1:  $V_{wc(std)}$  = (0.04707) (280.0) = 13.2 cu.ft  
 $V_{wsg(std)}$  = (0.04715) ( 6.0) = .3 cu.ft

Run # 2:  $V_{wc(std)}$  = (0.04707) (275.0) = 12.9 cu.ft  
 $V_{wsg(std)}$  = (0.04715) ( 14.0) = .7 cu.ft

Run # 3:  $V_{wc(std)}$  = (0.04707) (330.0) = 15.5 cu.ft  
 $V_{wsg(std)}$  = (0.04715) ( 7.0) = .3 cu.ft

Moisture content of stack gases: 
$$B_{ws} = \frac{V_{wc\_std} + V_{wsg\_std}}{V_{wc\_std} + V_{wsg\_std} + V_m\_std} \times 100$$

Where:

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

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

$V_{wc\_std}$  = Volume of water vapor condensed corrected to standard conditions (scf).

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

Run # 1: 
$$B_{ws} = \frac{13.2 + .3}{13.2 + .3 + 51.88} \times 100 = 20.6 \%$$

Run # 2: 
$$B_{ws} = \frac{12.9 + .7}{12.9 + .7 + 51.64} \times 100 = 20.8 \%$$

Run # 3: 
$$B_{ws} = \frac{15.5 + .3}{15.5 + .3 + 49.09} \times 100 = 24.3 \%$$

---

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: 
$$M_s = 29.3 (1 - .206) + 18 (.206) = 27.0 \text{ (lb./lb.-mole).}$$

Run # 2: 
$$M_s = 29.0 (1 - .208) + 18 (.208) = 26.7 \text{ (lb./lb.-mole).}$$

Run # 3: 
$$M_s = 29.0 (1 - .243) + 18 (.243) = 26.3 \text{ (lb./lb.-mole).}$$

Stack gas velocity:

$$V_s = K_p C_p \left[ \Delta P \right]^{1/2} \text{ avg. } \left[ \frac{T_s(\text{avg.})}{P_s M_s} \right]^{1/2}$$

Where:

- $V_s$  = Average velocity of gas stream in stack, ft./sec.  
 $K_p$  = 85.49 ft/sec  $\left[ \frac{(\text{g/g-mole}) - (\text{mm Hg})}{(^{\circ}\text{K})(\text{mm H}_2\text{O})} \right]^{1/2}$   
 $C_p$  = Pitot tube coefficient, ( dimensionless ).  
 $\Delta P$  = Velocity head of stack gas, in. H<sub>2</sub>O.  
 $P_{\text{bar}}$  = Barometric pressure at measurement site, (in.Hg).  
 $P_g$  = Stack static pressure (in.Hg).  
 $P_s$  = Absolute stack gas pressure, (in.Hg) =  $P_{\text{bar}} + P_g$   
 $P_{\text{std}}$  = Standard absolute pressure, ( 29.92 in.Hg ).  
 $t_s$  = Stack temperature, ( $^{\circ}\text{f}$ ).  
 $T_s$  = Absolute stack temperature, ( $^{\circ}\text{R}$ ). = 460 +  $t_s$ .  
 $M_s$  = Molecular weight of stack gas, wet basis, (lb/lb-mole).

$$\text{Run \# 1: } V = (85.49) (.81) (.91) \left[ \frac{613}{(30.46)(26.97)} \right]^{1/2} = 54.30 \text{ ft/sec}$$

$$\text{Run \# 2: } V = (85.49) (.81) (.91) \left[ \frac{613}{(30.46)(26.71)} \right]^{1/2} = 54.56 \text{ ft/sec}$$

$$\text{Run \# 3: } V = (85.49) (.81) (.85) \left[ \frac{617}{(30.40)(26.33)} \right]^{1/2} = 51.55 \text{ ft/sec}$$

Stack gas flow rate:

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

Where:

- $Q_{sd}$  = Dry volumetric stack gas flow rate corrected to standard conditions, (dscf/hr).  
 $A$  = Cross sectional area of stack (ft.)<sup>2</sup>.  
 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:

$$Q_{sd} = 3600 (1 - .206) ( 54.30 ) ( 17.7 ) \left[ \frac{528}{613} \right] \left[ \frac{30.46}{29.92} \right] = 2411728 \text{ dscf/h}$$

Run # 2:

$$Q_{sd} = 3600 (1 - .208) ( 54.56 ) ( 17.7 ) \left[ \frac{528}{613} \right] \left[ \frac{30.46}{29.92} \right] = 2417172 \text{ dscf/h}$$

Run # 3:

$$Q_{sd} = 3600 (1 - .243) ( 51.55 ) ( 17.7 ) \left[ \frac{528}{617} \right] \left[ \frac{30.40}{29.92} \right] = 2164470 \text{ dscf/h}$$

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).

$$\text{Run \# 1: } E = \frac{(.0668) (2411728)}{7000} = 23.0 \text{ lb. / hr.}$$

$$\text{Run \# 2: } E = \frac{(.0557) (2417172)}{7000} = 19.2 \text{ lb. / hr.}$$

$$\text{Run \# 3: } E = \frac{(.0000) (2164470)}{7000} = .0 \text{ lb. / hr.}$$



(29)

Sulfuric Acid Concentration (Including SO<sub>3</sub>) Impinger 1

$$\text{CH}_2\text{SO}_4 = \frac{K_2 N (V_t - V_{tb})(V_{\text{soln}})}{V_{\text{m(std)}} V_a}$$

Where; H<sub>2</sub>SO<sub>4</sub> = Sulfuric acid concentration (including SO<sub>3</sub>),  
(g/dscm)

K<sub>2</sub> = 0.04904 g/meq

N = Normality of barium perchlorate titrant, g equivalents/liter

V<sub>t</sub> = Volume of barium perchlorate titrant used for the sample, ml.

V<sub>tb</sub> = Volume of barium perchlorate titrant used for the blank, ml.

V<sub>soln</sub> = Total volume of solution in which the sulfuric acid sample is contained, 250 ml.

V<sub>m(std)</sub> = Volume of gas sample measured by the dry gas meter corrected to standard conditions, dscm.

V<sub>a</sub> = Volume of sample aliquot titrated (100 ml for H<sub>2</sub>SO<sub>4</sub>).

$$\text{Run \#1: } \text{CH}_2\text{SO}_4 = 0.04904 \frac{[.0100 (16.0 - .00) \frac{(250)}{25}]}{(1.4691 \text{ m}^3)} = 0.05341 \text{ g/dscm}$$

or

$$= 53.41 \text{ mg/m}^3$$

$$\text{Run \#2: } \text{CH}_2\text{SO}_4 = 0.04904 \frac{[.0100 (12.0 - .00) \frac{(250)}{25}]}{(1.4623 \text{ m}^3)} = 0.04024 \text{ g/dscm}$$

or

$$= 40.24 \text{ mg/m}^3$$

$$CSO_2 = \frac{K_3 N (V_t - V_{tb}) (V_{soln})}{V_{m(std)} V_a}$$

Where;  $CSO_2$  = Sulfur dioxide concentration, (lbs/dscf)

$$K_3 = 7.061 \times 10^{-5} \text{ Lb/meq}$$

$N$  = Normality of barium perchlorate titrant, g equivalents/liter

$V_t$  = Volume of barium perchlorate titrant used for the sample, ml.

$V_{tb}$  = Volume of barium perchlorate titrant used for the blank, ml.

$V_{soln}$  = Total volume of solution in which the sulfuric acid or sulfur dioxide sample is contained, 250 ml or 1,000 ml respectively

$V_{m(std)}$  = Volume of gas sample measured by the dry gas meter corrected to standard conditions, dscf.

$V_a$  = Volume of sample aliquot titrated (10 ml for  $SO_2$ )

$$\text{Run \# 1: } CSO_2 = 7.061 \times 10^{-5} \left[ \frac{.0100000 ( .40 - .00 ) ( \frac{1000}{10} )}{( 51.880 )} \right] = .0000005400 \text{ lbs./dscf}$$

$$\text{Run \# 2: } CSO_2 = 7.061 \times 10^{-5} \left[ \frac{.0100000 ( 1.25 - .00 ) ( \frac{1000}{10} )}{( 51.640 )} \right] = .0000017100 \text{ lbs./dscf}$$

$$\text{Run \# 3: } CSO_2 = 7.061 \times 10^{-5} \left[ \frac{.0000000 ( .00 - .00 ) ( \frac{0}{0} )}{( 49.090 )} \right] = .0000000000 \text{ lbs./dscf}$$

## Sulfur Dioxide Emissions

## Impinger 2

$$E = CSO_2 \times Q_{sd}$$

Where; E = Emissions of sulfur dioxide in pounds per hour

$Q_{sd}$  = Stack gas flow rate (dscf/hr)

$CSO_2$  = Sulfur dioxide concentration (lbs/dscf)

Run # 1:  $E = (.000000540 \text{ lbs/dscf}) ( 2411728 \text{ dscf/hr} ) = 1.30 \text{ lbs/hr}$

Run # 2:  $E = (.000001710 \text{ lbs/dscf}) ( 2417172 \text{ dscf/hr} ) = 4.13 \text{ lbs/hr}$

Run # 3:  $E = (.000000000 \text{ lbs/dscf}) ( 2164470 \text{ dscf/hr} ) = .00 \text{ lbs/hr}$

Emissions of SO<sub>2</sub> PPM (Parts Per Million)

Impinger 2

$$E = \text{CSO}_2 \left| \frac{453.593 \text{ g}}{1 \text{ lb}} \right| \left| \frac{\text{MOL SO}_2}{64 \text{ g SO}_2} \right| \left| \frac{22.4 \text{ l}}{\text{MOL}} \right| \left| \frac{293^\circ \text{K}}{273^\circ \text{K}} \right| \left| \frac{\text{ft}^3}{28.317 \text{ l}} \right| \left| 1,000,000 \right|$$

Where; CSO<sub>2</sub> = Concentration of SO<sub>2</sub> in lbs/dscf  
 453.593 = Conversion to grams  
 MOL SO<sub>2</sub> = Molar conversion for SO<sub>2</sub>  
 22.4 l/MOL = Volumetric molar conversion @ 273°K  
 293°K/273°K = Temperature correction to std conditions  
 28.317 l = Conversion of liters to cubic feet  
 1,000,000 = Conversion to parts per million

Run # 1:

$$E = \frac{.0000005400 \text{ lbs}}{\text{dscf}} \left| \frac{453.593 \text{ g}}{1 \text{ lb}} \right| \left| \frac{\text{MOL SO}_2}{64 \text{ g SO}_2} \right| \left| \frac{22.4 \text{ l}}{\text{MOL}} \right| \left| \frac{293^\circ \text{K}}{273^\circ \text{K}} \right| \left| \frac{\text{ft}^3}{28.317 \text{ l}} \right| \left| 1,000,000 \right| =$$

3.249 ppm

Run # 2:

$$E = \frac{.0000017100 \text{ lbs}}{\text{dscf}} \left| \frac{453.593 \text{ g}}{1 \text{ lb}} \right| \left| \frac{\text{MOL SO}_2}{64 \text{ g SO}_2} \right| \left| \frac{22.4 \text{ l}}{\text{MOL}} \right| \left| \frac{293^\circ \text{K}}{273^\circ \text{K}} \right| \left| \frac{\text{ft}^3}{28.317 \text{ l}} \right| \left| 1,000,000 \right| =$$

10.289 ppm

Run # 3:

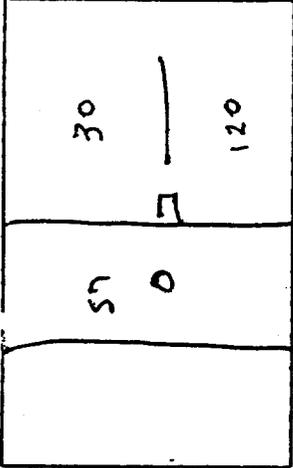
$$E = \frac{.0000000000 \text{ lbs}}{\text{dscf}} \left| \frac{453.593 \text{ g}}{1 \text{ lb}} \right| \left| \frac{\text{MOL SO}_2}{64 \text{ g SO}_2} \right| \left| \frac{22.4 \text{ l}}{\text{MOL}} \right| \left| \frac{293^\circ \text{K}}{273^\circ \text{K}} \right| \left| \frac{\text{ft}^3}{28.317 \text{ l}} \right| \left| 1,000,000 \right| =$$

.000 ppm

## VIII. FIELD DATA

Plant Orthuminous Const Inver

Location CA Offlow Med  
 Operator Spem Turner  
 Date 5-2-86  
 Run No. 1  
 Sample Box No. 670775  
 Meter Box No. 1.79  
 Meter H @ 1.025  
 C Factor .808  
 Pitot Tube Coefficient Cp .808



Ambient Temperature 70  
 Barometric Pressure 30.46 FINAL 590  
 Assumed Moisture, % 2.5 INITIAL 300  
 Probe Length, m(ft) 6 DIFFERENCE 210  
 Nozzle Identification No. 225-25-25  
 Avg. Calibrated Nozzle Dia., (in.) 25/25/25  
 Probe Heater Setting 6.5  
 Leak Rate, m<sup>3</sup>/min. (cfm) .019 at 15 in Oae  
 Probe Liner Material Pynox  
 Static Pressure, mm Hg (in. Hg) 2.05/13.6  
 Filter No. SG-1350

Schematic of Stack Cross Section SG-1348 - Back half

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 <sup>3</sup> S	GAS SAMPLE TEMP. AT DRY GAS METER °F		FILTER HOLDER TEMP °F	GAS TEMP LVG CONDENSER OR LAST IMPINGER °F
							Inlet	Outlet		
1	<del>9:55</del> 9:58	6	151	1.0	2.2	<del>428.5</del> 430.80	70	68	240	60
2	10:01	6	151	1.0	2.2	433.20	86	68	240	60
3	10:04	7	150	1.0	2.2	435.30	90	68	240	55
4	10:07	7	150	1.0	2.2	437.70	94	70	240	55
5	10:10	7	155	.80	1.8	439.90	95	70	260	55
6	10:13	5	155	.60	1.3	441.90	100	74	260	55
7	10:16	5	155	.60	1.3	443.40	100	74	260	55
8	10:19	10	155	.80	1.8	445.40	105	74	260	55
9	10:22	12	157	.90	2.0	447.80	100	76	260	55
10	10:25	12	155	1.0	2.2	450.10	98	78	255	55
11	10:28	12	155	1.0	2.2	452.00	98	78	255	60
12	10:31	12	155	1.0	2.2	454.53	98	78	255	60
1	<del>10:37</del> 10:40	12	150	1.0	2.2	456.90	90	80	255	60

CO<sub>2</sub> = 4.0%  
 O<sub>2</sub> = 14.5%  
 CO<sub>2</sub> = 5.0%  
 O<sub>2</sub> = 12.0%



Plant Bituminous Coast Inc.  
 Location Crofton Md.  
 Operator Sam Luoma  
 Date 5-2-86  
 Run No. 2  
 Sample Box No. 2  
 Meter Box No. 670775  
 Meter H @ 1.74  
 C Factor 1.025  
 Pitot Tube Coefficient Cp .809

Ambient Temperature 70  
 Barometric Pressure 30.46 FINAL 507  
 Assumed Moisture, % 25 INITIAL 493  
 Probe Length, m(ft) 6 DIFFERENCE 14  
 Nozzle Identification No. 003409  
 Avg. Calibrated Nozzle Dia. 6.5 (in.) .25/.25/.25  
 Probe Heater Setting 740  
 Leak Rate, m<sup>3</sup>/min. (cfm) 0.012 at 12"  
 Probe Liner Material PVC  
 Static Pressure, mm Hg (in. Hg) 4.05/13.6  
 Filter No. B-1 SG, 1849

Schematic of Stack Cross Section

SG. 135 (- back half)

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 <sup>3</sup>	GAS SAMPLE TEMP. AT DRY GAS METER °F		FILTER HOLDER TEMP °F	GAS TEMP LVG CONDENSER OR LAST IMPINGER °F
							Inlet	Outlet		
A 1	14:20 <del>14:23</del>	4	146	1.0	2.2	<del>479.90</del> 492.30	85	79	240	60
2	14:26	4	149	1.0	2.2	484.40	96	79	250	60
3	14:29	4	150	.90	2.0	487.00	102	80	225	60
4	14:32	4	150	.90	2.0	499.20	106	80	240	60
5	14:35	4	150	.80	1.8	491.20	108	80	240	60
6	14:38	3	152	.60	1.3	493.20	110	82	245	60
7	14:41	5	148	.60	1.3	495.00	112	82	245	60
8	14:44	4	153	1.70	1.5	497.10	114	82	245	60
9	14:47	6	154	1.0	2.2	499.50	116	84	230	60
10	14:50	6	154	1.0	2.2	501.80	116	84	230	60
11	14:53	6	155	1.0	2.2	504.10	118	86	235	60
12	14:56	7	155	1.0	2.2	506.41	118	86	235	60
(	15:02 <del>15:05</del>	8	151	1.0	2.2	508.91	100	88	235	60

CO2 = 2.0%  
 CO2 = 16.5%  
 CO2 = 2.0%  
 CO2 = 16.5%



Plant Bidwell  
 Location Crafters  
 Operator ADAMS  
 Date 5-3-86  
 Run No. 3  
 Sample Box No. 2  
 Meter Box No. 620775  
 Meter H @ 1.74  
 C Factor 1.025  
 Pitot Tube Coefficient Cp 0.99

Ambient Temperature 70  
 Barometric Pressure 30.40  
 Assumed Moisture, % 25%  
 Probe Length, m(ft) 1.90  
 Nozzle Identification No. 000320  
 Avg. Calibrated Nozzle Dia., (in.) 25/32  
 Probe Heater Setting 6.5  
 Leak Rate, m<sup>3</sup>/min. (cfm) 0.016  
 Probe Liner Material St 72-2  
 Static Pressure, mm Hg (in. Hg) 1.05/13.6  
 Filter No.

AMBIENT TEMP. 70  
 BAROMETRIC PRESSURE 30.40  
 ASSUMED MOISTURE, % 25%  
 PROBE LENGTH, M (FT) 1.90  
 NOZZLE IDENTIFICATION NO. 000320  
 AVG. CALIBRATED NOZZLE DIA., (IN.) 25/32  
 PROBE HEATER SETTING 6.5  
 LEAK RATE, M<sup>3</sup>/MIN. (CFM) 0.016  
 PROBE LINER MATERIAL St 72-2  
 STATIC PRESSURE, MM HG (IN. HG) 1.05/13.6  
 FILTER NO.

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 <sup>3</sup>	GAS SAMPLE TEMP. AT DRY GAS METER °F		FILTER HOLDER TEMP °F	GAS TEMP LVG CONDENSER OR LAST IMPINGER °F
							Inlet	Outlet		
1	<del>8:04</del> 8:07	2	150	.80	1.8	<del>534.4</del> 536.4	58	56	250	40
2	8:10	4	150	1.0	2.2	538.7	72	56	250	40
3	8:13	5	151	1.0	2.2	540.9	80	56	250	40
4	8:16	5	156	.80	1.8	543.0	80	56	250	40
5	8:19	2	159	.40	.90	544.6	86	58	255	45
6	8:22	2	160	.40	.90	546.1	88	58	255	45
7	8:25	2	161	.30	.70	547.5	90	60	255	45
8	8:28	1	157	.40	.90	549.0	90	60	255	50
9	8:31	2	157	.60	1.3	550.7	92	60	255	65
10	<del>8:34</del> 8:37	4	158	1.0	2.2	553.0	96	62	255	50
11	8:37	5	158	1.0	2.2	555.4	96	62	250	50
12	8:40	5	158	1.0	2.2	557.8	100	70	250	50
1	<del>8:46</del> 8:49	4	155	.80	1.8	559.8	80	70	240	50



## **IX. CALIBRATIONS**

RAMCON ENVIRONMENTAL CORPORATION

EPA QA MANUAL VOL. III  
 Section No. 3.4.2  
 Revision No. 0  
 Date January 15, 1980  
 Page 17 of 22

Date 7-12-84 Thermocouple number Hotbox  
 Ambient temperature 25 °C Barometric pressure 29.34 in. Hg  
 Calibrator TURNED Reference: mercury-in-glass   
 other \_\_\_\_\_

Reference point number <sup>a</sup>	Source <sup>b</sup> (specify)	Reference Thermometer Temperature, °C	Thermocouple Potentiometer Temperature, °C	Temperature Difference, % <sup>c</sup>
100°C	boiling H <sub>2</sub> O	100°C	100°C	0%
76°F	Ambient	Mercury 75.8 F	75°C	0.1%
	Ambient 5-2-86	70°F	70°F	0%

<sup>a</sup>Every 30°C (50°F) for each reference point.

<sup>b</sup>Type of calibration system used.

<sup>c</sup>
$$\left[ \frac{(\text{ref temp, } ^\circ\text{C} + 273) - (\text{test thermom temp, } ^\circ\text{C} + 273)}{\text{ref temp, } ^\circ\text{C} + 273} \right] 100 \leq 1.5\%$$

Figure 2.5 stack temperature sensor calibration data form.

## STACK TEMPERATURE SENSOR CALIBRATION DATA FORM

Date 7-13-84 Thermocouple number INLET/OUTLET  
 Ambient temperature 77 °C Barometric pressure 29.34 in. Hg  
 Calibrator Sturmer Reference: mercury-in-glass   
 other \_\_\_\_\_

Reference point number	Source <sup>a</sup> (specify)	Reference thermometer temperature, °C	Thermocouple potentiometer temperature, °C	Temperature difference, % <sup>b</sup>
A	INLET AMBIENT	77°F	77°F	0.0%
B	OUTLET AMBIENT	77°F	77°F	0.0%
C	AMBIENT 5-2-86	70°F	70°F	0%

<sup>a</sup>Type of calibration system used.

<sup>b</sup>
$$\left[ \frac{(\text{ref temp, } ^\circ\text{C} + 273) - (\text{test thermom temp, } ^\circ\text{C} + 273)}{\text{ref temp, } ^\circ\text{C} + 273} \right] 100 \leq 1.5\%$$

## METER BOX CALIBRATION DATA AND CALCULATION FORM

(English units)

Date 5-7-86Meter box number 670775Barometric pressure,  $P_b =$  30.34 in. Hg Calibrated by Sam Tunney

Orifice manometer setting ( $\Delta H$ ), in. H <sub>2</sub> O	Gas volume		Temperature			Time ( $\theta$ ), min	$Y_i$	$\Delta H \theta_i$ in. H <sub>2</sub> O	
	Wet test meter ( $V_w$ ), ft <sup>3</sup>	Dry gas meter ( $V_d$ ), ft <sup>3</sup>	Wet test meter ( $t_w$ ), °F	Dry gas meter					
				Inlet ( $t_{d_i}$ ), °F	Outlet ( $t_{d_o}$ ), °F				Avg <sup>a</sup> ( $t_d$ ), °F
0.5	5	<del>75.89</del> 73.96	76	<del>97</del> 91	<del>82</del> 82	93	12.4	1.018	1.67
1.0	5	<del>75.3</del> 75.75	76	<del>96</del> 92	<del>81</del> 82	92.75	8.87	1.019	1.71
1.5	10								
2.0	10								
3.0	10	<del>742.50</del> 752.50	76	<del>100</del> 95	<del>71</del> 81	93.75	1032	1.026	1.73
4.0	10								
Avg							1.021	1.70	

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

<sup>a</sup> If there is only one thermometer on the dry gas meter, record the temperature under  $t_d$ .

## METER BOX CALIBRATION DATA AND CALCULATION FORM

(English units)

Date 4-18-86Meter box number 670 775Barometric pressure,  $P_b = 30.43$  in. Hg Calibrated by San. Eng. Co.

Orifice manometer setting ( $\Delta H$ ), in. H <sub>2</sub> O	Gas volume		Temperature			Time ( $\theta$ ), min	$Y_i$	$\Delta H \theta_i$ in. H <sub>2</sub> O	
	Wet test meter ( $V_w$ ), ft <sup>3</sup>	Dry gas meter ( $V_d$ ), ft <sup>3</sup>	Wet test meter ( $t_w$ ), °F	Dry gas meter					
				Inlet ( $t_{d_i}$ ), °F	Outlet ( $t_{d_o}$ ), °F				Avg <sup>a</sup> ( $t_d$ ), °F
0.5	5	<del>884.40</del> 889.43	72	<del>98</del> 108	<del>78</del> 80	91	12.05	1.028	1.171
1.0	5	<del>879.20</del> 884.22	72	<del>93</del> 107	<del>78</del> 78	89	9.00	1.025	1.174
1.5	10								
2.0	10								
3.0	10	<del>869.00</del> 878.973	72	<del>85</del> 105	<del>78</del> 78	86.5	10:50	1.023	1.178
4.0	10								
Avg							1.025	1.174	

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

<sup>a</sup> If there is only one thermometer on the dry gas meter, record the temperature under  $t_d$ .

RAMCON

Lear Siegler Stack Sampler

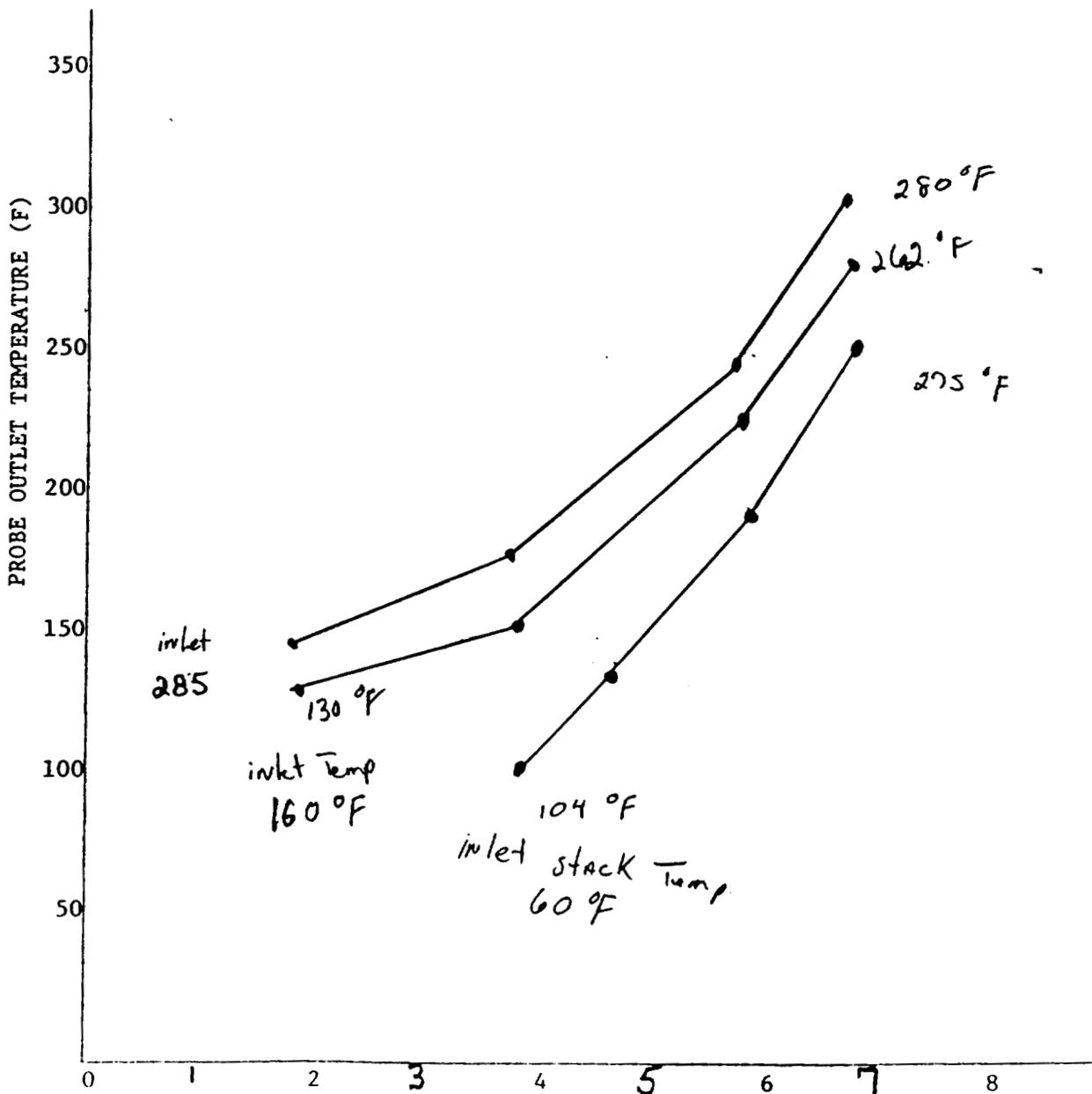
Heating Probe Calibration

Probe No. 61 Probe Length 6'

Date of Calibration 3-24-86 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



RAMCON ENVIRONMENTAL CORPORATION

Lear Siegler Stack Sampler

Nozzle Diameter Calibration

Date \_\_\_\_\_ Signature \_\_\_\_\_

Nozzle No.	Average Diameter	Nozzle No.	Average Diameter
1	_____	7	_____
2	_____	8	_____
3	_____	9	_____
4	_____	10	_____
5	_____	11	_____
6	_____	12	_____

Pitot Tube Calibration (S Type)

Pitot Tube Identification No. 61 Date 6/7/85

Calibrated by: John R. Pigg

"A" SIDE CALIBRATION

Run No.	$\Delta p$ std cm H <sub>2</sub> O (in. H <sub>2</sub> O)	$\Delta p$ (s) cm H <sub>2</sub> O (in. H <sub>2</sub> O)	$C_p$ (s)	DEVIATION $C_p(s) - \bar{C}_p(A)$
1	0.91	1.4	0.806	-0.002
2	0.38	0.58	0.809	+0.001
3	0.45	0.69	0.808	0.00
			$\bar{C}_p$ (SIDE A)	0.808

"B" SIDE CALIBRATION

Run No.	$\Delta p$ std cm H <sub>2</sub> O (in. H <sub>2</sub> O)	$\Delta p$ (s) cm H <sub>2</sub> O (in. H <sub>2</sub> O)	$C_p$ (s)	DEVIATION $C_p(s) - \bar{C}_p(B)$
1	0.91	1.40	0.806	-0.002
2	0.38	0.58	0.809	+0.001
3	0.45	0.69	0.808	0.00
			$\bar{C}_p$ (SIDE B)	0.808

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

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

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

## STACK TEMPERATURE SENSOR CALIBRATION DATA FORM

Date 6-28-85 Thermocouple number 61  
 Ambient temperature 78 °C Barometric pressure 30.33 in. Hg  
 Calibrator SAM TURNER Reference: mercury-in-glass ✓  
 other \_\_\_\_\_

Reference point number	Source <sup>a</sup> (specify)	Reference thermometer temperature, °C	Thermocouple potentiometer temperature, °C	Temperature difference, % <sup>b</sup>
1.	Ice water	32 °F	32 °F	0 %
2.	Boiling water	212	212 °F	0 %
3.	Boiling oil	379.4	381.0	.42 %
	Ambient 5-2-85	70 °F	70 °F	0 %

<sup>a</sup>Type of calibration system used.

<sup>b</sup>
$$\left[ \frac{(\text{ref temp, } ^\circ\text{C} + 273) - (\text{test thermom temp, } ^\circ\text{C} + 273)}{\text{ref temp, } ^\circ\text{C} + 273} \right] 100 \leq 1.5\%$$

**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.