

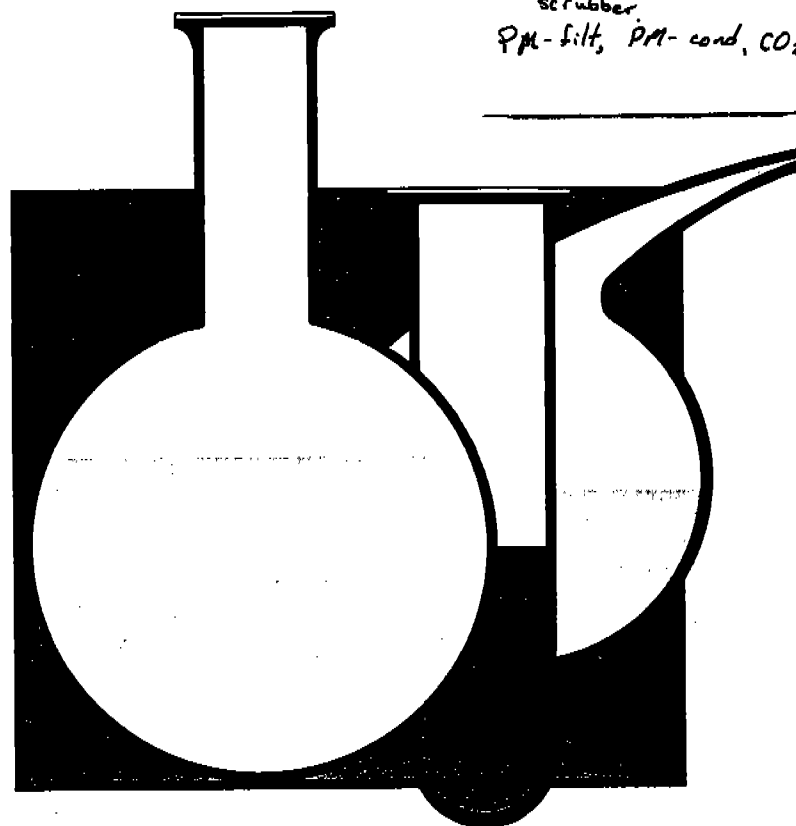
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AP-42 Section 11.17
Reference 2.7
Report Sect. 4
Reference 24

GUARDIAN SYSTEMS INC.

P.O. Box 300
Leeds, Alabama 35094
205/699-6647

3 runs on 1 coal-fired rotary kiln controlled by multi-cyclones and venturi scrubber
PM-filt, PM-cond, CO₂



Test Report

Allied Products Corporation

Lime Kiln #1

Alabaster, Alabama

10/15/91

Compliance Test for State of Alabama (PM)

EPA Methods 1-5

PARTICULATE EMISSION TESTS

CONDUCTED ON

#1 LIME KILN

IN

ALABASTER, ALABAMA

FOR

ALLIED PRODUCTS CORPORATION

ON

OCTOBER 15, 1991

APPROVED BY



Tom Lotz
Director, Field Services

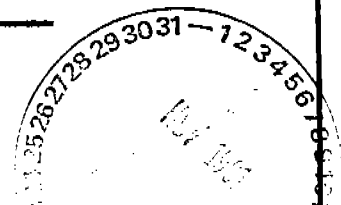
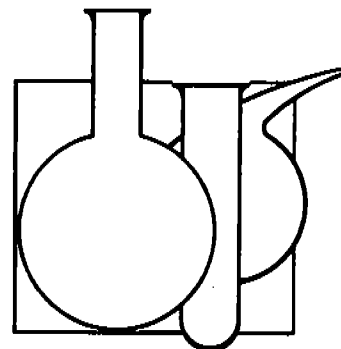


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Introduction



I. INTRODUCTION AND PROCESS DESCRIPTION

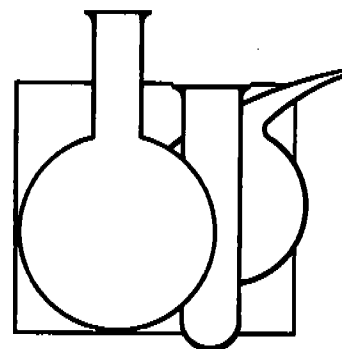
On October 15, 1991, Guardian Systems Inc., performed a series of particulate emission tests on the #1 Rotary Lime Kiln stack of Allied Products Corporation located near Alabaster, Alabama. These tests were conducted in accordance to the rules and regulation expressed in the Code of Federal Regulations, Title 40, Section 60, Reference Methods 1-5, as amended. The purpose of these tests were to determine if this unit is in compliance with the rules and regulations of the Alabama Department of Environmental Management (ADEM).

Raw carbonate material moves through the heated revolving kiln to drive off carbon dioxide and form the lime product. The emissions from the kiln were passed through a multiclone to remove the larger particles, then through a venturi scrubber to remove the smaller ones prior to be vented to the atmosphere.

The following personnel were present during the actual field sampling and represented the companies indicated:

Mr. Joe Dial	Allied Products (205) 663-2471
Mr. Daniel Price	ADEM
Mr. Tom Gravlee	Guardian Systems, Inc
Mr. Robert Scoggins	Guardian Systems, Inc

Test Results



II. SUMMARY OF TEST RESULTS

The following is a summary of the test results conducted on the #1 Kiln stack on October 15, 1991. All production data was supplied by Allied Products personnel (See Plant Operational Data). The allowables were computed from the following formula:

$$E = 3.59 (P)^{.62} \text{ for } P \text{ less than } 30 \text{ ton/hr}$$

Kiln #1

Feed

Run Number	1	2	3	Composite
Process Weight, Tons/hr	22.98	22.88	22.88	22.91
Particulate Mass Rate #/hr	11.07	12.70	9.37	11.07
Allowable Mass Rate #/hr	25.07	25.00	25.00	25.02
% of Allowable	44%	51%	37%	44%
Venturi DP, in H ₂ O	15.0	15.0	15.0	15.0

Feed weight includes coal ($\sim 3 \text{ tons/h}$)

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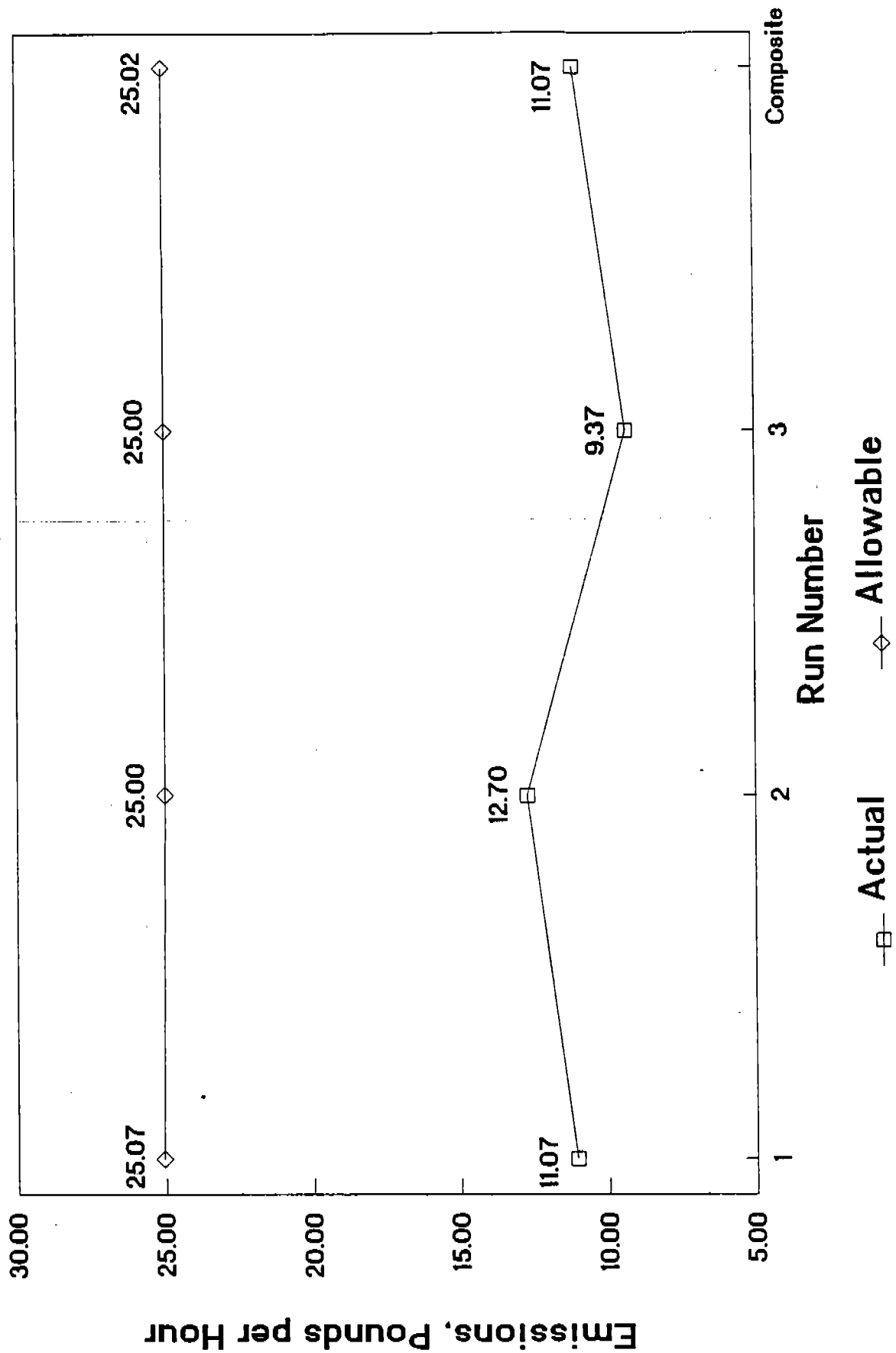
Summarized Air Test Results for Allied Products

Run Number	1	2	3	Composite
Date	10/14/91	10/14/91	10/14/91	10/14/91
Location	Kiln #1	Kiln #1	Kiln #1	Kiln #1
Time	1044-1534	1044-1534	1044-1534	1044-1534
Stack Gas Temperature, F	145	141	143	143
Moisture Content, % v/v	21.54	20.21	19.92	20.57
Oxygen Content, % v/v	11.00	10.50	11.50	11.00
Carbon Dioxide Content, % v/v	14.50	13.50	15.00	14.33
Carbon Monoxide, % v/v	0.00	0.00	0.00	0
Excess Air, %	126.90	109.79	145.50	126.26
Stack Gas Velocity Feet per Second	42.75	42.95	43.30	43.00
Volumetric Flow Actual Cubic Feet per Minute	50,369	50,596	51,011	50,661
Volumetric Flow Dry Std Cubic Feet per Minute	33,778	34,743	35,034	34,512
Concentration Particulate Grains per Dry Std Cubic Ft	0.038	0.043	0.031	0.037
Allowable Concentration Grains per Dry Std Cubic Ft	0.012	0.012	0.012	0.012
Concentration Particulate Grains per Actual Cubic Foot	0.026	0.029	0.021	0.025
Particulate Mass Rate, #/hr	11.07	12.70	9.37	11.07
Allowable Mass Rate, #/hr	25.07	25.00	25.00	25.02
% Isokinetic	105.62	103.03	99.26	102.61

Table 1

ALLIED PRODUCTS KILN #1 PARTICULATE EMISSIONS

On October 15, 1991



Graph 1

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Computer Input Parameters for Allied Products

Run Number	1	2	3	Composite
Date	10/15/91	10/15/91	10/15/91	10/15/91
Location	Kiln #1	Kiln #1	Kiln #1	Kiln #1
Time	0929-1050	1126-1249	1347-1500	092-1500
Barometric Pressure, in Hg	29.34	29.34	29.34	29.34
Static Pressure, in H2O	-0.50	-0.43	-0.49	-0.473
Run Time, minutes	60.00	60.00	60.00	180.00
Meter Volume, CF	38.063	38.532	37.971	114.566
Meter Correction factor, MCF	1.0889	1.0889	1.0889	
Meter Volume (Corrected)	41.447	41.957	41.347	124.751
Stack Temperature, F	145	141	143	143
Meter Temperature, F	97	102	110	103
Meter Pressure, in H2O	1.35	1.38	1.32	1.35
Sqr Velocity Pressure	0.713	0.719	0.727	0.720
Mass of Particulate, mg	96.0	107.4	76.4	279.8
MI of Water Collected	225.5	208.7	199.1	633.3
% Oxygen	11.00	10.50	11.50	11.00
% Carbon Dioxide	14.50	13.50	15.00	14.33
% Carbon Monoxide	0.00	0.00	0.00	0.00
Stack Area, Sq ft	19.635	19.635	19.635	19.635
Pitot Correction Factor	0.817	0.817	0.817	0.817

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Computer Input Parameters for Allied Products

Run Number	1	2	3	Composite
Date	10/14/91	10/14/91	10/14/91	10/14/91
Location	Kiln #1	Kiln #1	Kiln #1	Kiln #1
Time	1044-1534	1044-1534	1044-1534	1044-1534
Nozzle Diameter, in	0.255	0.255	0.255	0.255
Feed Rate, Ton/hr	22.98	22.88	22.88	22.91
Venturi Pressure Drop, in H2O	15.0	15.0	15.0	15.0

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Computed Results for Allied Products

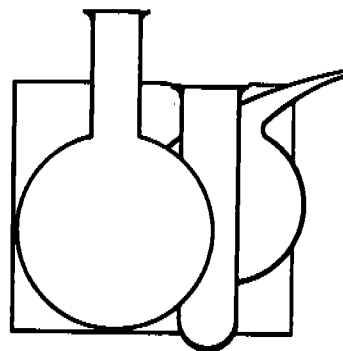
Run Number	1	2	3	Composite
Date	10/14/91	10/14/91	10/14/91	10/14/91
Location	Kiln #1	Kiln #1	Kiln #1	Kiln #1
Time	1044-1534	1044-1534	1044-1534	1044-1534
1. Stack Pressure				
Inches Hg	29.30	29.31	29.30	29.31
Millimeters Hg	744.30	744.43	744.32	744.35
2. Meter Pressure				
Inches Hg	29.44	29.44	29.44	29.44
Millimeters Hg	747.76	747.82	747.71	747.76
3. Meter Volume				
Dry Std Cubic Feet	38.658	38.789	37.682	115.116
Dry Std Cubic Meters	1.095	1.099	1.067	3.260
4. Water Volume				
Std Cubic Feet	10.614	9.824	9.372	29.809
Std Cubic Meters	0.301	0.278	0.265	0.844
5. Moisture Content, %	21.54	20.21	19.92	20.57
6. Molecular Weight Dry	30.76	30.58	30.86	30.73
7. Molecular Weight Wet	28.01	28.04	28.30	28.11
8. Stack Velocity				
Feet per Second	42.75	42.95	43.30	43.00
Meters per Second	13.03	13.09	13.20	13.11
9. Volumetric Flow				
Actual Cubic Ft per minute	50,369	50,596	51,011	50,661
Actual Cubic M per second	23.77	23.88	24.08	23.91
10. Volumetric Flow				
Dry Std Cubic Ft per minute	33,778	34,743	35,034	34,512
Dry Std Cubic M per second	15.94	16.40	16.54	16.29

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Computed Results for Allied Products

Run Number	1	2	3	Composite
Date	10/14/91	10/14/91	10/14/91	10/14/91
Location	Kiln #1	Kiln #1	Kiln #1	Kiln #1
Time	1044-1534	1044-1534	1044-1534	1044-1534
11. Concentration				
Grains per Dry Std Cubic Ft	0.0382	0.0426	0.0312	0.0374
Grams per Dry Std Cubic M	0.0875	0.0976	0.0714	0.0857
12. Excess Air, %	126.90	109.79	145.50	126.26
13. Particulate Concentration adjusted to 50% excess air				
Grains per Dry Std Cubic Ft	0.0557	0.0583	0.0485	0.0545
15. Particulate Mass Rate				
Pounds per Hour, #/hr	11.07	12.70	9.37	11.07
16. Volume at Nozzle				
Actual Cubic Feet	57.654	56.496	54.874	169.006
Actual Cubic Meters	1.633	1.600	1.554	4.786
17. Concentration				
Grains per Actual Cubic Ft	0.0256	0.0293	0.0214	0.0255
Grams per Actual Cubic M	0.0587	0.0670	0.0491	0.0583
18. Isokinetic, %	105.62	103.03	99.26	102.61

Sampling & Analytical Procedures



III. SAMPLING AND ANALYTICAL PROCEDURES

General

All sampling and analytical procedures for the determination of the particulate emissions from this source were conducted in strict adherence with the Code of Federal Regulations, Title 40, Part 60, Appendix A, Methods 1-5, as amended. The sampling equipment to be used in these tests was manufactured by Research Appliance Corporation and was properly calibrated before these tests (See **Calibrations**). The particulate mass was determined gravimetrically after removal of uncombined water.

METHOD 1

This method was used to determine the number of sampling points and the required sampling matrix. The dimension of the sample location (see **Figure 1**) indicated that 24 points would be required to sample this source. We will sample 24 points (12 per diameter) for two and a half minutes at each point. Verification of absence of cyclonic flow was not determined because cyclonic flow does not seem to exist from the stack exhaust.

METHOD 2

Velocity measurements were taken using a properly calibrated S type pitot tube and a 0-10.0 inch inclined vertical manometer, having 0.01 inch H₂O divisions on the 0 to 1 inch inclined scale, and 0.1 inch H₂O divisions on the 1 to 10 inch vertical scale.

METHOD 3

Gas composition for CO₂, O₂, and N₂ by difference was performed twice during each particulate test by using the grab sample technique and analyzed with a Fyrite Gas Analyzer (0-20% scale with 0.5% divisions).

METHOD 4

Moisture content of the stack gases was determined in conjunction with Method 5 for each test by measuring the amount of water collected in the condenser and the increase in weight of the silica gel. These weights were combined to give the total amount of water collected.

METHOD 5

Sampling Techniques

Preliminary data was used to determine stack temperature, pressure, range of velocity heads, moisture content and stack gas dry molecular weight prior to sampling. A Radio Shack PC-4 computer and a TI-55 were used to calculate the sampling rate for isokinetic sampling. The particulate determinations were made by utilizing the sample train in Figure 2. The meter box was leak checked from the pump to the orifice and initial and final leak checks of the sampling system and pitot lines were performed as outlined in Method 5 and were recorded on the data sheets (See Field Data). The nozzle (stainless steel 316 with an angle of taper of 30 degrees and of button hook design) was calibrated before and after each test using a micrometer and was also recorded on the data sheets.

The sampling probe was placed at each sampling point for two and a half minutes to provide a total sampling time of 60 minutes. The gases were drawn through a stainless steel nozzle attached to a heated glass lined probe. The probe was maintained at the proper setting to obtain an exit temperature of $248 \pm 25^{\circ} \text{F}$ (See Calibrations). The gases then pass through a glass fiber filter (Gelman, Class A) of 0.3 micron retention to remove particulate matter. The filter was maintained at a temperature of $248 \pm 25^{\circ} \text{F}$. These temperatures were recorded at each point on the data sheets.

The gases then pass through a condenser placed in an ice bath to maintain a maximum exit temperature of 68°F . This temperature was also recorded on the data sheets. The gases then pass through a pre-weighed drying column filled with indicating silica gel to remove any remaining moisture. The clean and cool gases then entered the meter box where the gas flow and temperature were measured. (See Field Data)

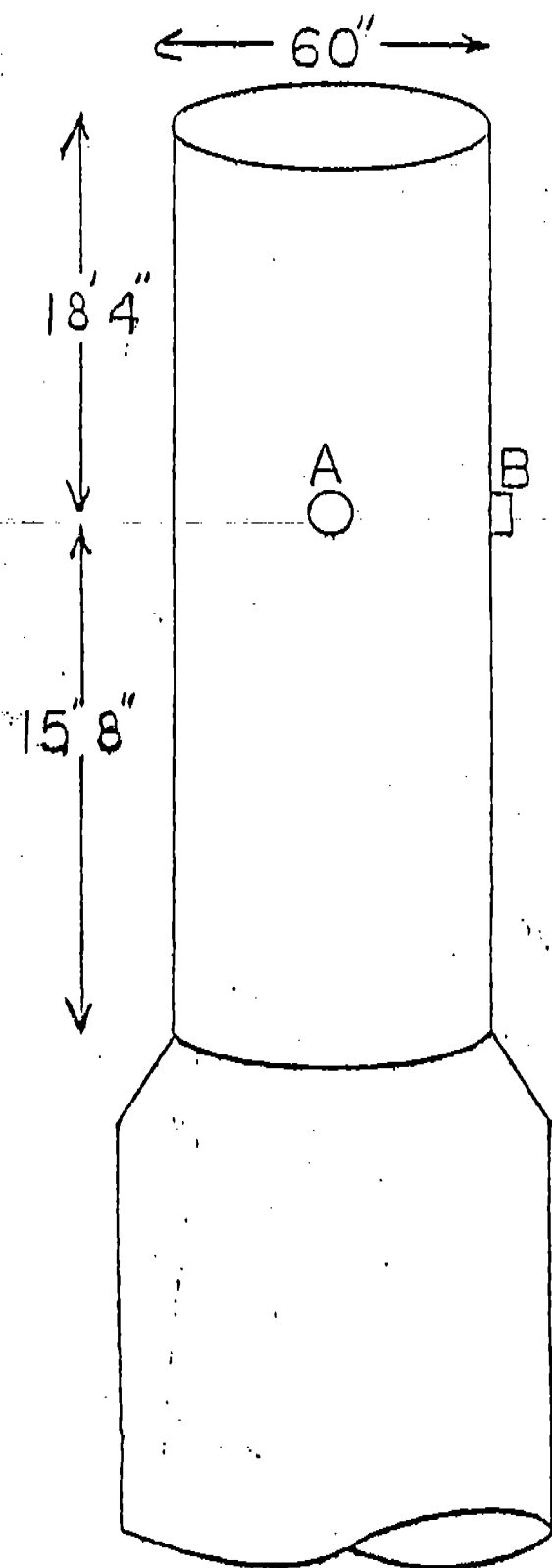
Upon completion of the sampling and the final leak checks, the sampling train and the probe nozzle assembly was transferred to the cleanup area making sure no particulate was lost. The cleanup data was recorded on **Particulate Sample Recovery and Integrity Sheet** located in the Field Data Section.

Particulate catches were placed in sealed petri dishes. Each acetone rinse from the nozzle, probe, and filter holder was combined and placed in a sealed container. For the group of tests an acetone blank of approximately 200 milliliters was placed in a sealed container. These containers were clearly marked and transported to our laboratory for analysis.

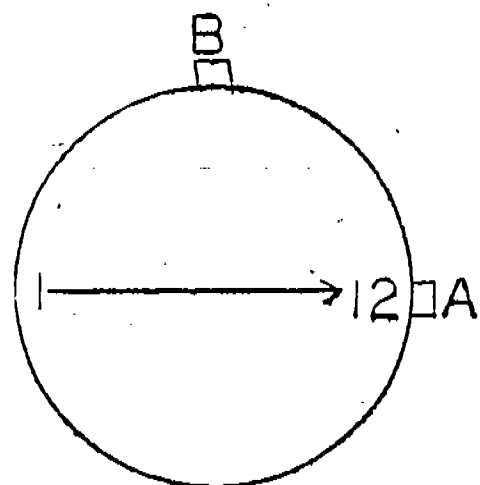
Analysis

The filters (Gelman, Class A, without organic binder, minimum 99.9% retention for particles of 0.3 microns as determined by DOP tests) were prepared for the field test by first heating for 2 hours 220 degrees F then desiccating at $68 \pm 10^{\circ}$ F at ambient pressure for 24 hours and weighing at intervals of at least six (6) hours to a constant weight to the nearest 0.1 milligrams (less than 0.5 milligrams change from previous reading). Upon return to the laboratory, the filters were subjected to the same procedures as outlined above. The weights were recorded in a bound laboratory book and transferred to the sheets in this report (**Method 5 Train Analytical Particulate Data**). During each weighing the filter was not exposed to laboratory atmosphere for more than two (2) minutes and a relative humidity of less than fifty percent (50%).

The acetone (reagent grade, 0.001% residue, in glass bottles) blank (**Blank Analytical Data**) for the group of tests and the acetone rinses for each test were evaporated to dryness in tared glass beakers. They were then desiccated for twenty-four (24) hours and weighed to a constant weight as described above.



STACK BREECHING & SAMPLING LOCATION

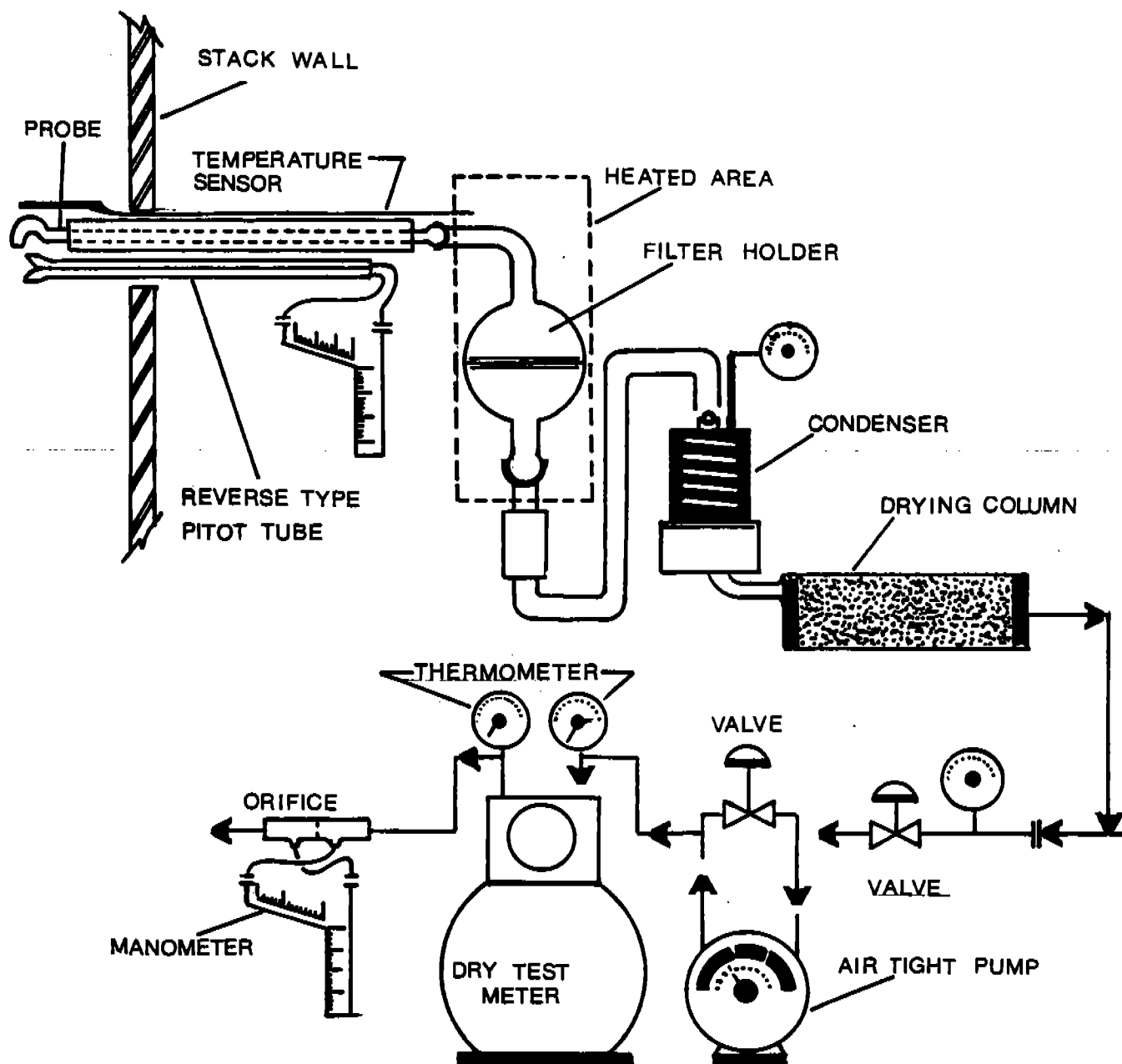


POINT DISTANCE TO WALL

1	5.3"
2	8.0"
3	11.1"
4	14.6"
5	19.0"
6	25.3"
7	42.7"
8	49.0"
9	53.4"
10	56.9"
11	60.0"
12	62.7"

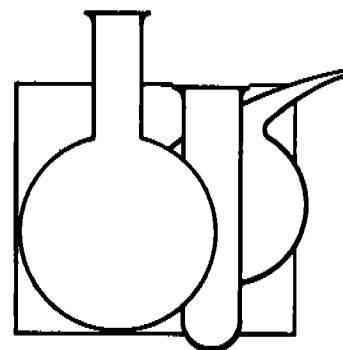
INCLUDES 4" Nipple

Figure 1



PARTICULATE SAMPLING TRAIN.. METHOD 5

Field Data



NOMENCLATURE

ACF -	Actual Cubic Feet
ACFM -	Actual Cubic Feet per minute
ACM -	Actual Cubic Meters
ACMS -	Actual Cubic Meters per second
An -	Cross sectional area of nozzle, (ft ²)
As -	Area of Stack, (ft ²)
Bws -	Water vapor in the gas stream, proportion by volume (dimensionless)
C _a -	Acetone blank residue concentration, mg/g
c _a -	Particulate Concentration, ACF
CFM -	Cubic feet per minute
C _p -	Pitot tube coefficient, (dimensionless)
c _s -	Particulate Concentration, grains/DSCF
C _{so₂} -	Concentration of sulfur dioxide (dry basis) corrected to standard conditions, lb/DSCF
C ₁₂ -	Particulate concentration (c _s adjusted to 12% excess air), grains/DSCF
C ₅₀ -	Particulate concentration (c _s adjusted to 50% excess air), grains/DSCF
DSCF -	Dry Standard Cubic Feet
DSCFM -	Dry Standard Cubic Feet per minute
DSCM -	Dry Standard Cubic Meters
DSCMS -	Dry Standard Cubic Meters per second
EA -	Excess Air, %
I -	Isokinetic Sampling, %

NOMENCLATURE - continued

Km -	Orifice Correction Factor, (dimensionless)
Kp -	Pitot tube constant, $85.49 \frac{(\text{lb/lb-mole})(\text{in.Hg})^{1/2}}{(^{\circ}\text{R})(\text{in. H}_2\text{O})}$
La -	Maximum acceptable leakage rate for either a pretest leak check or for a leak check following a component change; equal to 0.02 CFM or 4 percent of the average sampling rate, whichever is less.
Li -	Individual leakage rate observed during the leak check conducted prior to the "i th " component change (i = 1,2,3,...n), CFM.
Lp -	Leakage rate observed during the post test leak check, ft ³ /min. (cfm).
Ma -	Mass of residue of acetone after evaporation, mg.
Md -	Molecular weight of stack gas; dry basis, lb/lb-mole.
Mn -	Total amount of particulate matter collected, mg.
Ms -	Molecular weight of stack gas; wet basis, lb/lb-mole.
Mw -	Molecular weight of water, 18.0g/g-mole(18.01lb/lb-mole)
ΔP -	Velocity head of stack gas, in. H ₂ O
Pa -	Density of acetone, mg/ml
Pbar -	Barometric pressure at the sampling site, in. Hg
Pg -	Stack static pressure, in. H ₂ O
Pm -	Meter pressure, in. Hg
PMR -	Particulate Mass Rate, lbs per hour
Ps -	Absolute stack pressure, in. Hg
Pstd -	Standard absolute pressure, 29.92 in. Hg
Pw -	Density of water, 0.9982 g/ml (0.002201 lb/ml)
Qa -	Volumetric flow rate, ACFM

NOMENCLATURE - continued

- Qs - Volumetric flow rate, DSCFM
- R - Ideal gas constant, 0.06236 mm Hg - m³/°K-g-mole (21.85 in. Hg-ft³/°R-lb-mole)
- SCF - Standard Cubic Foot
- ta - Ambient Temperature, °F
- tm - Average Temperature of meter, °F
- ts - Average Temperature of stack, °F
- tstd - Standard Temperature, 68°F

NOTE: Capital "T" denotes degrees Rankin

- Va - Volume of acetone blank, ml
- Vaw - Volume of acetone used in wash, ml
- Vlc - Total volume of liquid collected in condenser and silica gel, ml
- Vm - Volume of gas sample, as measured by the dry gas meter, ACF
- Vmc - Volume of gas sample, corrected for leak, ACF
- Vm(std) - Volume of gas sample measured by the dry gas meter, corrected to standard conditions, DSCF
- Vn - Volume collected at stack conditions through nozzle, ACF
- Vs - Average stack gas velocity, ft/sec.
- Vw(std) - Volume of water in the gas sample, corrected to standard conditions, SCF
- Wa - Weight of residue in acetone wash, mg
- Y - Dry gas meter calibration factor, (dimensionless)
- ΔH - Average pressure differential across the calibrated orifice, in. H₂O

NOMENCLATURE - continued

- ΔH_s - Value of H measured for a specific orifice when operated under the following conditions: 0.75 cfm of dry air (M.W. = 29) at 68°F, 29.92 in. Hg.
- $\sqrt{\Delta P}$ - Average of the square roots of the velocity pressure, in. H₂O
- Θ - Total Sampling time, min.
- Θ_1 - Sampling time interval from the beginning of a run until the first component change, minutes.
- Θ_i - Sampling time interval between two successive component changes, beginning with the interval between the first and second changes, minutes.
- Θ_p - Sampling time interval from the final (n^{th}) component change until the end of the sampling run, minutes.
- %CO₂, %O₂, %N₂, %CO - Number percent (%) by volume (dry basis) of each compound in the stack gas.

EQUATIONS

1.

$$P_s = P_{b_{sr}} + \frac{P_g}{13.6}$$

2.

$$P_m = P_{b_{sr}} + \frac{\Delta H}{13.6}$$

3.

$$V_m(std) = V_m Y \left(\frac{T_{std}}{T_m} \right) \left(\frac{P_m}{P_{std}} \right)$$

4.

$$V_w(std) = 0.04707 V_{I_c}$$

5.

$$B_{w_s} = \frac{V_w(std)}{V_m(std) + V_w(std)}$$

6.

$$M_d = 0.440 (\%CO_2) + 0.320 (\%O_2) + 0.280 (\%N_2 + \%CO)$$

7.

$$M_g = M_d (1 - B_{w_s}) + 18 (B_{w_s})$$

EQUATIONS - Continued

8.

$$v_s = K_p C_p (\sqrt{\Delta P}) \text{ avg. } \sqrt{\frac{T_s}{M_s P_s}}$$

9.

$$Q_a = (v_s) (A_s) (60)$$

10.

$$Q_s = Q_a (1 - B_{w_s}) \left(\frac{528}{T_s} \right) \left(\frac{P_s}{29.92} \right)$$

11.

$$c_s = [0.0154 (Mn/Vmstd)]$$

12.

$$EA = \left[\frac{\%O_2 - 0.5\%CO}{0.264\%N_2 - (\%O_2 - 0.5\%CO)} \right] 100$$

13.

$$C_{s_0} = C_s / 1 - \left[\frac{(1.5)(\%O_2) - 0.133(\%N_2) - 0.75(\%CO)}{21} \right]$$

14.

$$C_{1_2} = C_s \frac{12}{\%CO_2}$$

EQUATIONS - Continued

15.

$$PMR = (C_s) (Q_s) \left(\frac{60}{7000} \right)$$

16.

$$V_n = \frac{T_s}{P_s} \left[(0.002669) (V_{1c}) + \frac{V_m}{T_m} (P_m) \right]$$

17.

$$C_a = (0.0154) (M_n) / V_n$$

18.

$$I = \frac{100 V_n}{60 v_s \theta A n}$$

19.

$$V_{m_c} = V_m - (L_p - L_a) \theta$$

20.

$$W_a = C_a V_a w P_a$$

HAND EQUATIONS

Run # 1

$$1. P_s = P_{bar} + (P_g/13.6) = (29.34) + (-.02)/13.6 = 29.303 \checkmark$$

$$2. P_m = P_{bar} + (\Delta H/13.6) = (29.34) + (1.15)/13.6 = 29.439 \checkmark$$

$$3. V_{m(std)} = V_m Y (T_{std}/T_m) (P_m/P_{std}) \\ = (38.06) (1.058) (528/557) (29.439/29.92) = 38.6572 \checkmark$$

97460

$$4. V_{w(std)} = 0.04707 V_{lc} = 0.04707 (225.5) = 10.6143 \checkmark$$

$$5. B_{ws} = V_{w(std)} / (V_{m(std)} + V_{w(std)}) = (10.6143) / (38.6572 + 10.6143) = .2154 \checkmark$$

$$6. M_d = 0.44 \%CO_2 + 0.32 \%O_2 + 0.28(\%N_2 + \%CO) = \\ .44(14.5) + .32(1) + .28(74.5) = 30.76 \checkmark$$

$$7. M_s = M_d (1-B_{ws}) + 18(B_{ws}) = (30.76)(1-.2154) + 18(.2154) = 28.01 \checkmark$$

.7846

$$8. v_s = K_p C_p (\sqrt{\Delta p}) \sqrt{(T_s/(M_s P_s))} \\ = 85.49 (.817) (1.713) \sqrt{(605/(28.01)(29.303))} = 42.755 \checkmark$$

1457460

$$9. Q_s = v_s A_s (60) = (42.755) (19.655) (60) = 50,370 \checkmark$$

(60/24) 24 =

$$10. Q_g = Q_s (1-B_{ws}) (528/T_s) (P_s/29.92) \\ = (50370) (1-.2154) (528/605) (29.303/29.92) = 33,779 \checkmark$$

.7846

$$11. c_s = 0.0154 (M_n/V_{m(std)}) = 0.0154 (96/38.6572) = .0382 \checkmark$$

$$15. PMR = c_s Q_s (60/7000) = (.0382) (33775) (60/7000) = 11.07 \checkmark$$

$$16. V_n = T_s/P_s \times \{(0.002669)V_{lc} + V_m Y P_m/T_m\} \\ = (605/29.102) \{(0.002669)(225.5) + (1)(1)(1)\} = 57.6537 \checkmark$$

38.06 1.058 528/557

HAND EQUATIONS - Continued

$$18.1 = V_n(100)/\{(60)\Theta v_s A_n\} = 100 \left(\frac{57.6537}{1} \right) / \{60(60) \left(\frac{42.753}{1} \right) \left(\frac{10354}{1} \right)\} = 105.81 \checkmark$$

$$\left(\frac{.253}{24} \right) \frac{2}{11} = .0002$$

FIELD DATA SHEET

PLANT

Allred-Alabaster

RUN #

1

LOCATION

1

DATE

10-15-91

BARO. PRES.

29.34

TIME

925-10:50

GUARDIAN SYSTEMS INC.

BOX 190

LEEDS, ALABAMA 35094

	TIME		METER VOL FT 3	STACK TEMP OF	METER TEMP. OF			IMP TEMP OF	BOX TEMP OF	METER PRESSURE "H ₂ O	VELOCITY PRESSURE "H ₂ O	VACUUM PRESSURE "Hg	STATIC PRESSURE "H ₂ O	
	MIN	DUR			IN	OUT	AVG							
			942.609	0	②	②		④	⑤				- .50	
													PROBE TIP SIZE	
													BEFORE	AFTER
A1	2.5	2.5	944.5	154	90	88	89	35	241	1.90	.76	0	.255	.255
2	5.0		946.4	151	92	90	91	37	249	1.94	.77	2.5	.255	.255
3	7.5		948.3	148	96	91	94	44	265	2.09	.82	3.5	.255	.255
4	10.0		950.2	158	100	92	96	46	262	2.01	.80	6.0		
5	12.5		952.2	156	102	92	97	47	264	1.95	.77	7.0	#5 WATER	
6	15.0		953.8	152	104	93	99	47	263	1.35	.53	6.5	ml.	215
7	17.5		955.0	151	104	93	99	46	263	.84	.33	4.5	gram	10.5
8	20.0		956.6	145	103	94	99	43	263	1.27	.49	8.0	Total	225.5
9	22.5		958.2	146	104	94	99	47	263	1.32	.51	9.5	OPERATOR	
10	25.0		959.7	146	104	94	99	49	265	1.26	.49	10.0	Gravlee	
11	27.5		961.2	147	104	95	100	50	265	1.21	.47	11.0	Sample Box No. 2	
12	30.0		962.7	144	105	95	100	50	265	1.09	.42	11.0	Meter Box No. 400	
LB1	32.5		964.402 964.623	158	101	95	98	45	259	1.57	.62	15.5	Meter ΔH@ 1.55	
2	35.0		966.3	145	96	95	96	36	230	1.59	.62	0	Pitot, CP .817	
3	37.5		968.0	144	99	97	98	42	238	1.52	.59	0	Temp. Device 211	
4	40.0		969.8	144	103	98	101	47	241	1.56	.60	1.0	Probe No. 5.2	
5	42.5		971.6	144	106	98	102	49	246	1.64	.63	2.5	Probe Liner 55	
6	45.0		973.5	145	109	99	104	50	253	1.67	.64	3.0	Probe Htr. Set 70	
7	47.5		974.4	145	110	99	105	49	263	.35	.15	0	Ambient Temp. 67	
8	50.0		975.4	147	108	100	104	45	263	.62	.24	1.0	% O ₂ 12/10	
9	52.5		976.8	146	107	99	103	46	263	.99	.38	3.0	% CO ₂ 14/15	
10	55.0		978.2	146	107	100	104	48	263	1.07	.41	3.5	NOTES	
11	57.5		979.4	146	107	100	104	49	264	.78	.30	3.0	Orifice ✓ 5" H ₂	
12	60.0		980.893	130	107	100	104	47	266	.78	.29	3.5	Pitot R 6.1 55.5	
			38.063	147			99			1.350	.713		Meter	
leak			965.585	145			97						Final leak	
leak			965.583										✓ @ 5" H ₂	
													980.936	
													980.928	
													.008	

FIELD DATA SHEET

DLR
10/15/91
Run 2

PLANT

Allied-Alabaster

RUN #

2

LOCATION

#1

DATE

10-15-91

BARO. PRES.

29.34

TIME

1126-1249

GUARDIAN SYSTEMS INC.

BOX 190

LEEDS, ALABAMA 35094

	TIME		METER VOL FT 3	STACK TEMP OF	METER TEMP. OF			IMP TEMP OF	BOX TEMP OF	METER PRESSURE "H2O	VELOCITY PRESSURE "H2O	VACUUM PRESSURE "Hg	STATIC PRESSURE "H2O	
	MIN	DUR			IN	OUT	AVG							
			981.664	⑤	②	③		④	⑤				-43	
													PROBE TIP SIZE	
													BEFORE	AFTER
A1	2.5	2.5	983.5	142	98	98	98	36	263	1.81	.70	0	.255	.255
2	5.0		985.4	142	102	100	101	37	265	1.82	.70	1.0	.255	.255
3	7.5		987.3	143	107	101	104	38	267	1.96	.75	2.0	.255	.255
4	10.0		989.3	143	110	101	106	38	268	1.99	.76	4.0		
5	12.5		991.2	144	113	102	108	39	271	2.00	.76	6.0		
6	15.0		992.8	144	114	102	108	39	267	1.39	.53	6.0		
7	17.5		994.0	144	114	102	108	38	267	.79	.30	4.0		
8	20.0		995.5	144	112	102	107	37	268	1.21	.46	7.0		
9	22.5		997.1	145	111	102	107	39	268	1.31	.50	8.5		
10	25.0		998.7	144	111	102	107	39	269	1.26	.48	10.0		
11	27.5		1000.2	144	111	102	107	39	268	1.18	.45	10.5		
12	30.0		1001.566 1001.789	142	111	102	102	39	269	.97	.37	10.0		
B1	32.5		1003.5	141	99	98	99	36	257	1.60	.64	0		
2	35.0		1005.4	143	99	99	99	36	263	1.63	.63	1.0		
3	37.5		1007.1	143	102	100	101	37	256	1.59	.61	2.0		
4	40.0		1008.8	143	104	100	102	37	263	1.67	.64	3.5		
5	42.5		1010.6	143	106	100	103	38	263	1.70	.65	5.0		
6	45.0		1012.5	145	107	100	104	38	266	1.72	.66	6.0		
7	47.5		1013.5	141	108	100	104	39	263	.54	.22	2.0		
8	50.0		1014.7	143	108	100	104	38	265	.81	.31	4.0		
9	52.5		1016.2	145	107	100	104	38	267	1.07	.41	6.0		
10	55.0		1017.6	145	107	100	104	38	267	1.12	.43	7.0		
11	57.5		1019.2	145	107	100	104	38	264	1.17	.45	8.5		
12	60.0	✓	1020.419	126	108	100	104	39	266	.81	.30	7.0		
			38.532	143			104			1.384	.719			
			1001.640 1001.634	④			④							

WATER

#7

ml. 20.2

gram 6.7

Total 208.7

OPERATOR

Grader

Sample Box No. 2

Meter Box No. 400

Meter ΔH@ 1.55

Pitot, CP 817

Temp. Device 211

Probe No. 5-2

Probe Liner 35

Probe Htr. Set 70

Ambient Temp. 68

% O₂ 10/11% CO₂ 12/15

NOTES

Orifice ✓

Pitot 28.255

Meter

Frail/leak

✓ 100"

1020.486

1020.481

.005

FIELD DATA SHEET

DIB
10/15/91
Run 2
 PLANT Allied-Alabaster RUN # 2
 LOCATION #1 DATE 10-15-91
 BARO. PRES. 29.34 TIME 1126-1249

GUARDIAN SYSTEMS INC.

BOX 190
LEEDS, ALABAMA 35094

	TIME		METER VOL FT 3	STACK TEMP OF	METER TEMP. OF			IMP TEMP OF	BOX TEMP OF	METER PRESSURE H ₂ O	VELOCITY PRESSURE H ₂ O	VACUUM PRESSURE H _g	STATIC PRESSURE H ₂ O	
	MIN	DUR			IN	OUT	AVG						-43	
			981.664	⑤	②	③		④	⑤				PROBE TIP SIZE	
													BEFORE	AFTER
A1	2.5	2.5	983.5	142	98	98	98	36	263	1.81	.70	0	.255	.255
2	5.0		985.4	142	102	100	101	37	265	1.82	.70	1.0	.255	.255
3	7.5		987.3	143	107	101	104	38	267	1.96	.75	2.0	.255	.255
4	10.0		989.3	143	110	101	106	38	268	1.99	.76	4.0		
5	12.5		991.2	144	113	102	108	39	271	2.00	.76	6.0	WATER	
6	15.0		992.8	144	114	102	108	39	267	1.39	.53	6.0		
7	17.5		994.0	144	114	102	108	38	267	.79	.30	4.0		
8	20.0		995.5	144	112	102	107	37	268	1.21	.46	7.0		
9	22.5		997.1	145	111	102	107	39	268	1.31	.50	8.5	OPERATOR	
10	25.0		998.7	144	111	102	107	39	269	1.26	.48	10.0		
11	27.5		1000.2	144	111	102	107	39	268	1.18	.45	10.5		
12	30.0		1001.566 1001.789	142	111	102	102	39	269	.97	.37	10.0		
B1	32.5		1003.5	141	99	98	99	36	257	1.60	.64	0	Sample Box No. <u>2</u> Meter Box No. <u>400</u> Meter ΔH ₀ <u>1.55</u> Pitot, CP <u>.817</u> Temp. Device <u>211</u> Probe No. <u>5-2</u> Probe Liner <u>35</u> Probe Htr. Set <u>70</u> Ambient Temp. <u>68</u> % O ₂ <u>10/11</u> % CO ₂ <u>12/15</u>	
2	35.0		1005.4	143	99	99	99	36	263	1.63	.63	1.0		
3	37.5		1007.1	143	102	100	101	37	256	1.59	.61	2.0		
4	40.0		1008.8	143	104	100	102	37	263	1.67	.64	3.5		
5	42.5		1010.6	143	106	100	103	38	263	1.70	.65	5.0		
6	45.0		1012.5	145	107	100	104	38	266	1.72	.66	6.0		
7	47.5		1013.5	141	108	100	104	39	263	.58	.22	2.0		
8	50.0		1014.7	143	108	100	104	38	265	.81	.31	4.0		
9	52.5		1016.2	145	107	100	104	38	267	1.07	.41	6.0		
10	55.0		1017.6	145	107	100	104	38	267	1.12	.43	7.0		
11	57.5		1019.2	145	107	100	104	38	264	1.17	.45	8.5		
12	60.0	✓	1020.49	126	108	100	104	39	266	.81	.30	7.0		
			38.532	143			104			1.384	.719		NOTES Orifice ☒ Pitot <u>R8.255</u> Meter <u>Frac/Leak</u> <u>✓ 100"</u> <u>1020.486</u> <u>1020.481</u> <u>.005</u>	
			1001.640				102							
			1001.634											

FIELD DATA SHEET

PLANT

Allied-Alabaster

RUN

3

LOCATION

#1

DATE

10-15-91

BARO. PRES.

29.34

TIME

1347-1500

GUARDIAN SYSTEMS INC.

BOX 190

LEEDS, ALABAMA 35094

	TIME		METER VOL FT 3	STACK TEMP OF	METER TEMP. OF			IMP TEMP OF	BOX TEMP OF	METER PRESSURE "H ₂ O	VELOCITY PRESSURE "H ₂ O	VACUUM PRESSURE "Hg	STATIC PRESSURE "H ₂ O	
	MIN	DUR			IN	OUT	AVG							
			21.734	①	②	③		④	⑤				-49	
													PROBE TIP SIZE	
													BEFORE	AFTER
B1	2.5	2.5	23.4	145	103	103	103	38	264	1.54	.64	0	-255	.255
2	5.0		25.2	143	104	105	105	39	266	1.60	.66	1.0	-255	.255
3	7.5		26.9	143	108	105	107	40	267	1.53	.63	2.0	-255	.255
4	10.0		28.6	143	110	105	108	40	266	1.56	.64	3.0		
5	12.5		30.4	142	112	106	109	40	269	1.66	.68	5.0	#11 WATER	
6	15.0		32.1	144	114	107	111	41	269	1.64	.67	6.0	ml.	195
7	17.5		33.2	141	116	107	112	42	269	.47	.19	1.0	gram	4.1
8	20.0		34.3	144	115	108	112	40	270	.81	.33	3.5	Total	199.1
9	22.5		35.7	146	115	108	112	40	266	1.00	.41	5.0	OPERATOR	
10	25.0		37.2	147	116	109	113	40	268	1.05	.43	6.5	Gravlee	
11	27.5		38.7	147	116	109	113	41	269	1.10	.45	7.5	Sample Box No. 2	
12	30.0		39.941	134	116	109	113	41	271	.87	.35	7.0	Meter Box No. 400	
13	32.5		41.801	142	113	109	111	42	269	1.79	.73	14.0	Meter ΔH@ 1.55	
14	35.0		43.9	146	111	109	110	39	225	1.82	.75	0	Pitot, CP .817	
15	37.5		45.7	147	113	110	112	40	236	1.97	.81	1.0	Temp. Device 241	
16	40.0		47.7	147	115	110	113	41	241	1.88	.77	2.0	Probe No. 52	
17	42.5		49.6	148	118	110	114	41	247	1.88	.77	3.0	Probe Liner 55	
18	45.0		51.3	147	119	111	115	42	265	1.32	.54	3.0	Probe Htr. Set 70	
19	47.5		52.5	146	120	111	116	41	266	.83	.34	2.0	Ambient Temp. 68	
20	50.0		54.0	147	119	111	115	41	265	1.17	.48	4.0	% O ₂ 11/12	
21	52.5		55.5	147	118	111	115	40	265	1.22	.50	5.0	% CO ₂ 15/15	
22	55.0		57.0	146	117	111	114	40	266	1.17	.48	6.0	NOTES	
23	57.5		58.6	147	117	111	114	40	263	1.12	.46	6.5	Orifice ✓	
24	60.0	✓	59.899	141	117	110	114	41	236	.764	.31	7.0	Pitot R5.4 S61	
25			37.971	145			112			1.323	.727		Meter	
26			41.908	143									Final leak	
27			41.895										✓ @ 10" H ₂ O	
28													59.967	
29													59.965	
30													.0020	

GUARDIAN * SYSTEMS * INCORPORATED
P.O. BOX 190
LEEDS, AL 35094
205-699-6647

Blank Analytical Data

Plant: Allied Products
Sample location: Kiln #1
Relative humidity: 25%
Type of blank: Acetone
Liquid level at mark and container sealed: Yes
Density of blank: 0.7852 g/ml
Blank Volume 200 ml
Date & time of wt.: 10/17/91 0800 Gross wt. 94283.6 mg
Date & time of wt.: 10/17/91 1600 Gross wt. 94283.2 mg
Average Gross wt. 94283.4 mg
Tare wt. 94282.5 mg
Weight of blank 0.90 mg

Concentration of Blank	0.0057 mg/g	0.0006% of weight
------------------------	-------------	-------------------

Note: In no case shall a blank residue greater than (0.01mg/g) or 0.001% of the weight of the blank used be subtracted from the sample weight.

Remarks: _____

Signature of analyst: _____

Signature of reviewer: _____

METHOD 5

PARTICULATE SAMPLE RECOVERY AND INTEGRITY SHEET

Plant: Allied Lime Sample date: 10/15/91
Sample location: Alabaster #7 Run no.: 1
Sample recovery person: RS/TC Recovery date: 10/16/91
Filter(s) no.: L21, L19

MOISTURE

Impingers Silica gel #5
Final volume (wt) 215 ml(gm) Final wt. 987.3 g
Initial volume (wt) 0 ml(gm) Initial wt. 976.8 g
Net volume (wt) 215 ml(gm) Net wt. 10.5 g
Total moisture 2255 g
Color of silica gel Mixed
Description of impinger water Clear

RECOVERED SAMPLE

Filter container no. Run 1 sealed ☒
Description of particulate on filter Grey Brown to Green

Acetone rinse container no. Run 1 #1 Liquid level marked ☒
Acetone blank container no. BL Liquid level marked ☒
Samples stored and locked ☒

Remarks: _____

Date of laboratory custody _____

Laboratory personnel taking custody Robert Loggins

Remarks: Trans to TO-L22 10/16/91

GUARDIAN * SYSTEMS * INCORPORATED
P.O. BOX 190
LEEDS, AL 35094
205-699-6647

Method 5 Analytical Particulate Data

Plant: Allied Products Run Number: 1

Sample location: Kiln #1
Relative humidity: 25%
Density of Acetone: 0.7852 g/ml

Liquid level at mark and container sealed: Yes
Filter marked and container sealed: Yes

Acetone rinse container number: 1
Acetone rinse volume: 80 ml
Acetone blank residue concentration: 0.0057 mg/g
Acetone blank weight: 0.4 mg

ACETONE RINSE WEIGHT

Date & time of wt.:	10/17/91	0800 Gross wt.	105214.9 mg
Date & time of wt.:	10/17/91	1600 Gross wt.	105214.6 mg
		Average Gross wt.	105214.8 mg
		Tare wt.	105196.3 mg
		Less weight of acetone blank	0.4 mg
		Weight of particulate in acetone rinse	18.1 mg

PARTICULATE WEIGHT

Filter(s) container number: 1

Date & time of wt.:	10/17/91	0800 Gross wt.	583.1 mg
Date & time of wt.:	10/17/91	1600 Gross wt.	582.9 mg
		Average Gross wt.	583.0 mg
		Tare wt.	505.1 mg
		Weight of particulate on filter (s)	77.9 mg
		Weight of particulate in acetone rinse	18.1 mg
		TOTAL WEIGHT OF PARTICULATE	96.0 mg

Note: In no case shall a blank residue greater than (0.01mg/g) or 0.001% of the weight of the blank used be subtracted from the sample weight.

Remarks: _____

Signature of analyst: _____

Signature of reviewer: _____

METHOD 5

PARTICULATE SAMPLE RECOVERY AND INTEGRITY SHEET

Plant: Allied Lime Sample date: 10/15/91
Sample location: Alabaster #1 Run no.: 2
Sample recovery person: RS/TE Recovery date: 10/16/91
Filter(s) no.: L 20, L 19

MOISTURE

Impingers Silica gel #7
Final volume (wt) 202 ml (gm) Final wt. 1013.6 g _____ g
Initial volume (wt) 0 ml (gm) Initial wt. 1006.9 g _____ g
Net volume (wt) 202 ml (gm) Net wt. 6.7 g _____ g
Total moisture 208.7 g
Color of silica gel Mixed
Description of impinger water Clear

RECOVERED SAMPLE

Filter container no. Run 2 sealed ☒
Description of particulate on filter Light Brown

Acetone rinse container no. Run 2 #1 Liquid level marked ☒
Acetone blank container no. BL Liquid level marked ☒
Samples stored and locked ☒

Remarks: _____

Date of laboratory custody _____

Laboratory personnel taking custody Robert Scoppia

Remarks: Trans to To- Lot 2 10/16/91

GUARDIAN * SYSTEMS * INCORPORATED
P.O. BOX 190
LEEDS, AL 35094
205-699-6647

Method 5 Analytical Particulate Data

Plant: Allied Products Run Number: 2

Sample location: Kiln #1
Relative humidity: 25%
Density of Acetone: 0.7852 g/ml

Liquid level at mark and container sealed: Yes
Filter marked and container sealed: Yes

Acetone rinse container number: 2
Acetone rinse volume: 120 ml
Acetone blank residue concentration: 0.0057 mg/g
Acetone blank weight: 0.5 mg

ACETONE RINSE WEIGHT

Date & time of wt.:	10/17/91	0800 Gross wt.	102555.1 mg
Date & time of wt.:	10/17/91	1600 Gross wt.	102554.6 mg
		Average Gross wt.	102554.9 mg
		Tare wt.	102526.7 mg
		Less weight of acetone blank	0.5 mg
		Weight of particulate in acetone rinse	27.6 mg

PARTICULATE WEIGHT

Filter(s) container number: 2

Date & time of wt.:	10/17/91	0800 Gross wt.	585.3 mg
Date & time of wt.:	10/17/91	1600 Gross wt.	584.9 mg
		Average Gross wt.	585.1 mg
		Tare wt.	505.3 mg
		Weight of particulate on filter (s)	79.8 mg
		Weight of particulate in acetone rinse	27.6 mg
		TOTAL WEIGHT OF PARTICULATE	107.4 mg

Note: In no case shall a blank residue greater than (0.01mg/g) or 0.001% of the weight of the blank used be subtracted from the sample weight.

Remarks: _____

Signature of analyst: _____

Signature of reviewer: _____

METHOD 5

PARTICULATE SAMPLE RECOVERY AND INTEGRITY SHEET

Plant: Allied Lime Sample date: 10/15/91
 Sample location: Alabaster #1 Run no.: 3
 Sample recovery person: RS/TG Recovery date: 10/16/91
 Filter(s) no.: L16, L17

MOISTURE

Impingers Silica gel # 11
 Final volume (wt) 195 ml (gm) Final wt. 926.8 g
 Initial volume (wt) 0 ml (gm) Initial wt. 921.9 g
 Net volume (wt) 195 ml (gm) Net wt. 4.1 g
 Total moisture 199.1 g
 Color of silica gel Mixed
 Description of impinger water Clear

RECOVERED SAMPLE

Filter container no. Run 3 sealed ✓
 Description of particulate on filter Light Brown

Acetone rinse container no. Run 3 #1 Liquid level marked ✓
 Acetone blank container no. BL Liquid level marked ✓
 Samples stored and locked ✓

Remarks: _____

Date of laboratory custody _____

Laboratory personnel taking custody Robert Scaggs

Remarks: Trans. to TDM Lot 2 10/16/91

GUARDIAN * SYSTEMS * INCORPORATED
P.O. BOX 190
LEEDS, AL 35094
205-699-6647

Method 5 Analytical Particulate Data

Plant: Allied Products Run Number: 3

Sample location: Kiln #1
Relative humidity: 25%
Density of Acetone: 0.7852 g/ml

Liquid level at mark and container sealed: Yes
Filter marked and container sealed: Yes

Acetone rinse container number: 3
Acetone rinse volume: 80 ml
Acetone blank residue concentration: 0.0057 mg/g
Acetone blank weight: 0.4 mg

ACETONE RINSE WEIGHT

Date & time of wt.:	10/17/91	0800 Gross wt.	105145.4 mg
Date & time of wt.:	10/17/91	1600 Gross wt.	105145.0 mg
		Average Gross wt.	105145.2 mg
		Tare wt.	105136.9 mg
		Less weight of acetone blank	0.4 mg
		Weight of particulate in acetone rinse	7.9 mg

PARTICULATE WEIGHT

Filter(s) container number: 3

Date & time of wt.:	10/17/91	0800 Gross wt.	574.7 mg
Date & time of wt.:	10/17/91	1600 Gross wt.	574.4 mg
		Average Gross wt.	574.6 mg
		Tare wt.	506.1 mg
		Weight of particulate on filter (s)	68.5 mg
		Weight of particulate in acetone rinse	7.9 mg
		TOTAL WEIGHT OF PARTICULATE	76.4 mg

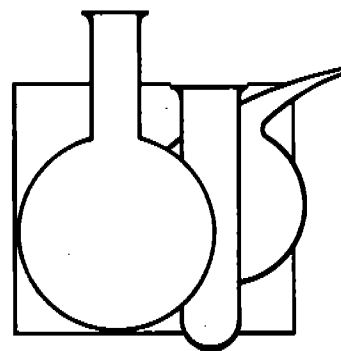
Note: In no case shall a blank residue greater than (0.01mg/g) or 0.001% of the weight of the blank used be subtracted from the sample weight.

Remarks: _____

Signature of analyst: _____

Signature of reviewer: _____

Plant Operation Data



V. PLANT OPERATIONAL DATA

The following information was supplied by Allied Products Corporation personnel.

ALLIED LIME COMPANY
ALABASTER PLANT

Date: 10-15-91

IRNER'S REPORT

#1 Kilm During Stack Test

TIME	KILN FEED RATE	FUEL		O ₂	ROTARY KILN TEMPERATURES				COOLER TEMPERATURES				AMPERAGE		BOWL MILL	HOURLY CONTROL TEST
					TC 1	TC 2	TC 3	TC 4 & 5	TC 1	TC 2	TC 3	TC 4				
7	20.3		3.0	1.9	460	460	460		15.0	28	160		200	390	120	0.2800%
8	20.5		3.0	1.2	460	460	460		15.0	26	180		200	380	120	0.2800%
9	19.9		3.0	1.1	460	460	460		15.0	26	160		200	375	120	0.5800%
10	20.7		3.0	1.1	460	460	460		15.0	26	170		185	370	120	0.4800%
11	20.1		3.0	1.0	460	460	460		15.0	26	170		200	375	120	0.2800%
12	20.3		2.9	1.3	460	460	460		15.0	26	170		180	370	115	0.2800%
1	19.9		2.9	1.4	460	460	460		15.0	34	160		185	370	115	0.5800%
2	20.1		2.9	1.3	470	470	470		15.0	32	160		190	370	115	0.3800%

COOLER
FEED
EAND

HOOP
MID

KILN
REV.

ID FAN
TEMP.

KILN
DR.

ID FAN

PERCENT
RESIDUE

#1 KILN

ALLIED PRODUCTS Co. DATE

0-15-91

TEST No.

PROCESS DATA

KILN NO.

TIME	STONE FEED RATE	SCRUBBER WATER FLOW	VENTURRI PRESS. DROP	MECH. COLL. PRESS. DROP	COAL FEED RATE 1 K.
9:30	20.0	120	15.0	2"	3.0
9:45	20.0	120	15.0	2"	3.0
10:00	20.0	120	15.0	2"	2.9
10:15	20.0	120	15.0	2"	3.0
10:30	20.0	120	15.0	2"	3.0
10:50	20.0	120	15.0	2"	3.0
Test # 1 EN					
11:20	20.0	120	15.0	2"	2.9
11:45	20.0	120	15.0	2"	2.9
12:00	20.0	120	15.0	2"	2.8
12:15	20.0	120	15.0	2"	2.9
12:30	20.0	120	15.0	2"	2.9
12:50	20.0	120	15.0	2"	2.9
END OF TEST # 2					

TEST No.

ALLIED PRODUCTS Co.

DATE 6-7-8

PROCESS DATA

~~RTENALD~~

COAL
FEED
RATE

TIME	STONE FEED RATE	SCRUBBER WATER FLOW	VENTURRI PRESS. DROP	MECH. COLL. PRESS. DROP
------	-----------------------	---------------------------	----------------------------	-------------------------------

45	20.0	120	15.0	2"	2.9
----	------	-----	------	----	-----

200	200	120	15.0	2"	2.9
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2.15	200	120	15.0	2.11	2.9
------	-----	-----	------	------	-----

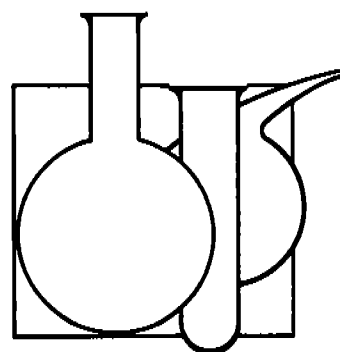
2.30	20.0	120	15.0	2"	2.8
------	------	-----	------	----	-----

5.45	20.0	120	15.0	2"	2.9
------	------	-----	------	----	-----

3.00	20.0	120	15.0	2"	2.9
------	------	-----	------	----	-----

END OF TEST #3

Calibrations



VI. CALIBRATIONS

Meter Box

The meter box is initially calibrated every 6 months at the fixed settings of 0.5, 1.0, 1.5, 2.0, and 2.5 inches of H₂O. Upon return to the laboratory from this test the meter box was recalibrated using the average meter pressure for the test series. The recalibration point shall be the closest point to the initial calibration (for an average meter pressure of 1.35 a 1.50 "H₂O was used as the recalibration point). These recalibrations produced a single point MCF and a $\hat{H}$ @ which shall be compared to the original calibration to see if they are within the 5% allowed at the highest vacuum seen. These recalibration sheets are located behind the original calibration sheets.

Pitot Tubes

The S type tubes are calibrated against a standard pitot tube ($C_p = 0.99$) in a wind tunnel with a capacity to generate a test section velocity of approximately 3000 feet/minute every 6 months. Additionally the pitot tube is measured as to its specifications and alignment. Upon return, the intercomponent spacings and the face opening alignment of the pitot tube assembly were rechecked and if no changes are noticed; it shall be assumed that the coefficient of the assembly had not changed.

Temperature Measurements

All temperature devices (impinger, meter box, hot box and stack) are calibrated every 6 months against an ASTM mercury-in-glass reference thermometer or a reference thermocouple and potentiometer calibrated by fixed points, e.g., ice bath and boiling water (corrected to barometric pressure). Upon return the stack temperature device was recalibrated within 10% of the average absolute stack temperature. If the device being tested agrees within 1.5% of the reference device, the temperature data taken in the field shall be considered valid.

VI. CALIBRATIONS CONTINUED

Barometric Pressure

An aneroid barometer capable of measuring atmospheric pressure to within 0.1 inches Hg was used. If this device is defective the following alternate method shall be used. The barometric reading may be obtained from a nearby national weather service station, in which case the station value (which is the absolute barometric pressure) shall be requested and an adjustment for elevation differences between the weather station and sampling point shall be applied at a rate of minus 0.1 inches Hg per 100 feet elevation increase or vice versa for elevation decrease.

Specific Test Equipment and Measurements

The equipment used during these tests was as follows:

Probe:	5-2
Meter Box:	#400
Stack Temperature:	Omega II
Sample Box:	#1
Impinger	#1

For an average temperature of 143° F the Omega II was recalibrated at 150 ° F and agreed exactly with an ASTM mercury-in-glass reference thermometer. The intercomponent spacing and the face opening alignment of the Pitot Tube assembly was rechecked and no changes were noticed; therefore, it was assumed that the coefficient of the assembly had not changed.

Type A Glass Fiber Filters

FEATURES

- High tensile strength. ■ Excellent handling characteristics. ■ Good wetting properties. ■ Minimum of 99.9% retention for particles of $.3 \mu\text{m}$ as determined by DOP tests. ■ Binder free.

This is the original glass fiber filter pioneered by Gelman Instrument Company over 15 years ago. It continues to be widely used for high volume sampling. Since zinc is one of the raw materials incorporated in the glass fibers, Type A Filters have a variable zinc content. Another component of the filter, sulfuric acid, is used as a dispersion medium, making the sheets unsuitable for measurement of sulfates.

Type A Glass Fiber Filters are less likely to develop static charge or tear than other glass fiber media types. They are used extensively in applications where zinc and iron content is not important, or where sulfate content is not being determined.

Size	37 mm	47 mm	102 mm	8"x10"
Product No.	61715	61694	61696	61701
Filters/Pkg.	500	100	100	100

TYPE A GLASS FIBER FILTER SPECIFICATION REPORT

The following physical/chemical properties represent typical, average values obtained in accordance with accepted test methods. They are subject to normal manufacturing variations and are supplied as a technical service. The analysis has been made in accordance with EPA procedures (micrograms/8" x 10" sheet).

ELEMENTS:

Antimony	.30	Manganese	.200
Arsenic	.30	Mercury	.100
Beryllium	.1	Molybdenum	.10
Bismuth	.10	Nickel	.10
Cadmium	.5	Selenium	.5000
Chromium	.10	Tin	.10
Cobalt	.10	Titanium	.170
Copper	.2	Vanadium	.10
Iron	.2300	Zinc	.5000
Lead	.20		to 25,000

OTHER PHYSICALS:

BSO	.522	Flow Resistance (Max.)	
*pH	.8.5	@ 320 cm/min.	.80 mm
DOP @ 320/cm/min		Flow Rate (air)	
(ASTM Method 2986)	.99.9%	lpm/cm ² @ 70 cm Hg	.50
Tensile Strength		Max. Use Temp.	.400°C
(Fed. Spec. UUP31B)	.750 gr	Static Properties	.Low
Weight.		Ability to	
8"x10" sheet	.4.0±.3 gr.	Fold	.Excellent

WATER EXTRACTABLE IONS:

Sulfate	.100	Chloride	.1500
Nitrate	.50	Fluoride	.15
Ammonia	.20		

*pH—Gelman Procedure:

- 500 ml distilled water.
- Add 15 drops saturated KCl solution
- Shred one 8"x10" sheet and soak in prepared water for one hour.
- Run pH at ambient temperature.

Type A/E Glass Fiber Filters

FEATURES

- Low trace metals. ■ Medium Handling characteristics. ■ Available in all sizes. ■ Minimum of 99.9% retention for particles of $.3 \mu\text{m}$ as determined by DOP tests. ■ Binder free.

Type A/E Glass Fiber Filters are composed of low acid soluble glass fiber. They contain low levels of both zinc and iron. The filters do react with atmospheric sulfur dioxide; and therefore, when high levels of sulfur are expected, corrections for this reaction should be accounted for.

Type A/E Glass Fiber Filters are binder free and ideal for gravimetric analysis of air pollutants. This pure, organic free filter is the basis for procedures widely used in determining municipal and industrial air polluting substances.

Size	25 mm	37 mm	47 mm	102 mm	8"x10"
Product No.	61630	61652	61631	61633	61638
Filters/Pkg.	500	500	100	100	100

TYPE A/E GLASS FIBER FILTER SPECIFICATION REPORT

The following physical/chemical properties represent typical, average values obtained in accordance with accepted test methods. They are subject to normal manufacturing variations and are supplied as a technical service. The analysis has been made in accordance with EPA procedures (micrograms/8" x 10" sheet).

ELEMENTS:

Antimony	.20	Manganese	.2
Arsenic	.20	Mercury	.80
Beryllium	.1	Molybdenum	.10
Bismuth	.10	Nickel	.10
Cadmium	.2	Selenium	.200
Chromium	.10	Tin	.10
Cobalt	.10	Titanium	.10
Copper	.2	Vanadium	.10
Iron	100,1800	Zinc	.90
Lead	.10		

OTHER PHYSICALS:

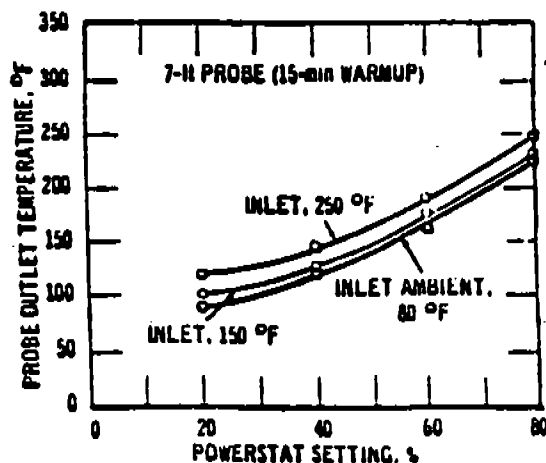
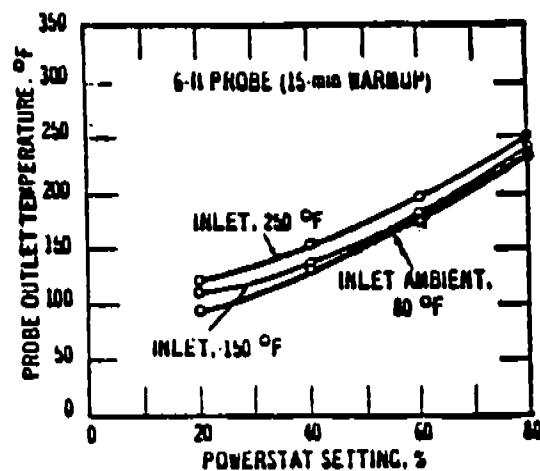
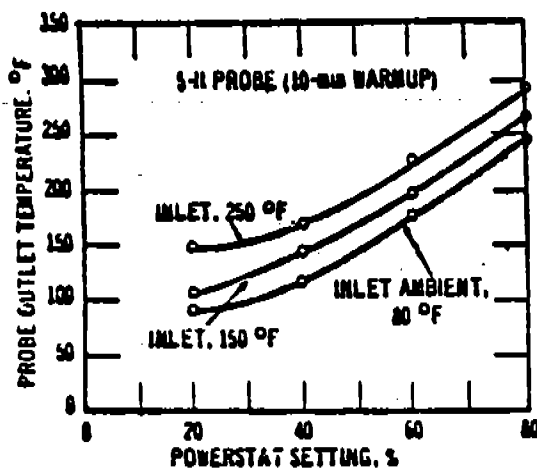
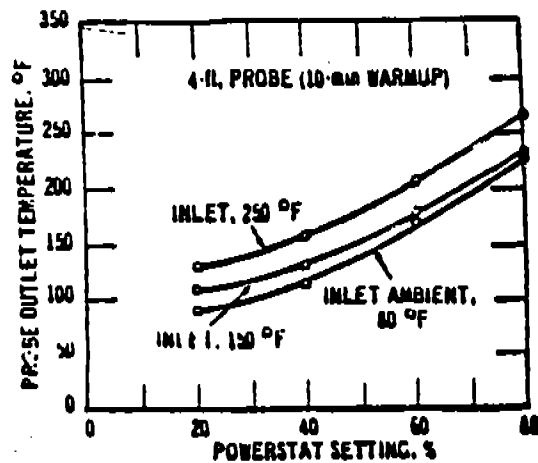
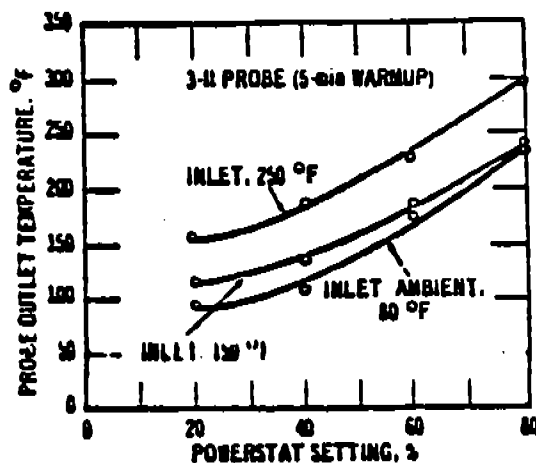
BSO	.522	Flow Resistance (Max.)	
*pH	.9.0	@ 320 cm/min.	.80 mm
DOP @ 320/cm/min		Flow Rate (air)	
ASTM Methods 2986)	.99.9%	lpm/cm ² @ 70 cm Hg	.60
Tensile Strength		Max. Use Temp.	.400°C
(Fed. Spec. UUP31B)	.600 gr.	Static Properties	.Medium
Weight		Ability to	
8"x10" sheet	.4.0±.3 gr.	Fold	.Good

WATER EXTRACTABLE IONS:

Sulfate	.600	Chloride	.1500
Nitrate	.175	Fluoride	.87
Ammonia	.13		

*pH—Gelman Procedure:

- 500 ml distilled water.
- Add 15 drops saturated KCl solution.
- Shred one 8"x10" sheet and soak in prepared water for one hour.
- Run pH at ambient temperature.



NOTE: Flow rate held constant at 0.75; 50% change in flow rate has little effect on probe temperature.

GUARDIAN SYSTEMS INC
Initial Meter Calibration Box 400
on 7/23/91

Run Number	1	2	3	4	5
Barometric Pres, in Hg	29.58	29.58	29.58	29.58	29.58
Orifice pres drop, in H2O	0.5	1.0	1.5	2.0	2.5
Pres Wet Test Meter, in H2O	-0.20	-0.40	-0.60	-0.80	-1.00
Gas Volume Wet Init, CF	0.005	6.750	15.804	28.656	40.853
Gas Volume Wet Final, CF	6.361	15.589	26.646	40.887	54.527
Gas Volume Dry Init, CF	750.593	757.089	766.036	778.947	791.343
Gas Volume Dry Final, CF	756.706	765.813	776.669	791.119	805.104
Temp Wet Init, C	20.5	20.5	20.5	20.5	20.5
Temp Wet Final, C	20.5	20.5	20.5	20.5	20.5
Dry Gas Temp Init In, F	84	96	101	105	107
Dry Gas Temp Final In, F	94	102	105	108	110
Dry Gas Temp Init Out, F	90	98	107	111	114
Dry Gas Temp Final Out, F	98	111	118	122	125
Run Time, sec	900	902	900	900	900
Meter Calibration Factor, Y	1.0823	1.0724	1.0889	1.0783	1.0691
Average Y	1.0782				
Qm	0.4431	0.6254	0.7781	0.8824	0.9899
Km	0.7802	0.7719	0.7791	0.7630	0.7641
Average Km	0.7716				
Delta H@	1.51	1.55	1.52	1.58	1.58
Average H@	1.55				

SIGNATURE

Robert Scoggins

GUARDIAN SYSTEMS INC
Recalibration of Meter Box 400
on 10/16/91

Run Number	1	2	3	Average
Barometric Pres, in Hg	29.52	29.52	29.52	29.52
Orifice pres drop, in H2O	1.5	1.5	1.5	1.50
Pres Wet Test Meter, in H2O	-0.55	-0.55	-0.55	-0.55
Gas Volume Wet Init, CF	0.000	11.167	22.249	33.416
Gas Volume Wet Final, CF	11.167	22.249	33.215	66.631
Gas Volume Dry Init, CF	66.600	77.074	87.698	231.372
Gas Volume Dry Final, CF	77.074	87.698	98.369	263.141
Temp Wet Init, C	18.0	17.8	17.5	17.8
Temp Wet Final, C	17.8	17.5	17.5	17.6
Dry Gas Temp Init In, F	78	89	100	89
Dry Gas Temp Final In, F	91	101	106	99
Dry Gas Temp Init Out, F	69	77	87	78
Dry Gas Temp Final Out, F	77	87	93	86
Run Time, sec	900	900	900	2700
Meter Calibration Factor, Y	1.0901	1.0868	1.0869	1.0880
Qm	0.7531	0.7606	0.7642	0.7594
Km	0.7807	0.7820	0.7799	0.7809
Delta H@	1.51	1.51	1.51	1.51

Previous Y	1.0889	% Difference	0.08%
Previous H@	1.52	% Difference	0.64%

Project Ariel Stack Kim #1

SIGNATURE L. L. A.

GUARDIAN SYSTEMS INC
Temperature Calibration for Omega II
on 7/24/91

Actual Temperature, F	Reading Temperature, F	Correction in Reading, F
50	50	0
100	101	-1
150	152	-2
200	203	-3
250	254	-4
300	304	-4
350	352	-2
400	403	-3
450	452	-2
500	503	-3
550	552	-2
600	602	-2
650	651	-1
700	701	-1
750	751	-1
800	801	-1
850	851	-1
900	902	-2
950	952	-2
1000	1003	-3

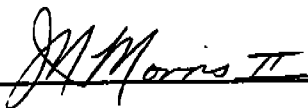
Regression Output:

Constant	-2.23097
Std Err of Y Est	1.097495
R Squared	0.999986
No. of Observations	20
Degrees of Freedom	18

Read	Actual
200	198

X Coefficient(s)	1.000438
Std Err of Coef.	0.000851

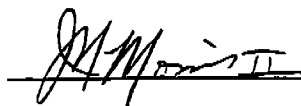
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GUARDIAN SYSTEMS INC-
Temperature Calibration for Hot Boxes
on 7/24/91

Device	Actual Temperature, F	Reading Temperature, F	Correction in Reading, F
Hot Box 1	225	225	0
	250	250	0
	275	275	0
Hot Box 2	225	225	0
	250	250	0
	275	275	0
Hot Box 3	225	225	0
	250	250	0
	275	275	0
Hot Box 4	225	225	0
	250	250	0
	275	275	0
Hot Box 5	225	225	0
	250	250	0
	275	275	0
Hot Box 6	225	225	0
	250	250	0
	275	275	0
Hot Box 7	225	225	0
	250	250	0
	275	275	0
Hot Box 8	225	225	0
	250	250	0
	275	275	0

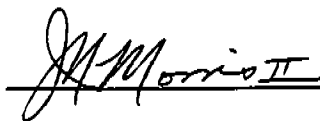
SIGNATURE



GUARDIAN SYSTEMS INC
Temperature Calibration for Impingers
on 7/24/91

Device	Actual Temperature, F	Reading Temperature, F	Correction in Reading, F
Impinger 1	40	40	0
	60	60	0
	80	80	0
Impinger 2	40	40	0
	60	60	0
	80	80	0
Impinger 3	40	40	0
	60	60	0
	80	80	0
Impinger 4	40	40	0
	60	60	0
	80	80	0
Impinger 5	40	40	0
	60	60	0
	80	80	0
Impinger 6	40	40	0
	60	60	0
	80	80	0
Impinger 7	40	40	0
	60	60	0
	80	80	0
Impinger 8	40	40	0
	60	60	0
	80	80	0

SIGNATURE



GUARDIAN SYSTEMS INC

Pitot Calibration Form

Date: 9/5/91

Probe #: 5-2

Calibrated By: John Morris II

Average Velocity, f/m

2,817

Side A

Run #	Pstd	Ptype s	Cp(s)	Deviation
1	0.50	0.72	0.825	0.004
2	0.50	0.73	0.819	-0.002
3	0.50	0.73	0.819	-0.002

Avg Cp = 0.821

Avg = 0.000

Is average deviation less than or equal to 0.01?

YES

Side B

Run #	Pstd	Ptype s	Cp(s)	Deviation
1	0.50	0.74	0.814	0.000
2	0.50	0.74	0.814	0.000
3	0.50	0.74	0.814	0.000

Avg Cp = 0.814

Avg = 0.000

Is average deviation less than or equal to 0.01?

YES

Is average PCF equal to or less than 0.01

YES

Average PCF = 0.817

SIGNATURE

