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/

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.

AP42 Section:	11.18
Reference:	7
Title:	*Particulate Emissions Tests For U. S. Gypsum Company On The Number 4 Dry Filter And Cupola Stack Located In Birmingham, Alabama On January 14, 1981*, Guardian Systems, Inc., Birmingham, AL, Undated.

3/

DRAFT/WP
d3006-4/971130
03/30/92 .1

Emission Test Report
Review Checklist

Reviewer: O. Wallace
Review Date: 8/4/92

A. Background Information

1. Facility name: United States Gypsum

   Location: Birmingham AL

2. Source category: Mineral Wool

3. Test date: January 1981

4. Test sponsor: Facility

5. Testing contractor: Guardian Systems, Inc

6. Purpose of test: Demonstrate Compliance

7. Pollutants measured

   (PM) PM-10 CO SO_2 NO_x VOC Pb CO_2

   Others (list):

8. Process overview: On an attached page provide a block diagram of the unit operations and associated air pollution control systems at the facility. Identify process tested with letters from the beginning of the alphabet (A, B, C, etc.) and APC systems with letters from end of alphabet (V, W, X, etc.). Also identify test locations with Arabic numerals (1,2,3, ...). Using the ID symbols from that sketch complete the table below that identifies processes or unit operations tested.

No process diagram in test report but State provided attached diagram

Test ID	Process	Process ID	Emissions tested		APCD (controlled emissions only)
			Uncontrolled	Controlled	
1	Cupola	A		X	Baghouse
2	Blow Chamber	B		X	Dry Filter

B. Process Information

1. Provide a brief narrative description of the process. With as much detail as possible, (e.g., if a furnace or conveyor system is used, identify the type of unit) describe the equipment used for those operations tested. (Note: If process description provided in test report is adequate, attach copy or reproduce here.)

No process description presented in test report. Limited process data indicate that the total charge to the system is about 4.9 tons/hour with about 85% of the charge slag and the other 15% coke. The data sheets reported a % recovery of 44.6 for an average product rate of 2.08 ton/hr which was quoted as the process rate. However, I could not replicate this value.

2. For each process tested list feedstock materials and products. Indicate if activity factors are for feed (F) rate or product (P) rate.

Process ID	Feedstock materials	Products	Basis for activity factor	F/P
A	Slag / Coke	Raw Wool	Total Feed	F
		or	Slag Feed	F
B	Raw Wool	Mineral Wood	Raw wool	F

Basis for data: _____
(Indicate page/table Nos. in test report)

3. For each process or operation tested and each test run note process capacity and operating rate during test.

Process ID	Capacity	Units	Test run	Process rate	Units
A	NA	NA	1	4.9	Ton/hr
			2	"	
			3	"	
			4		
A (alt)			1	4.17	Ton/hr
			2	"	"
			3	"	"
			4		
B	NA	NA	1	2.08	Ton/hr
			2	"	"
			3	"	"
			4		
			1		
			2		
			3		
			4		

Basis for data: Process A - Average of 24 hr data pp 37-39
Process B - Page 37

C. Air Pollution Control Systems Tested

1. For each air pollution control system pollution control system identified in A.8, note the following

ID	Type of APCD	Manufacturer	Model No.
W	Baghouse	NA	NA
X	Dry Filter	NA	NA

Note: Be as specific as possible in identifying APCD. For example, indicate "pulse jet fabric filter" rather than simply "fabric filter."

2. For each system identified above, provide a narrative description. For fugitive systems describe capture techniques as well as the removal techniques (use a separate page if necessary)

No description of control devices presented

3. Using the attached parameter list for guidance complete the table below. (Use additional pages as needed.)

APCD ID	Parameter	Units	Readings			
			Run 1	Run 2	Run 3	Run 4
Type of APCD:						
Type of APCD:						
Type of APCD:						

No data available

D. Sampling and Analysis Methods

1. Complete the following table

Test location	Pollutant	S & A method	Reference/ conditional method	Deviations noted
1	PM	EPA Method 5	Y/N	Y/N
			Y/N	Y/N
			Y/N	Y/N
			Y/N	Y/N
			Y/N	Y/N
2	PM	EPA Method 5	Y/N	Y/N
			Y/N	Y/N
			Y/N	Y/N
			Y/N	Y/N
			Y/N	Y/N
			Y/N	Y/N
			Y/N	Y/N
			Y/N	Y/N
			Y/N	Y/N
			Y/N	Y/N
			Y/N	Y/N
			Y/N	Y/N
			Y/N	Y/N
			Y/N	Y/N
			Y/N	Y/N
			Y/N	Y/N
			Y/N	Y/N
			Y/N	Y/N
			Y/N	Y/N
			Y/N	Y/N
			Y/N	Y/N
			Y/N	Y/N

2. If a method used was not a reference or conditional method, provide a narrative discussion including any data manipulation needed to make results correspond to reference or conditional method results.

NA

3. Describe any deviations identified above.

Moisture at location 2 determined by impinger weight

Note, no Orsat done for either train. O_2 found by Fyrite which is acceptable for MW determination

E. Emission Data Documentation

1. Tabulate the following stack gas data from the test report. (Use additional pages as needed.)

Test ID	Parameter	Units	Values reported			
			Run 1	Run 2	Run 3	Run 4
1	Stack temperature	°F	190	174	179	
	Moisture	%	8.61	9.99	8.99	
	Oxygen	%	8	9	6	
	Volumetric flow, actual	acfm	5482	5486	5738	
	Volumetric flow, standard	dscfm	4095	4138	4342	
	Percent isokinetic	%	108	109	108	
	Pollutant concentration:					
	PM	gr/dscf	0.013	0.001	0.006	
0	Stack temperature	°F	155	156	152	
	Moisture	%	2.66	2.64	2.77	
	Oxygen	%	21	21	21	
	Volumetric flow, actual	acfm	36,483	34,827	34,678	
	Volumetric flow, standard	dscfm	30,677	29,247	29,272	
	Percent isokinetic	%	97	100	98	
	Pollutant concentration:					
	PM	gr/dscf	0.008	0.010	0.005	
	Stack temperature					
	Moisture					
	Oxygen					
	Volumetric flow, actual					
	Volumetric flow, standard					
	Percent isokinetic					
	Pollutant concentration:					

Obtained from pages 11, 12, 18-23

2. Tabulate pollutant mass flux rates

Test ID	Pollutant	Units	Mass flux rates			
			Run 1	Run 2	Run 3	Run 4
A	PM	lb/hr	0.48	0.02	0.24	
B	PM	lb/hr	1.98	2.46	1.23	

3. Present example emission factor calculations below.

4. Tabulate emission factors

Process	Pollutant	Units	Average emission factor	
			Uncontrolled	Controlled
A	PM	lb/Ton Feed		0.051
	PM	lb/Ton Slag		0.060
B	PM	lb/Ton Wool		0.91

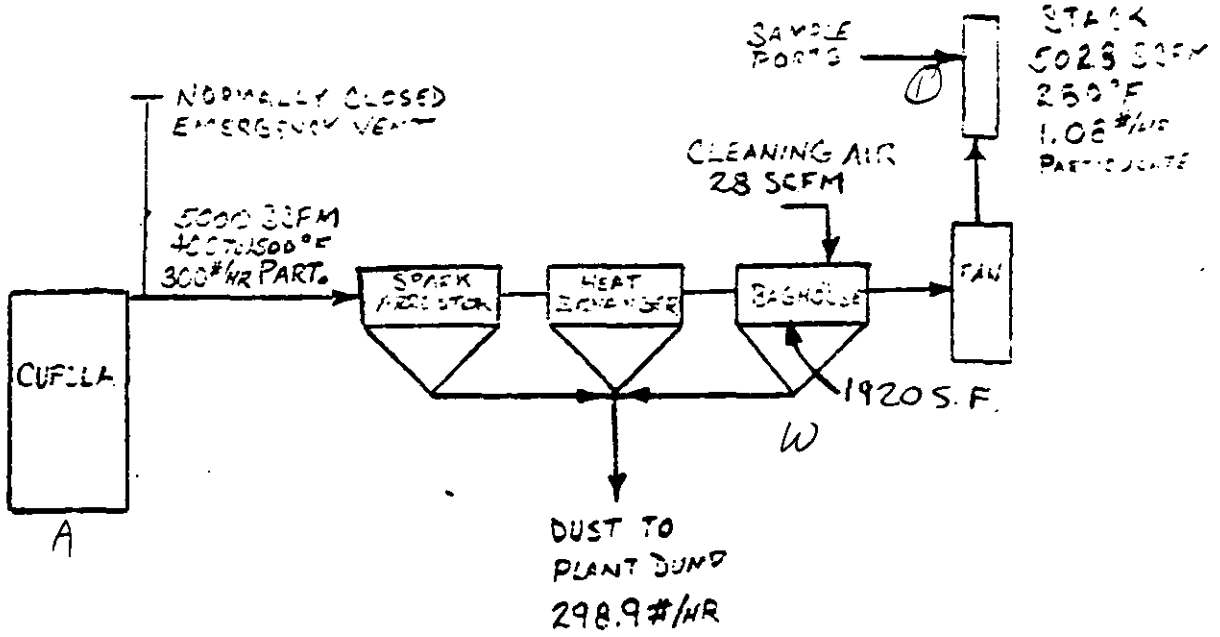
ATTACHMENT A
APCD PARAMETERS

Type of APCD	Parameters
Fabric filter	Cleaning mechanism Bag type Cleaning frequency Air to cloth ratio (A/C) Pressure drop Inlet temperature
ESP	Type (wet or dry) Number of fields Rapping cycle (if dry) Specific Collection Area (SCA) Particulate resistivity (if known) Spark rate Current and power levels
Venturi (or other high energy) scrubber	Pressure drop Liquid/gas (L/G) ratio Mist eliminator type
Packed-bed scrubber	Packing depth L/G ratio Caustic use (Y/N) pH Mist eliminator type
Carbon absorber	Bed depth Superficial gas velocity Bed temperature Desorption mechanism (media) Flue-gas moisture Cycle length Time-on-line after breakthrough

	Inlet	Intermediate Locations			
[illegible] (68°F, 29.92" Hg)	5,000				5,028
ACFM, existing conditions)	7,170				7,020
Temperature (°F)	300				280
Pressure inches Hg (Absolute)	29.41				29.96
Velocity (ft/sec)	45				44
Percent Moisture (Method: 4)	1.04				1.03
Pressure Drop (inches H_2O)	4				

6. Stack Dimensions: Height Approx. 52 Diameter at Exit 1.83

7. Draw a flow diagram which includes (a) gas exit from process (b) each control device (c) location of by-pass (d) fan or blower (e) each emission point (f) exits for collected pollutants (g) location of sampling ports.



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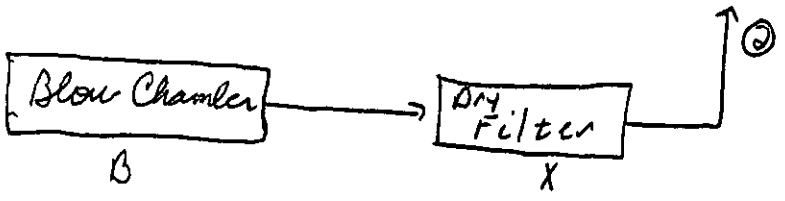

3)

PARTICULATE EMISSIONS TESTS

FOR

U.S. GYPSUM COMPANY

ON THE

NUMBER 4 DRY FILTER AND CUPOLA STACK

LOCATED IN

BIRMINGHAM, ALABAMA

ON

JANUARY 14, 1981

Sufficient data for PM-only
Data for Cupola and blow chamber
Process weight based on product.
Problem: No O2 sat data ⇒ How were isokinetics done
Use fyrite ?

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I. INTRODUCTION

On January 14, 1981, Guardian Systems, Inc., performed a series of particulate emission tests on the exhaust gases from the baghouse of the 4 cupolas and the dry filter collector exhaust from the number 4 blow chamber vent of the United States Gypsum plant in Birmingham, Alabama. These tests consisted of three runs on the dry filter and four runs on the cupola stack. Due to equipment problems run #3 on the cupola stack was repeated and is presented as run #3 . These tests were conducted in compliance with the regulations specified in the Code of Federal Regulations, Tital 40, Section 60, Methods 1-5 as revised. The only difference was on the cupola stack where the old impinger train was used and the impingers were weighed.

Mr. Bill Van Ells and Mr. Jim Watson of U.S. Gypsum coordinated the test schedule and is responsible for the production data. Mr. Gerald Coke, Mr. Joe Wilson and Ms. Linda Gosa of the Jefferson County Department of Health observed the tests. Mr. Tom Lotz, Mr. Jim Denton, Mr. Rick Scarborough, Mr. Bill McKinney of Guardian Systems, Inc., performed the tests.

II. SAMPLING AND ANALYTICAL PROCEDURES

Particulate

Preliminary measurements were made of the stacks to determine the number of sampling points according to Method 1. The cupola stack was sampled at 8 points, 4 points per diameter. The dry filter stack was sampled at 12 points. The sample point locations can be found in Figures 1 and 2.

Stack temperature, pressure, range of velocity heads, moisture content, stack gas dry molecular weight and proper nozzle size were determined to correctly set the nomograph for isokinetic sampling. The meter boxes were leak checked from the pump to the orifice meter as outlined in Method 5. The equipment used in this test was manufactured by Research Appliance Corporation and was properly calibrated before and after these tests. (See Calibrations)

Sampling Techniques

The particulate determinations were made by utilizing the sampling trains in Figures 3 and 4. Initial and final leak checks of the sampling systems and pitot lines were performed as outlined in Method 5 and these were recorded on the individual data sheets. The nozzles were calibrated before and after each test using a micrometer and were also recorded on the individual data sheets.

The gases were drawn through a stainless steel nozzle attached to a heated glass lined probe. The probe heater was maintained at the proper setting to obtain an exit temperature of 248 $\pm$ 25 ^{o}F. (See Calibrations) The gases then passed through a glass fiber (Gelman, Class A) of 0.3 microns retention to remove particulate matter. The filter was maintained at a temperature of 248 $\pm$ 25 ^{o}F. The sample box temperatures were recorded at each point on the data sheets.

The gases then passed through a condensing system placed in an ice bath during the test to maintain a maximum exit temperature of 68 °F. This temperature is also recorded on the data sheets. This condensing system consisted of 4 impingers filled with liquid and silica gel on the cupola stack and a stainless steel condenser with a pre-weighed gel column on the dry filter stack. The clean and cool gases then entered the meter box where the gas flow and temperature was measured. (See Data Sheets.)

Gas analysis for CO_2 and O_2 were determined for each run by using a fyrite gas analyzer. NO = CO

Particulate catches were placed in sealed petri dishes. Each acetone wash from the nozzle and probe was combined and placed in a sealed container. For these tests an acetone blank of approximately 300 milliliters was placed in a sealed container. These containers were transported to the laboratory for analysis.

Analysis

The filters (Gelman, Class A, without organic binder, minimum 99.9% retention for particles 0.3 microns as determined by DOP tests) were prepared for the field test by desiccating at 68 ± 10 °F and ambient pressure for 24 hours and weighing at intervals of at least six (6) hours to a constant weight (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 laboratory report sheets in this report. During each weighing the filter was exposed to the laboratory atmosphere for no more than two (2) minutes and a relative humidity of less than fifty percent (50%).

The acetone washes and blank for the group of tests were evaporated to dryness in tared glass beakers. They were then desiccated for twenty four (24) hours and weighed to a constant weight.

The moisture content for each test was determined by measuring or weighing 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.

The weight loss on the filters for the cupola stack was due in combination to the low mass collected and the adherence of a portion of the filter to the rubber gasket. This gasket was properly cleaned and placed in the acetone wash.

SAMPLE POINT LOCATION AND STACK BREECHING DIAGRAM

DRY FILTER STACK

Point #	Distance from Wall (inches)
1	2.1
2	7.0
3	14.1
4	33.4
5	40.5
6	45.4

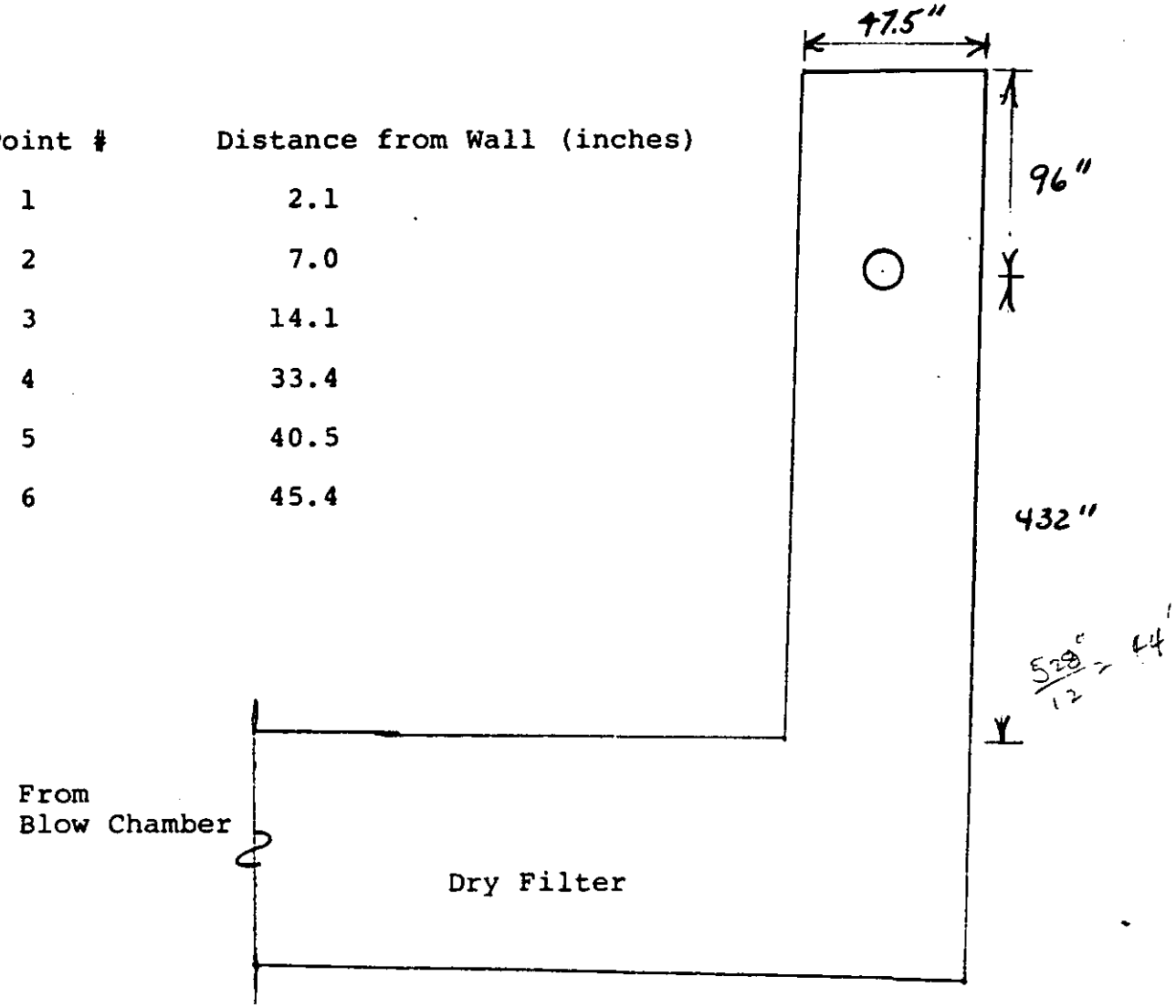
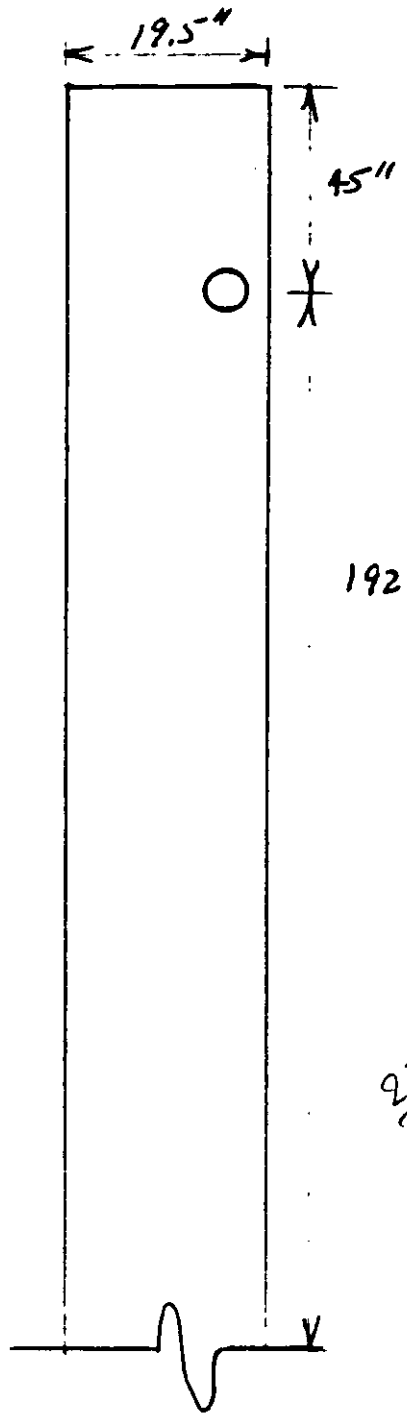


Figure 1

SAMPLING POINT LOCATION AND STACK BREECHING DIAGRAM

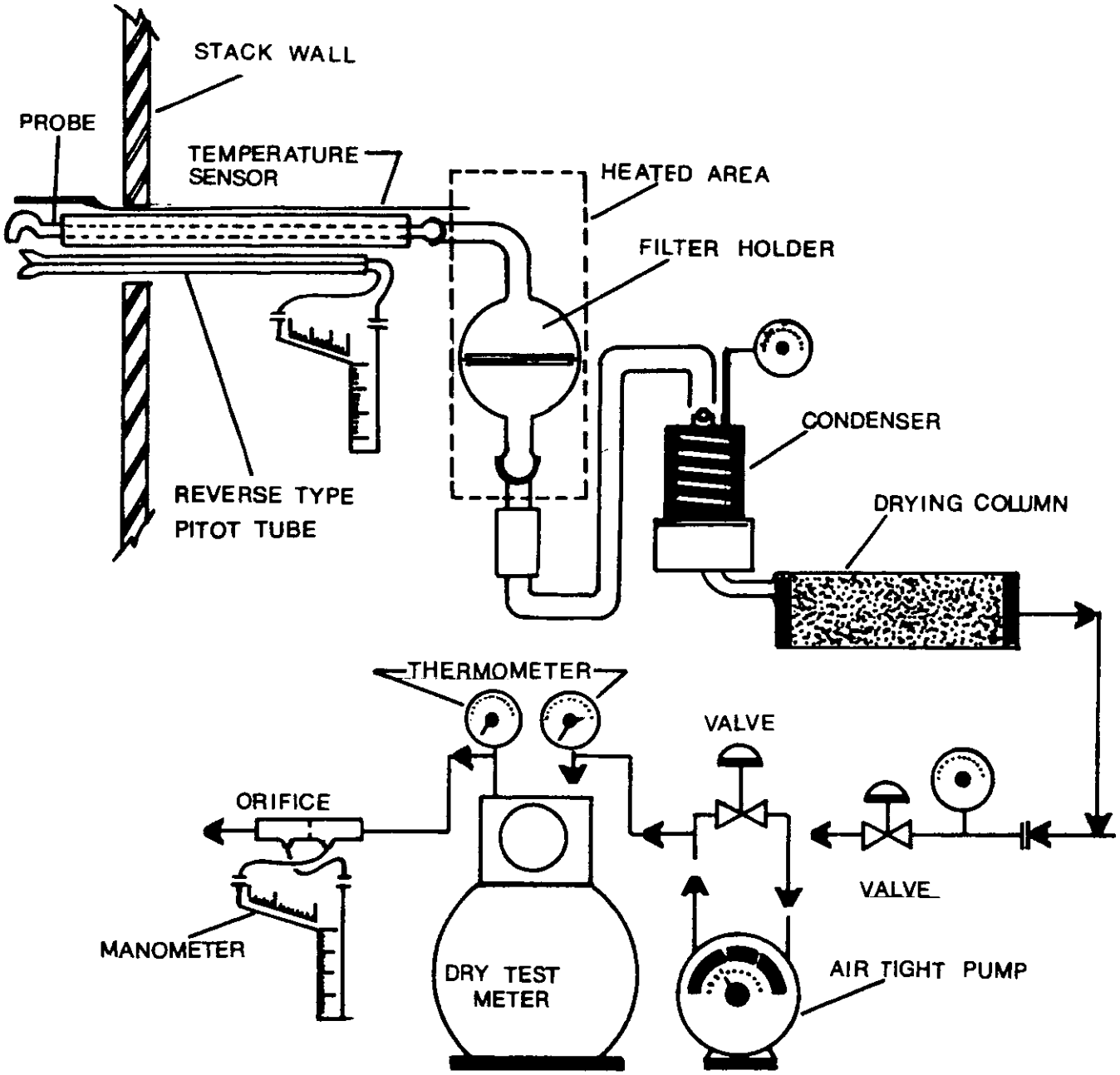
CUPOLA #4 STACK

Point Number	Distance from wall (inches)
1	1.3
2	4.9
3	14.6
4	18.2

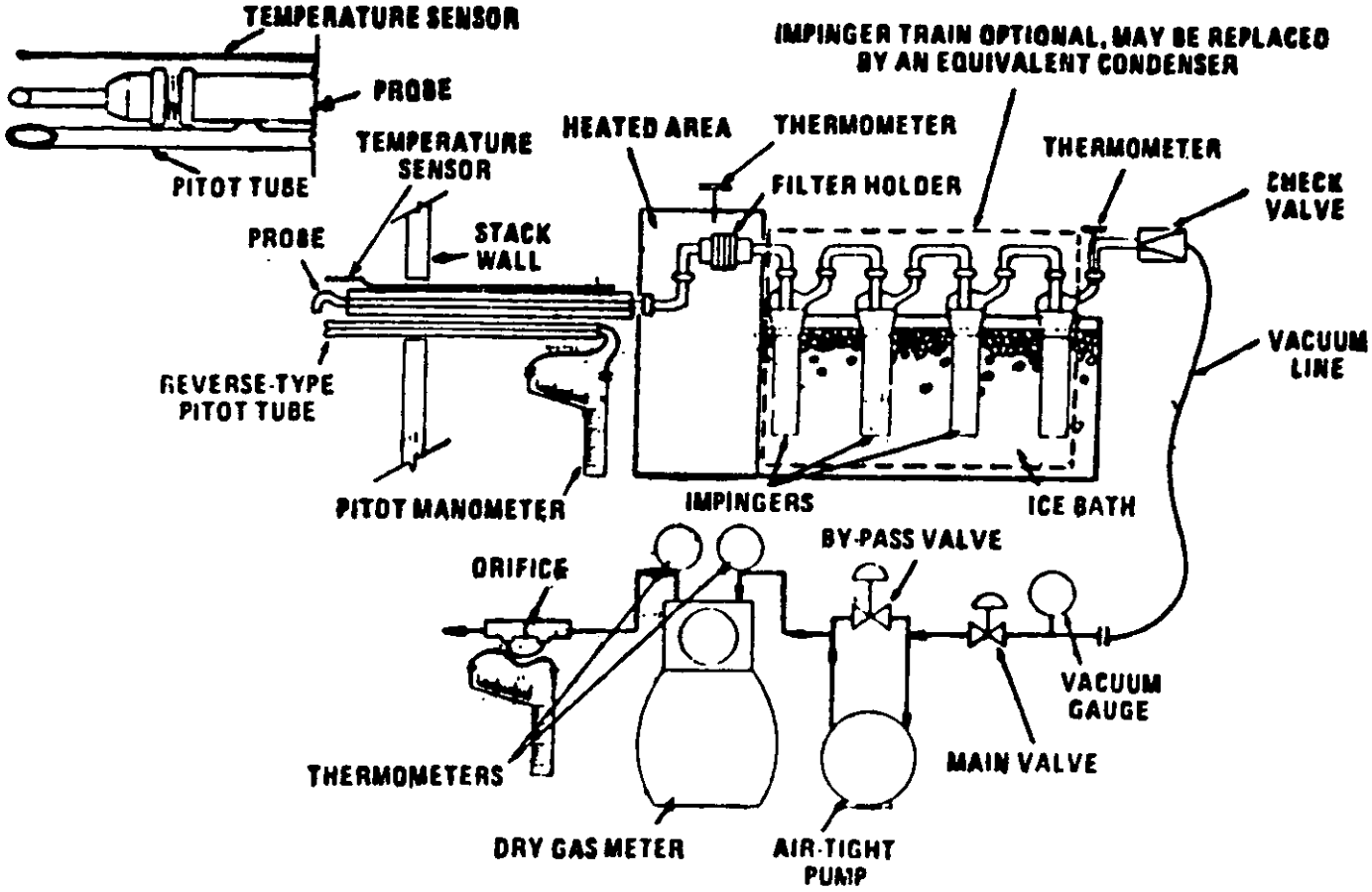


273" / 12" = 19.25'

Figure 2



PARTICULATE SAMPLING TRAIN.. METHOD 5



PARTICULATE SAMPLING TRAIN

FOR CUPOLA STACK

Figure 4

III. SUMMARY OF TEST RESULTS

The following table summarizes the particulate emissions for the dry filter stack and the #4 cupola stack. More detailed results are in Tables 1 and 2.

The allowable emission rate can be found in the Temperature Operating Permit for 4-07-0300-1507 and 1508, Paragraphs 17 and 19. The allowable are 6.5 lbs/hr.

SUMMARY OF EMISSIONS
Dry Filter Stack

13 C

	Run #1	Run #2	Run #3	Avg.
Emission Rate #/hr.	1.98	2.46	1.23	1.89
Allowable Emission Rate #/hr.	6.5	6.5	6.5	6.5
% of Allowables				29.1

SUMMARY OF EMISSIONS
#4 Cupola Stack

	Run #1	Run #2	Run #3	Avg.
Emission Rate #/hr.	0.48	0.02	0.24	0.25
Allowable Emission Rate #/hr.	6.5	6.5	6.5	6.5
% of Allowables				3.8

TABLE I

Summary of Test Reults
Dry Filter Stack

Run Number	1	2	3	Avg.
Date	1-14-81	1-14-81	1-14-81	
Time	900-1005	1140-1247	1400-1505	
Stack Temperature °F	155	156	152	154
Moisture, %	2.66	2.64	2.77	2.69
Stack Velocity, f/s	49.41	47.17	46.97	47.85
Volumetric Flow, ACFM	36,483	34,827	34,678	35,329
Volumetric Flow, DSCFM	30,674	29,247	29,272	29,731
Concentration, Grains/ACF	0.006	0.008	0.004	0.006
Concentration Grains/DSCF	0.008	0.010	0.005	0.008 0.02
Particulate Mass Rate, lb/hr	1.98	2.46	1.23	1.89 5.00
Process Weight Tons/hr	2.08	2.08	2.08	2.08
Allowable Emission Rate, lbs.	6.5	6.5	6.5	6.5

TABLE II

Summary of Test Results
#4 Cupola Stack

Run Number	1	2	3	Avg.
Date	1-14-81	1-14-81	1-14-81	1-14-81
Time	900-1009	1142-1248	1734-1920	
Stack Temperature °F	190	174	179	181
Moisture, %	8.61	9.99	8.99	9.20
Stack Velocity, f/s	44.05	44.08	46.11	44.75
Volumetric Flow ACFM	5,482	5,486	5,738	~~5569~~ 5585
Volumetric Flow DSCFM	4,095	4,138	4,342	4,192
Concentration, Grains/ACF	0.010	0.001	0.005	0.005
Concentration, Grains/DSCF	0.013	0.001	0.006	0.007 .02
Particulate Mass Rate, lb/hr	0.48	0.02	0.24	0.25 .72
Process Weight Tons/hr	2.08	2.08	2.08	2.08
Allowable Emission Rate, lbs/hr	6.5	6.5	6.5	6.5

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)

Ca - Acetone blank residue concentration, mg/g

c_a - Particulate Concentration, ACF

CFM - Cubic feet per minute

Cp - Pitot tube coefficient, (dimensionless)

c_s - Particulate Concentration, grains/DSCF

Cso_2 - 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, %

Km - Orifice Correction Factor, (dimensionless)

Kp - Pitot tube constant, 85.49 $\left[\frac{(lb/lb\text{-}mole)(in.\ Hg)}{(^{o}R)\ (in.\ H_2O)}\right]^{1/2}$

La - Maximum acceptable leakage rate for either a pretest leak check or for a leak check following a component change; equal to C.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, 18.0 g/g-mole (18.01 lb/lb-mole)

ΔP - Velocity head of stack gas, in. H_2O

Pa - Density of acetone, mg/ml

Pbar - Barometric pressure at the sampling site, in. Hg

Pg - Stack static pressure, in. H_2O

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

Qs - Volumetric flow rate, DSCFM

R - Ideal gas constant, 0.06236 mm Hg - $m^3/^oK$-g-mole (21.85 in. Hg-$ft^3/^oR$-lb-mole)

SCF - Standard Cubic Foot

ta - Ambient Temperature, ^oF

tm - Average Temperature of meter, ^oF

t_s - Average Temperature of stack, ^oF

tstd - Standard Temperature, $68^{o}F$

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. H_2O

ΔH_a - Value of ΔH measured for a specific orifice when operated under the following conditions: 0.75 cfm of dry air (M.W. = 29) at $68^{o}F$, 29.92 in. Hg.

$\sqrt{\Delta P}$ - Average of the square roots of the velocity pressure, in. H_2O

Θ - Total sampling time, min.

Θ_1 - Sampling time interval from the beginning of a run until the first component change, min.

Θ_i - Sampling time interval between two successive component changes, beginning with the interval between the first and second changes, min.

Θp - Sampling time interval from the final (n^{th}) component change until the end of the sampling run, min.

$\%CO_2$, $\%O_2$, $\%N_2$, $\%CO$ - Number percent (%) by volume (dry basis) of each compound in the stack gas.

EQUATIONS

1. $P_s = P_{bar} + \frac{P_g}{13.6}$

2. $P_m = P_{bar} + \frac{\overline{\Delta H}}{13.6}$

3. $V_{m(std)} = V_m Y \left(\frac{Tstd}{Tm}\right) \left[\frac{Pbar + \frac{\overline{\Delta H}}{13.6}}{Pstd}\right]$

4. $V_w(std) = 0.04707\ V_{lc}$

5. $B_{ws} = \frac{V_{w(std)}}{V_{m(std)} + V_{w(std)}}$

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

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

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

9. $Q_a = (v_s)\ (A_s)\ (60)$

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

11. $c_s = \left[0.0154\ (Mn/Vmstd)\right]$

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

13. $c_{50} = \frac{c_s}{1 - \left[\frac{(1.5)(\%O_2) - 0.133(\%N_2) - 0.75\ (\%CO)}{21}\right]}$

14. $c_{12} = c_s \frac{12}{\%\ CO_2}$

15. $PMR = (c_s)(Q_s)\left(\frac{60}{7000}\right)$

16. $V_n = \frac{T_s}{P_s}\left[(0.002669)(V_{1c}) + \frac{V_m}{T_m}\left(P_{bar} + \frac{\overline{\Delta H}}{13.6}\right)\right]$

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

18. $I = \frac{100\ V_n}{60\ \Theta\ v_s\ An}$

19. $V_{mc} = V_m - (L_p - L_a)\ \Theta$

20. $W_a = Ca\ Vaw\ p_a$

. . . . . .

1. Dry Filter — Run Number

1-14-81 — Date

30.15 — Barometric Pressure (in. Hg.)

-.43 — Static Pressure (in. H_2O)

60.00 — Time (minutes)

48.783 — Meter Volume (corrected)

155.00 — Stack Temperature (^oF)

68.00 — Meter Temperature (^oF)

2.02 — Meter Pressure (in. H_2O)

.804 — Sq. Root Velocity Pressure

24.20 — Mg of Particulate

28.70 — Ml of water condensed

21.00 — % O_2

.00 — % CO_2

12.305964 — Stack Area (Ft^2) $\frac{\pi D^2}{4} = 12.30$

.85 — Pitot Correction Factor

.000341 — Nozzle Area (Ft^2)

. . . . . .

1. Stack Pressure

30.11 Inches Hg

764.80 Millimeters Hg

2. Meter Pressure

30.30 Inches Hg

769.62 Millimeters Hg

3. Meter Volume

49.380 Dry Standard Cubic Feet

1.398 Dry Standard Cubic Meters

4. Water Volume

1.351 Standard Cubic Feet

.038 Standard Cubic Meters

5. Moisture Content

.0266 (Convert to % X 100)

6. Molecular Weight Dry

28.84

7. Molecular Weight Wet

28.55

8. Stack Velocity

49.41 Feet per Second

15.06 Meters per Second

9. Volumetric Flow

36,483. Actual Cubic Feet per Minute

17.2182 Actual Cubic Meters per Second

10. Volumetric Flow

30,674. Dry Standard Cubic Feet per Minute

14.4766 Dry Standard Cubic Meters per Second

11. Concentration

.0075 Grains per Dry Standard Cubic Foot

.0172 Grams per Dry Standard Cubic Meter

15. Particulate Mass Rate

1.98 Pounds per Hour

16. Volume at Nozzle

58.732 Actual Cubic Feet

1.663 Actual Cubic Meters

17. Concentration

.0063 Grains per Actual Cubic Foot

.0144 Grams per Actual Cubic Meter

18. % Isokinetic

96.85

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2. DRY FILTER — Run Number

1-14-81 — Date

30.15 Barometric Pressure (in. Hg.)

-.39 Static Pressure (in. H_2O)

60.00 Time (minutes)

47.63 Meter Volume (corrected)

156.00 Stack Temperature (^oF)

66.00 Meter Temperature (^oF)

1.84 Meter Pressure (in. H_2O)

.767 Sq. Root Velocity Pressure

30.80 Mg of Particulate

27.90 Ml of water condensed

21.00 % O_2

.00 % CO_2

12.305964 Stack Area (Ft^2)

.85 Pitot Correction Factor

.000341 Nozzle Area (Ft^2)

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1. Stack Pressure

30.12 Inches Hg

765.05 Millimeters Hg

2. Meter Pressure

30.29 Inches Hg

769.37 Millimeters Hg

3. Meter Volume

48.375 Dry Standard Cubic Feet

1.370 Dry Standard Cubic Meters

4. Water Volume

1.313 Standard Cubic Feet

.037 Standard Cubic Meters

5. Moisture Content

.0264 (Convert to % X 100)

6. Molecular Weight Dry

28.84

7. Molecular Weight Wet

28.55

8. Stack Velocity

47.17 Feet per Second

14.38 Meters per Second

9. Volumetric Flow

34,827. Actual Cubic Feet per Minute

16.4366 Actual Cubic Meters per Second

10. Volumetric Flow

29,247. Dry Standard Cubic Feet per Minute

13.8031 Dry Standard Cubic Meters per Second

11. Concentration

.0098 Grains per Dry Standard Cubic Foot

.0224 Grams per Dry Standard Cubic Meter

15. Particulate Mass Rate

2.46 Pounds per Hour

16. Volume at Nozzle

57.606 Actual Cubic Feet

1.631 Actual Cubic Meters

17. Concentration

.0082 Grains per Actual Cubic Foot

.0188 Grams per Actual Cubic Meter

18. % Isokinetic

99.51

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3. DRY FILTER — Run Number

1-14-81 — Date

30.15 Barometric Pressure (in. Hg.)

-.42 Static Pressure (in. H_2O)

60.00 Time (minutes)

47.443 Meter Volume (corrected)

152.00 Stack Temperature (^oF)

69.00 Meter Temperature (^oF)

1.84 Meter Pressure (in. H_2O)

.766 Sq. Root Velocity Pressure

15.30 Mg of Particulate

29.00 Ml of water condensed

21.00 % O_2

.00 % CO_2

12.305964 Stack Area (Ft^2)

.85 Pitot Correction Factor

.000341 Nozzle Area (Ft^2)

. . . . . .

1. Stack Pressure

30.12 Inches Hg

765.05 Millimeters Hg

2. Meter Pressure

30.29 Inches Hg

769.37 Millimeters Hg

3. Meter Volume

47.912 Dry Standard Cubic Feet

1.357 Dry Standard Cubic Meters

4. Water Volume

1.365 Standard Cubic Feet

.039 Standard Cubic Meters

5. Moisture Content

.0277 (Convert to % X 100)

6. Molecular Weight Dry

28.84

7. Molecular Weight Wet

28.54

8. Stack Velocity

46.97 Feet per Second

14.32 Meters per Second

9. Volumetric Flow

34,678. Actual Cubic Feet per Minute

16.3663 Actual Cubic Meters per Second

10. Volumetric Flow

29,272. Dry Standard Cubic Feet per Minute

13.8149 Dry Standard Cubic Meters per Second

11. Concentration

.0049 Grains per Dry Standard Cubic Foot

.0112 Grams per Dry Standard Cubic Meter

15. Particulate Mass Rate

1.23 Pounds per Hour

16. Volume at Nozzle

56.762 Actual Cubic Feet

1.607 Actual Cubic Meters

17. Concentration

.0042 Grains per Actual Cubic Foot

.0096 Grams per Actual Cubic Meter

18. % Isokinetic

98.47

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1. CUPOLA STACK — Run Number

1-14-81 — Date

30.15 Barometric Pressure (in. Hg.)

-.42 Static Pressure (in. H_2O)

64.00 Time (minutes)

43.179 Meter Volume (corrected)

190.00 Stack Temperature (^oF)

64.00 Meter Temperature (^oF)

1.56 Meter Pressure (in. H_2O)

.705 Sq. Root Velocity Pressure

39.00 Mg of Particulate

88.00 Ml of water condensed

8.00 % O_2

12.00 % CO_2

2.073942 Stack Area (Ft^2)

.85 Pitot Correction Factor

.000322 Nozzle Area (Ft^2)

. . . . . .

1. Stack Pressure
   - 30.12 Inches Hg
   - 765.05 Millimeters Hg
2. Meter Pressure
   - 30.26 Inches Hg
   - 768.61 Millimeters Hg
3. Meter Volume
   - 43.992 Dry Standard Cubic Feet
   - 1.246 Dry Standard Cubic Meters
4. Water Volume
   - 4.142 Standard Cubic Feet
   - .117 Standard Cubic Meters
5. Moisture Content
   - .0861 (Convert to % X 100)
6. Molecular Weight Dry
   - 30.24
7. Molecular Weight Wet
   - 29.19
8. Stack Velocity
   - 44.05 Feet per Second
   - 13.43 Meters per Second
9. Volumetric Flow
   - 5,482. Actual Cubic Feet per Minute
   - 2.5872 Actual Cubic Meters per Second
10. Volumetric Flow
    - 4,095. Dry Standard Cubic Feet per Minute
    - 1.9326 Dry Standard Cubic Meters per Second
11. Concentration
    - .0137 Grains per Dry Standard Cubic Foot
    - .0313 Grams per Dry Standard Cubic Meter
15. Particulate Mass Rate
    - .48 Pounds per Hour
16. Volume at Nozzle
    - 58.889 Actual Cubic Feet
    - 1.668 Actual Cubic Meters
17. Concentration
    - .0102 Grains per Actual Cubic Foot
    - .0233 Grams per Actual Cubic Meter
18. % Isokinetic
    - 108.14

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2. Cupola Stack — Run Number

1-14-81 — Date

30.15	Barometric Pressure (in. Hg.)
-.38	Static Pressure (in. H_2O)
64.00	Time (minutes)
43.68	Meter Volume (corrected)
174.00	Stack Temperature (^oF)
62.00	Meter Temperature (^oF)
1.54	Meter Pressure (in. H_2O)
.711	Sq. Root Velocity Pressure
2.00	Mg of Particulate
105.30	Ml of water condensed
9.00	% O_2
11.00	% CO_2
2.073942	Stack Area (Ft^2)
.85	Pitot Correction Factor
.000322	Nozzle Area (Ft^2)

• • • • • • • • • • • • • • •

1. Stack Pressure
   - 30.12 Inches Hg
   - 765.05 Millimeters Hg

2. Meter Pressure
   - 30.26 Inches Hg
   - 768.61 Millimeters Hg

3. Meter Volume
   - 44.671 Dry Standard Cubic Feet
   - 1.265 Dry Standard Cubic Meters

4. Water Volume
   - 4.956 Standard Cubic Feet
   - .140 Standard Cubic Meters

5. Moisture Content
   - .0999 (Convert to % X 100)

6. Molecular Weight Dry
   - 30.12

7. Molecular Weight Wet
   - 28.91

8. Stack Velocity
   - 44.08 Feet per Second
   - 13.44 Meters per Second

9. Volumetric Flow
   - 3,486. Actual Cubic Feet per Minute
   - 2.5891 Actual Cubic Meters per Second

10. Volumetric Flow
    - 4,138. Dry Standard Cubic Feet per Minute
    - 1.9529 Dry Standard Cubic Meters per Second

11. Concentration
    - .0007 Grains per Dry Standard Cubic Foot
    - .0016 Grams per Dry Standard Cubic Meter

15. Particulate Mass Rate
    - .02 Pounds per Hour

16. Volume at Nozzle
    - 59.216 Actual Cubic Feet
    - 1.677 Actual Cubic Meters

17. Concentration
    - .0005 Grains per Actual Cubic Foot
    - .0011 Grams per Actual Cubic Meter

18. % Isokinetic
    - 108.66

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34 • Cupola Stack — Run Number

1-14-81 — Date

30.15 Barometric Pressure (in. Hg.)

-.38 Static Pressure (in. H_2O)

64.00 Time (minutes)

46.061 Meter Volume (corrected)

179.00 Stack Temperature (°F)

69.00 Meter Temperature (°F)

1.66 Meter Pressure (in. H_2O)

.739 Sq. Root Velocity Pressure

19.20 Mg of Particulate

97.60 Ml of water condensed

6.00 % O_2

10.00 % CO_2

2.073942 Stack Area (Ft^2)

.85 Pitot Correction Factor

.000322 Nozzle Area (Ft^2)

• • • • • • • • • • • • • •

1. Stack Pressure

30.12 Inches Hg

765.05 Millimeters Hg

2. Meter Pressure

30.27 Inches Hg

768.86 Millimeters Hg

3. Meter Volume

46.496 Dry Standard Cubic Feet

1.317 Dry Standard Cubic Meters

4. Water Volume

4.594 Standard Cubic Feet

.130 Standard Cubic Meters

5. Moisture Content

.0899 (Convert to % X 100)

6. Molecular Weight Dry

29.84

7. Molecular Weight Wet

28.78

8. Stack Velocity

46.11 Feet per Second

14.05 Meters per Second

9. Volumetric Flow

5,738. Actual Cubic Feet per Minute

2.7080 Actual Cubic Meters per Second

10. Volumetric Flow

4,342. Dry Standard Cubic Feet per Minute

2.0492 Dry Standard Cubic Meters per Second

11. Concentration

.0064 Grains per Dry Standard Cubic Foot

.0146 Grams per Dry Standard Cubic Meter

15. Particulate Mass Rate

.24 Pounds per Hour

16. Volume at Nozzle

61.442 Actual Cubic Feet

1.740 Actual Cubic Meters

17. Concentration

.0048 Grains per Actual Cubic Foot

.0110 Grams per Actual Cubic Meter

18. % Isokinetic

107.79

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FIELD DATA SHEET

GUARDIAN SYSTEMS INC.
2809 Central Avenue
Birmingham, Alabama 35209
205/879-1860

PLANT USG Bg
LOCATION Dry Filter
BARO PRES. ~~30.35~~ 30.15

RUN # 1
DATE 10/14/81
TIME 9:06 – 10:05

POINT	TIME MIN	TIME DUR	METER VOL FT.3	STACK TEMP °F	METER TEMP °F IN	OUT	AVG	IMP TEMP F	BOX TEMP °F	METER PRESSURE "H_2O	VELOCITY PRESSURE "H_2O	Vacuum Pressure "Hg
tA		5	944.845									
1	5		948.8	151	42	46	44	40	255	1.8	.58	1
2	10		953.5	151	62	52	57	40	260	2.6	.85	3
3	15		958.4	155	66	54	60	40	240	2.8	.92	3
4	20		962.7	156	68	56	62	40	225	2.2	.72	3
5	25		966.7	156	66	58	62	40	230	1.8	.59	2
6	30		969.8	150	64	57	61	40	250	1.05	.34	1
tB												
	35		973.7	153	58	56	57	40	255	1.8	.58	2
	40		978.2	155	62	58	60	40	250	2.3	.78	3
	45		982.9	157	68	58	63	40	255	2.6	.85	4
	50		987.5	160	70	60	65	42	255	2.45	.80	5
	55		991.5	159	70	60	65	42	260	1.80	.60	4
	60	↓	994.624	152	68	60	64	42	260	1.0	.32	4
				1855			720			24.2	9.644	
12	60		49.779	155			68			2.02	.804	5

STATIC PRESSURE "H_2O -.48

PROBE TIP SIZE

BEFORE	AFTER
.290	.250
.250	.250
.280	.250

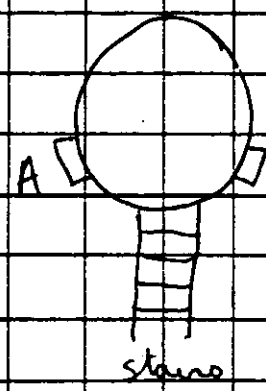
WATER
ml 20
gram 8.7
Total 28.7

OPERATOR
Denton

SAMPLE BOX NO. 4
METER BOX NO. 602
METER ΔH@ 1.60
PITOT, CP .85
TEMP. DEVICE Omega
PROBE LGTH. 5'-3
PROBE LINER glass
PROBE HTR SET. 75
AMBIENT TEMP. 44

NOTES
pitot-7" ok
orifice-ok
Leak check. Vac 20" Hg
Initial 944.845
- 944.840
.005
Vac 6" Hg
Final 994.668
- 994.666
.002

CO_2 - 0.
O_2 - 21
pitot-7" ok.



Point 1 → 6 are all the way in stack to out.

GUARDIAN SYSTEMS INC.
2809 Central Avenue
Birmingham, Alabama 35209
205/879-1850

Run Number 1

Date 1-14-81

Location Dry Filter

Amount liquid lost during transport None

Acetone blank volume, ml 305

Acetone wash volume, ml 150

Acetone blank concentration, mg/mg 8.33×10^{-6}

Acetone wash blank, mg 2.0

Filter Collections (mg)		Probe and Cyclone Wash (mg)	
Filter #	X-39	Dish #	5
Gross	277.7	Gross	81041.9
Tare	257.2	Tare	81037.2
Net	20.5	Acetone Blank	~~3.7~~ 1.0
		Net	3.7

Total Particulate Capture 24.2 mg.

Water		Silica Gel	
Final	20	Final	892.1
Initial	0	Initial	883.4
Net	20	Net	8.7

Total Water 28.7

Approved By [signature]

FIELD DATA SHEET

GUARDIAN SYSTEMS INC.
2809 Central Avenue
Birmingham, Alabama 35209
205/879-1850

PLANT USL RUN # 2
LOCATION Dry Filter stack DATE 1/14/80
BARO. PRES. 30.15 TIME 11:40 - 12:42

POINT	TIME MIN	TIME DUR	METER VOL FT.3	STACK TEMP °F	METER TEMP °F IN	OUT	AVG	IMP TEMP F	BOX TEMP °F	METER PRESSURE "H_2O	VELOCITY PRESSURE "H_2O	Vacuum Pressure "Hg
tB		5	994.750									
1	5		998.6	152	58	54	56	40	250	1.7	.55	2
2	10		1002.9	159	66	58	62	40	255	2.1	.70	2
3	15		1007.4	161	70	60	65	40	265	2.3	.75	3
4	20		1011.9	160	70	62	66	42	265	2.25	.75	3
5	25		1015.9	156	72	62	67	42	255	1.8	.57	2
6	30		1019.5	149	72	62	67	42	250	1.35	.44	2
tA												
	35		1023.4	158	69	64	66	42	245	1.7	.56	2
	40		1028.0	159	70	64	67	42	250	2.3	.75	3
2	45		1032.5	155	72	66	69	44	245	2.2	.70	3
1	50		1036.6	160	72	66	69	44	225	2.0	.63	3
	55		1040.4	161	76	68	72	44	250	1.55	.50	2
2	100	✓	1043.352	145	76	68	72	44	265	.86	28	1
				1875 ✓			798			22.11	9.998	
2	65		48.602 ✓	156 ✓			66 ✓			184 ✓	.767 ✓	3

STATIC PRESSURE "H_2O -.39.

PROBE TIP SIZE

BEFORE	AFTER
.250	.250
.250	.250
.258	.250

WATER
ml 20
gram 7.9
Total 27.9

OPERATOR
Denton

SAMPLE BOX NO. 4
METER BOX NO. 600
METER ΔH@ 1.60
PITOT, CP .85
TEMP. DEVICE Omega
PROBE LGTH. 5-3
PROBE LINER glass
PROBE HTR SET. 75
AMBIENT TEMP. 47

NOTES
orifice - ok
pitot - ok

leak check.
Initial vac 10" Hg
994.742
- 994.739
.003

Final vac 6"Hg 1040.394
- 1043391
.003

CO_2 - 0.
O_2 - 21

pitot - ok.

GUARDIAN SYSTEMS INC.
2309 Central Avenue
Birmingham, Alabama 35209
205/879-1800

Run Number 2

Date 1-14-81

Location DRY FILTER

Amount liquid lost during transport None

Acetone blank volume, ml 305

Acetone wash volume, ml 125

Acetone blank concentration, mg/mg 8.33 x 10-6

Acetone wash blank, mg 2.0

Filter Collections (mg)		Probe and Cyclone Wash (mg)	
Filter #	X-37	Dish #	6
Gross	278.0	Gross	82117.2
Tare	256.3	Tare	82107.3
Net	21.7	Acetone Blank	-0.8
		Net	9.1

Total Particulate Capture 30.8 mg.

Water		Silica Gel	
Final	20	Final	900.0
Initial	—	Initial	892.1
Net	20	Net	7.9

Total Water 27.9

Approved By

FIELD DATA SHEET

GUARDIAN SYSTEMS INC.
2809 Central Avenue
Birmingham, Alabama 35209
205/879-1850

PLANT USG RUN # 3
LOCATION Dry Filter Stack DATE 1/14/83
BARO PRES. 30.15 TIME 2:00 - 3:05

POINT NO.	TIME MIN	TIME DUR	METER VOL FT.3	STACK TEMP °F	METER TEMP °F IN	METER TEMP °F OUT	METER TEMP °F AVG	IMP TEMP °F	BOX TEMP °F	METER PRESSURE "H_2O	VELOCITY PRESSURE "H_2O	Vacuum Pressure "Hg
A		4	1043.460									
	5		1047.2	149	56	60	58	40	240	1.55	.51	1
	10		1051.4	150	66	62	64	40	230	2.0	.66	2
	15		1055.7	149	72	64	68	42	240	2.1	.70	3
	20		1059.9	152	72	66	69	42	250	2.0	.65	3
	25		1063.7	150	72	68	70	42	250	1.6	.53	2
	30		1066.5	140	72	68	70	42	250	.83	.27	1
B												
	35		1070.8	150	68	68	68	42	260	2.0	.67	3
	40		1075.4	159	72	68	70	42	250	2.4	.75	4
	45		1080.1	154	74	68	71	42	260	2.5	.80	4
	50		1084.6	155	78	70	74	42	250	2.2	.72	4
	55		1088.5	157	78	70	74	42	250	1.7	.54	3
	60	↓	1091.871	155	78	70	74	42	265	1.15	.37	3
				1820			830			22.03	9.188	
2	60		48.411	152			69			1.84	.766	4

STATIC PRESSURE "H_2O -.42

PROBE TIP SIZE

BEFORE	AFTER
.250	.250
.250	.250
.250	.250

WATER
ml 20
gram 9.0
Total 29.0

OPERATOR
Denton

SAMPLE BOX NO. 4
METER BOX NO. 602
METER ΔH@ 1.60
PITOT, CP .85
TEMP. DEVICE Omega
PROBE LGTH. 5'-3
PROBE LINER glass
PROBE HTR SET. 25
AMBIENT TEMP. 62

NOTES
orifice - ok
pitot - OK

Leak check.
Initial 10" Hg
1043.460
-1043.451
.009
Final vac 6" Hg 1091.918
- 1091.914
.004

CO_2 - 0
O_2 - 21.
pitot - 7". OK

GUARDIAN SYSTEMS INC.
2808 Central Avenue
Birmingham, Alabama 35209
205/879-1880

Run Number 3

Date 1-14-81

Location Dry Filter

Amount liquid lost during transport None

Acetone blank volume, ml 305

Acetone wash volume, ml 95

Acetone blank concentration, mg/mg 8.33×10^{-6}

Acetone wash blank, mg 2.0

Filter Collections (mg)		Probe and Cyclone Wash (mg)	
Filter #	X-42	Dish #	7
Gross	273.7	Gross	83758.1
Tare	261.9	Tare	83754.0
Net	11.8	Acetone Blank	-0.6
		Net	3.5

Total Particulate Capture 15.3 mg.

Water		Silica Gel	
Final	20	Final	909.0
Initial	—	Initial	900.0
Net	20	Net	9.0

Total Water 29.0

Approved By [signature]

FIELD DATA SHEET

GUARDIAN SYSTEMS INC.
2808 Central Avenue
Birmingham, Alabama 35209
205/879-1850

PLANT US Gypsum
LOCATION Capola
BARO PRES. 30.15

RUN # 1
DATE 11/4/81
TIME 9:00 – 10:09

Gerald Coker
Sampler Linda Gosa
County observer Joe Wilson

POINT	TIME MIN	TIME DUR	METER VOL FT.3	STACK TEMP °F	METER TEMP °F IN	OUT	AVG	IMP TEMP F	BOX TEMP F	METER PRESSURE "H2O	VELOCITY PRESSURE "H2O	Vacuum Pressure "Hg
TA		6	605.385									
1	6		611.65	195	60	48	54	34	230	1.6	.51	7
2	18		616.10	195	68	52	60	38	230	1.8	.57	8
3	24		621.85	195	74	54	64	40	240	1.7	.56	9
4	30		627.22	185	72	58	65	42	240	1.4	.45	8
TB												
1	40		632.85	190	74	56	65	44	230	1.6	.51	8
2	48		638.53	190	76	58	67	66	240	1.7	.54	9
3	56		644.03	190	78	62	70	62	230	1.6	.51	10
4	64		649.000	180	74	62	68	62	230	1.1	.35	7
				1520			53			12.5	5.643	10
Σ	64		43.615	190			64			1.56	.705	10

STATIC PRESSURE "H2O: -.42

PROBE TIP SIZE

BEFORE	AFTER
.243	.243
.243	.243
.243	.243

WATER

ml _____

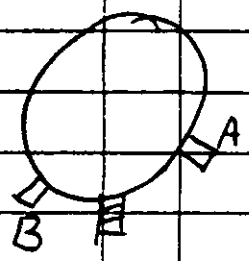
gram _____

Total _____

OPERATOR

Scarborough

SAMPLE BOX NO. ~~400~~ 6
METER BOX NO. 400
METER ΔH@ 1.82
PITOT, CP .84
TEMP. DEVICE Potentiometer
PROBE LGTH. 5'62
PROBE LINER Glass
PROBE HTR SET. 5.5
AMBIENT TEMP. 42



NOTES

Orifice 7"
Run 7"
Static 8"

Initial Leak check
605.371 15"Hg
605.352
.019

CO_2 12%
O_2 8%

Final Leak check
Pitot 8"
~~649.050~~ 649.230
649.210
.020
~~649.150~~
649.210

GUARDIAN SYSTEMS INC.
2909 Central Avenue
Birmingham, Alabama 35209
205/879-1550

Run Number 1

Date 1-14-81

Location Cupola Stack

Amount liquid lost during transport None

Acetone blank volume, ml 305

Acetone wash volume, ml 295

Acetone blank concentration, mg/mg 8.35×10^{-6}

Acetone wash blank, mg 2.0

Filter Collections (mg)		Probe and Cyclone Wash (mg)	
Filter #	Q-24	Dish #	1
Gross	249.9	Gross	81505.2
Tare	255.5	Tare	81458.7
Net	-5.6	Acetone Blank	-1.9
		Net	44.6

Total Particulate Capture 39.0 mg.

* Water		Silica Gel	
Final	2055.5	Final	801.4
Initial	2010.1	Initial	758.8
Net	45.4	Net	42.6

Total Water 88.0

* impingers were weighed

Approved By [signature]

FIELD DATA SHEET

GUARDIAN SYSTEMS INC.
2809 Central Avenue
Birmingham, Alabama 35209
205/879-1550

PLANT U S Gypsum
LOCATION Cupola
BARO. PRES. 30.15

RUN # 2
DATE 1/14/81
TIME 11:42 - 12:48

POINT	TIME MIN	TIME DUR	METER VOL FT.3	STACK TEMP °F	METER TEMP °F IN	METER TEMP °F OUT	METER TEMP °F AVG	IMP TEMP °F	BOX TEMP °F	METER PRESSURE "H_2O	VELOCITY PRESSURE "H_2O	Vacuum Pressure "Hg
		56	649.295									
1	8		654.95	180	52	48	50	40	230	1.7	.56	4
2	16		660.75	180	62	50	56	40	230	1.7	.56	4
3	24		666.800	175	64	52	58	40	230	1.6	.53	4
4	32		671.33	~~145~~ 175	68	54	61	44	235	1.2	.40	4
4A												
1	40		677.03	170	68	58	63	55	230	1.6	.53	4
2	48		682.68	170	72	60	66	52	230	1.6	.53	4
3	56		688.53	170	78	62	70	55	250	1.7	.55	5
4	64		693.416	170	80	66	73	58	260	1.2	.40	4
				1350			497			12.3	5.687	
8	64		44.121	174			62			1.54	.711	5

STATIC PRESSURE "H_2O -.38

PROBE TIP SIZE

BEFORE	AFTER
.243	.243
.243	.243
.243	.243

WATER

ml _____

gram _____

Total _____

OPERATOR

Scarborough

SAMPLE BOX NO. 6
METER BOX NO. 4100
METER ΔH@ 1.82
PITOT, CP .84
TEMP. DEVICE LAN
PROBE LGTH. 6'
PROBE LINER Glass
PROBE HTR SET. 85%
AMBIENT TEMP. 48

NOTES

Orifice 7"
Pitot 7.5"
Initial Leak 15" Hg

649.295
649.295
.010

CO_2 11%
O_2 9%

Final Leak 8" Hg
693.459
693.450
.009

Pitot 7"

GUARDIAN SYSTEMS INC.
2809 Central Avenue
Birmingham, Alabama 35209
205/879-1850

Run Number 2

Date 1-14-81

Location Cupola Stack

Amount liquid lost during transport None

Acetone blank volume, ml 305

Acetone wash volume, ml 80

Acetone blank concentration, mg/mg 8.33×10^{-6}

Acetone wash blank, mg 2.0

Filter Collections (mg)		Probe and Cyclone Wash (mg)	
Filter #	X-38	Dish #	2
Gross	247.3	Gross	81996.7
Tare	252.8	Tare	81988.7
Net	-5.5	Acetone Blank	.5
		Net	7.5

Total Particulate Capture 2.0 mg.

Water		Silica Gel	
* Final	1907.3	Final	743.4
Initial	1827.8	Initial	717.6
Net	79.5	Net	25.8

Total Water 105.3

* impingers were weighed

Approved By [signature]

FIELD DATA SHEET

GUARDIAN SYSTEMS INC.
2809 Central Avenue
Birmingham, Alabama 35209
205/879-1880

PLANT U S Gypsum
LOCATION Cupola
BARO PRES. 30.15

RUN # ~~3~~ 4 3
DATE 1/14/80
TIME 5:34 - 7:20

STATIC PRESSURE "H_2O -.38

POINT	TIME MIN	TIME DUR	METER VOL FT.3	STACK TEMP °F	METER TEMP. °F IN	OUT	AVG	IMP TEMP F	BOX TEMP F	METER PRESSURE "H_2O	VELOCITY PRESSURE "H_2O	Vacuum Pressure "Hg
4/3		8	740.864								~~.58~~	
1	8		746.86	186	64	60	62	40	235	1.8	.58	4
	16		753.15	188	70	60	65	50	230	2.0	.65	4
	24		758.40	186	72	60	66	50	230	1.7	.57	4
	32		764.05	182	76	64	70	50	230	1.5	.48	4
4												
	40		770.80	184	78	68	73	54	230	1.8	.58	4
	48	*	776.41	175	82	70	76	56	230	1.6	.55	4
	56		782.24	176	72	68	70	58	225	1.6	.55	4
	64		787.390	158	76	68	72	60	235	1.3	.42	4
				1435			554			13.3	5.908	
6	64		46.526	179			69			1.66	.739	4

* stopped during second point process shutdown
≈ 15 minutes later 6:30 - 7:00

	BEFORE	AFTER
PROBE TIP SIZE	.243	.243
	.243	.243
	.243	.243

WATER
ml
gram
Total

OPERATOR
Scarborough

SAMPLE BOX NO. 5
METER BOX NO. 400
METER ΔH@ 1.82
PITOT, CP .84
TEMP. DEVICE ~~Thermo~~ Omega
PROBE LGTH. 5'-2
PROBE LINER Glass
PROBE HTR SET. 859
AMBIENT TEMP. 55

NOTES
Pitot 8"
Initial Leak
~~739.730~~ 10" Hg
740.864
740.860
.004
CO_2 10%
O_2 6%
Final Leak 6" Hg
787.420
787.413
.007
Pitot 7"

GUARDIAN SYSTEMS INC.
2809 Central Avenue
Birmingham, Alabama 35209
205/879-1690

Run Number 43

Date 1-14-81

Location Cupola Stack

Amount liquid lost during transport None

Acetone blank volume, ml 305

Acetone wash volume, ml 100

Acetone blank concentration, mg/mg 8.33 x 10-6

Acetone wash blank, mg 2.0

Filter Collections (mg)		Probe and Cyclone Wash (mg)	
Filter #	X-34	Dish #	4
Gross	252.3	Gross	79613.6
Tare	256.0	Tare	79590.0
Net	-3.7	Acetone Blank	.7
		Net	22.9

Total Particulate Capture 19.2 mg.

Water		Silica Gel	
Final	1920.2	Final	668.0
Initial	1842.4	Initial	648.2
Net	77.8	Net	19.8

Total Water 97.6

Approved By [signature]

CUPOLA DATA	1	2	3	4	TOTAL PER.	TOTAL CUM.
AVAILABLE TIME				24.00		216.00
DOWN TIME				.17		61.16
% DOWN TIME				.7		28.3
GROSS HOURS				23.83		154.84
DELAY HOURS				2.33		25.58
% DELAY				9.8		16.5
DIVERSION TIME	PER	CUM	% RECOVERY		44.6	50.0
			SLAG FUEL RATIO		5.8	6.0
			MELT RATE		8401	8368

	GRANULATED PER	GRANULATED CUM	TILE PER	TILE CUM	BONDED PER	BONDED CUM
			24.00	216.00		
			.17	61.16		
			.7	28.3		
			23.83	154.84		
			2.33	25.58		
			9.8	16.5		
% WASTE			—	—		
% RECOVERY			44.6	50.0		

COMMODITY	DAILY PROD.	UNITS PER NET HOUR STD.	UNITS PER NET HOUR ACT.	DAILY NET MACH. HOURS STD.	DAILY NET MACH. HOURS ACT.	SALEABLE TONS PROD.	TONS PER NET HOUR STD.	TONS PER NET HOUR ACT.
BONDED	PER							
	CUM							
GRANULATED	PER							
	CUM							
TILE	PER	14.40	21.50	44.69	3.10	2.08		
	CUM	104.41	129.26	323.64	3.10	2.50		
CONWED	PER							
	CUM							
I.G.W.	PER							
	CUM							
	PER							
	CUM							
	PER							

ANALYSIS OF DELAY TIME

DESCRIPTION	GRANULATED PER	GRANULATED CUM	TILE PER	TILE CUM	BONDED PER	BONDED CUM	TOTAL PER	TOTAL CUM
PRODUCT CHANGES			—	—				
MECH. DELAYS			1.50	16.91				
OPERATIONAL DELAYS			.83	8.67				
TOTAL			2.33	25.58			2.33	25.58
ANALYSIS OF DOWN TIME								
Air Lift & Screen			.17					
			.17	61.16			.17	61.16

ANALYSIS OF MACHINE SPEED

DEPT.	PERIOD NET HOURS ACTUAL	PERIOD NET HOURS STD.	PERIOD NET HOURS VAR.	CUM NET HOURS ACTUAL	CUM NET HOURS STD.	CUM NET HOURS VAR.
BONDED						
TILE	21.50	14.40	(7.10)	129.26	104.41	(24.85)
GRANULATED						
TOTAL						

ANALYSIS OF DAILY PRODUCTION

PERIOD January 14, 1981

'73 REV. 6/65 (PRINTED IN U.S.A.)

SHIFT NO. 7-3

CUPOLA REPORT

Date 1-14-81

Operator JAMES ROBINSON NO. 4 CUPOLA Formulator

TIME	LBS COKE USED STANDARD	LBS COKE USED EXTRA	%	LBS. SLAG USED	%			TIME	LBS COKE USED STANDARD	LBS COKE USED EXTRA	Shale	LBS. SLAG USED	Phos	
7:00	[illegible]		[illegible]	[illegible]	[illegible]	19	17	11:41	450		0	2600	0	1[illegible]
7:17	450		0	2600	0	17	18	12:01	450		0	2600	0	2[illegible]
7:35	450		0	2600	0	18	19	12:20	450		0	2600	0	19
7:51	450		0	2600	0	16	20	12:37	450		0	2600	0	1[illegible]
8:08	450		0	2600	0	17	21	12:55	450		0	2600	0	1[illegible]
8:25	450		0	2600	0	17	22	1:15	450		0	2600	0	2[illegible]
8:42	450		0	2600	0	17	23	1:35	450		0	2600	0	2[illegible]
9:00	450		0	2600	0	18	24	1:57	450		0	2600	0	2[illegible]
9:18	450		0	2600	0	18	25	2:17	450		0	2600	0	2[illegible]
9:34	450		0	2600	0	16	26	2:39	450		0	2600	0	2[illegible]
9:52	450		0	2600	0	18	27	2:59	450		0	2600	0	2[illegible]
10:10	450		0	2600	0	18	28							
10:28	450		0	2600	0	18	29							
10:46	450		0	2600	0	18	30							
11:04	450		0	2600	0	18	31							
11:23	450		0	2600	0	19	32							

Remarks

Operator NO. CUPOLA Formulator

TIME	LBS COKE USED STANDARD	LBS COKE USED EXTRA		LBS. SLAG USED				TIME	LBS COKE USED STANDARD	LBS COKE USED EXTRA		LBS. SLAG USED		
							17							
							18							
							19							
							20							
							21							
							22							
							23							
							24							
							25							
							26							
							27							
							28							
							29							
							30							
							31							
							32							

Remarks

73 REV. 6/65 (PRINTED IN U.S.A.)

SHIFT NO. 3-11

CUPOLA REPORT

Date 1/14-81

Operator HOPINAND JONES NO. 4 CUPOLA Formulator

TIME	LBS COKE USED STANDARD	LBS COKE USED EXTRA	SHAKE	LBS. SLAG USED AFTER	PHOS			TIME	LBS COKE USED STANDARD	LBS COKE USED EXTRA	SHAKE	LBS SLAG USED AFTER	PHOS	
7:59														
8:20	450		0	2600	0	21	17	9:20	450		0	2600	0	18
8:37	450		0	2600	0	17	18	9:37	450		0	2600	0	17
8:52	450		0	2600	0	19	19	9:52	450		0	2600	0	15
9:13	450		0	2600	0	17	20	10:07	450		0	2600	0	15
9:33	450		0	2600	0	20	21	10:23	450		0	2600	0	16
9:52	450		0	2600	0	19	22	10:40	450		0	2600	0	17
10:10	450		0	2600	0	18	23	10:52	450		0	2600	0	16
10:27	450		0	2600	0	17	24							
10:43	450		0	2600	0	16	25							
10:59	450		0	2600	0	16	26							
11:39	450		0	2600	0	AIR OFF	27							
11:58	450		0	2600	0	19	28							
12:16	450		0	2600	0	18	29							
12:28	450		0	2600	0	AIR OFF	30							
12:46	450		0	2600	0	18	31							
13:02	450		0	2600	0	16	32							

Remarks

Operator NO. ____ CUPOLA Formulator

TIME	LBS COKE USED STANDARD	LBS COKE USED EXTRA		LBS. SLAG USED				TIME	LBS COKE USED STANDARD	LBS COKE USED EXTRA		LBS. SLAG USED		
							17							
							18							
							19							
							20							
							21							
							22							
							23							
							24							
							25							
							26							
							27							
							28							
							29							
							30							
							31							
							32							

Remarks

'73 REV. 6/65 (PRINTED IN U.S.A.)

SHIFT NO. 11-2

CUPOLA REPORT

Date 1-14-81

Operator _____ NO. 4 CUPOLA Formulator _____

TIME	LBS COKE USED STANDARD	LBS COKE USED EXTRA	SHAKE	LBS. SLAG USED	PHOS			TIME	LBS COKE USED STANDARD	LBS COKE USED EXTRA	SHAKE	LBS. SLAG USED	PHOS	
10:56														
11:13	450		0	2600	0	17	17	3:45	450		0	2600	0	18
11:30	450		0	2600	0	17	18	4:03	450		0	2600	0	18
11:46	450		0	2600	0	18	19	4:20	450		0	2600	0	17
12:05	450		0	2600	0	17	20	4:36	450		0	2600	0	16
12:21	450		0	2600	0	16	21	4:52	[illegible]		0	2600	0	16
12:38	450		0	2600	0	17	22	5:08	[illegible]		0	2600	0	16
12:55	450		0	2600	0	17	23	5:25	450		0	2600	0	17
1:11	450		0	2600	0	16	24	5:44	450		0	2600	0	19
1:27	[illegible]		0	2600	0	16	25	6:03	450		0	2600	0	19
1:44	450		0	2600	0	17	26	6:21	450		0	2600	0	18
2:01	450		0	2600	0	17	27	6:40	450		0	2600	0	19
2:19	450		0	2600	0	18	28							
2:36	450		0	2600	0	17	29							
2:53	450		0	2600	0	17	30							
3:10	450		0	2600	0	17	31							
3:27	450		0	2600	0	17	32							

Remarks _____

Operator _____ NO. _____ CUPOLA Formulator _____

TIME	LBS COKE USED STANDARD	LBS COKE USED EXTRA		LBS. SLAG USED				TIME	LBS COKE USED STANDARD	LBS COKE USED EXTRA		LBS SLAG USED		
							17							
							18							
							19							
							20							
							21							
							22							
							23							
							24							
							25							
							26							
							27							
							28							
							29							
							30							
							31							
							32							

Remarks _____

VI. CALIBRATIONS

General

The meter boxes were recalibrated upon return to the laboratory from this test. Using the average meter pressure, the boxes were calibrated at the closest point to the original calibration (for an average meter pressure of 1.59 a 1.50 "H_2O was used as the calibration point). These calibrations produced a single point of MCF and Δ H@ which was compared to the original calibration. All were within the 5% allowed at the highest vacuum seen. This new MCF was applied against all meter volumes in these tests. These calibration sheets are located behind the original calibration sheets.

The equipment used on the dry filter stack was as follows:

Probe: 5' - 3

Box: 600

Stack Temperature: OMEGA

Sample Box: 4

The average temperature of the stack was 154 °F. The OMEGA was recalibrated at 155 °F and agreed within 1.5% of the initial calibration value.

The equipment used on the cupola stack was as follows:

Probe: 5' - 2

Box: 400

Stack Temperature: L&N #2 and OMEGA

Sample Box: 5 and 6

The average temperature of the stack was 181 °F. The OMEGA and L&N #2 was recalibrated at 180 °F and agreed within 1.5% of the initial calibration value.

Type A
Glass Fiber Filters

FEATURES

• High tensile strength. • Excellent handling characteristics. • Good wetting properties. • Minimum of 99.9% retention for particles of .3 μm 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 physicochemical 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	6	Selenium	5000
Chromium	10	Tin	10
Cobalt	10	Titanium	170
Copper	2	Vanadium	10
Iron	2300	Zinc	5000 to 25,000
Lead	20		

OTHER PHYSICALS:

BSO	522	Flow Resistance (Max.) @ 320 cm/min.	80 mm
*pH	8.5	Flow Rate (air) lpm/cm² @ 70 cm Hg	50
DOP @320cm/min (ASTM Method 2986)	99.9%	Max. Use Temp.	400°C
Tensile Strength (Fed. Spec. UUP31B)	750 gr	Static Properties	Low
Weight 8"x10" sheet	4.0±.3 gr.	Ability to Fold	Excellent

WATER EXTRACTABLE IONS

Sulfate	100	Chloride	1500
Nitrate	50	Fluoride	15
Ammonia	20		

*pH - Gelman Procedure

A. Soaking in distilled water

B. Add 15 drops saturated KCl solution

C. Soak one 8" x 10" sheet and analyze prepared as per the Gelman Procedure

D. 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 μm 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, correction 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 and 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.) @ 320 cm/min.	80 mm
*pH	9.0	Flow Rate (air) lpm/cm² @ 70 cm Hg	5.0
DOP @320cm/min ASTM Methods 2986)	99.9%	Max. Use Temp.	400 C
Tensile Strength (Fed. Spec. UUP31B)	600 gr.	Static Properties	Medium
Weight 8"x10" sheet	4.0±.3 gr.	Ability to Fold	Good

WATER EXTRACTABLE IONS:

Sulfate	600	Chloride	1500
Nitrate	115	Fluoride	87
Ammonia	13		

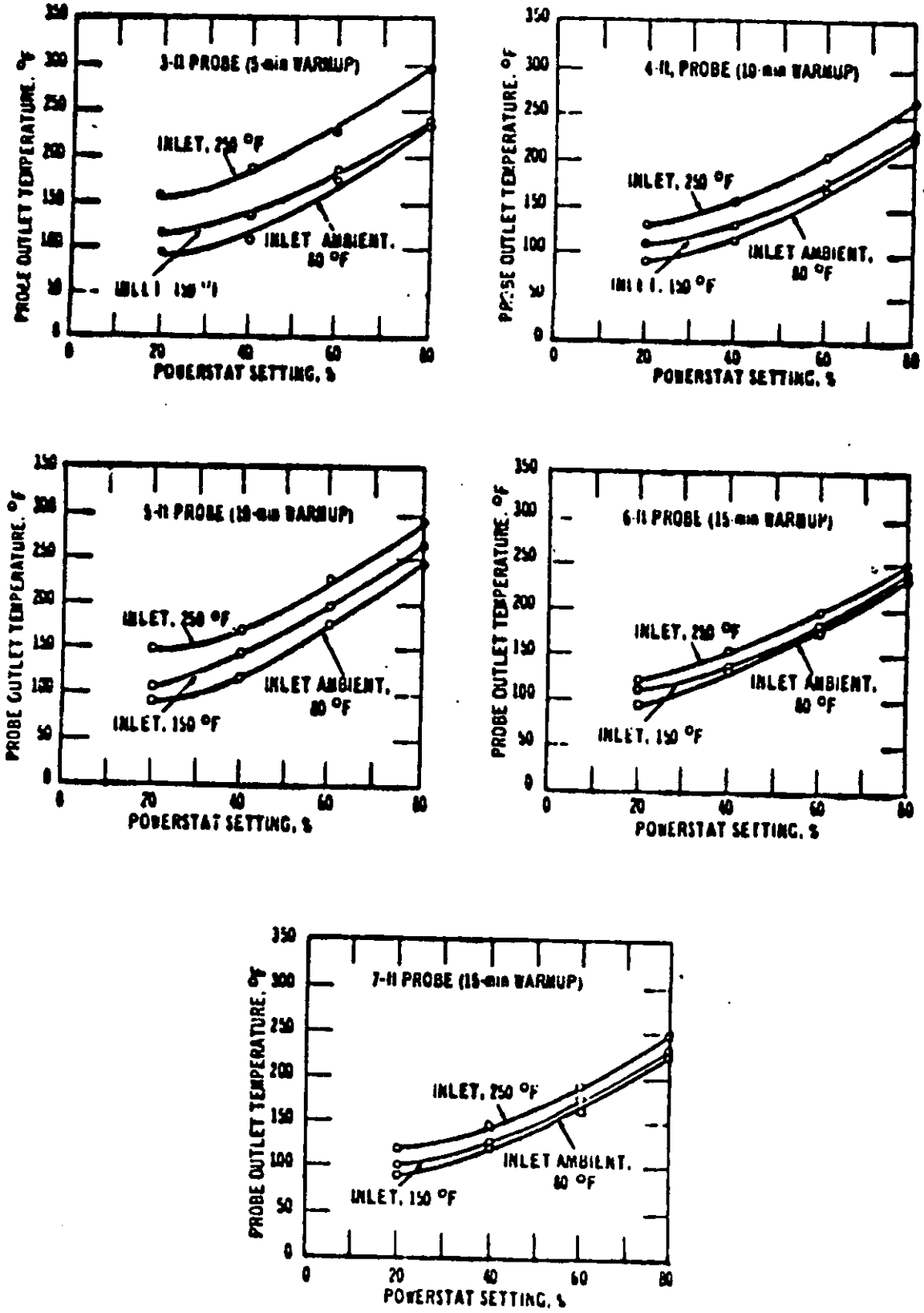
*pH - Gelman Procedure

A. Soaking in distilled water

B. Add 15 drops saturated KCl solution

C. Soak one 8" x 10" sheet and analyze prepared as per the Gelman Procedure

D. Run pH at ambient temperature



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

Figure 16

Probe Temperatures

METER CALIBRATION FORM

Date 12/30/80 Box No. 400

P_{bar} = 30.18 in. Hg Calibrated by Jim Denton

(min)	Orifice Manometer Setting ΔH (in. H_2O)		Δ wtm (in. H_2O)	Gas Volume Wet Test Meter Initial	Gas Volume Wet Test Meter Final	Gas Volume Dry Gas Meter Initial	Gas Volume Dry Gas Meter Final	Temperature Wet Test Meter Initial	Temperature Wet Test Meter Final	Avg. Temp. Dry Gas Mete Inlet	Avg. Temp. Dry Gas Mete Outle
5	.5	Vac 10" Hg	-.40	863.582	874.663	546.210	552.238	18.4	18.4	76/92	70/7
5	1.0	10"	-.60	875.424	883.918	552.729	561.276	18.4	18.4	88/100	76/8
5	1.5	10"	-.70	884.776	894.890	561.772	572.224	18.4	18.3	96/108	82/86
5	2.0	10"	-.90	896.436	907.325	572.522	584.653	18.3	18.3	100/106	86/90
5	2.5	10"	-1.15	907.432	921.240	585.277	599.072	18.3	18.2	102/108	90/92

Pump must be operated for at least 15 minutes at each ΔH setting (.5, 1, 1.5, 2 and 3)

T_{dgm} = average temperature of dry gas meter (inlet and outlet) + 460°F

T_{wtm} = average temperature of wet test meter + 460°F

$$P_{wtm} = P_{bar} - \frac{\Delta wtm}{13.6}$$

$$P_{dgm} = P_{bar} + \frac{\Delta H}{13.6}$$

Δwtm = pressure on wet test meter in inches of H_2O

Y = meter calibration factor

28.316 = conversion factor when using a wet test meter calibrated in liters

Calculations

$$Y = \frac{(\text{wet final} - \text{wet initial})(T_{dgm})(P_{wtm})}{(\text{dry final} - \text{dry initial})(28.316)(T_{wtm})(P_{dgm})}$$

or (1)

$$\bar{Y} = \frac{\Sigma Y}{5}$$

Meter Tolerance = 1.00 ± 0.01

If the meter calibration factor is not within the allowable tolerance, the calibration factory Y may be used to mathematically correct the gas meter dial readings to the proper values instead of physically adjusting the dry gas meter dials to correspond to the wet test meter readings.

METER CALIBRATION FORM

Date 1-16-81 Box No. 400

P_{bar} = 30.36 in. Hg Calibrated by [illegible]

Orifice Manometer Setting ΔH (in. H_2O)	Δ wtm (in. H_2O)	Gas Volume Wet Test Meter		Gas Volume Dry Gas Meter		Temperature Wet Test Meter		Avg. Temp. Dry Gas Meter	
		Initial	Final	Initial	Final	Initial	Final	Inlet	Outlet
1.5 @ 11" Hg	-.90	33.928	44.289	799.235	809.593	19.7	19.6	84/100	68/78
1.5 @ 11" Hg	-.90	44.289	54.615	809.593	820.120	19.6	19.6	100/106	74/82
1.5 @ 11" Hg	-.90	54.615	64.874	820.120	830.786	19.6	19.4	106/110	82/86

Pump must be operated for at least 15 minutes at each ΔH setting (.5, 1, 1.5, 2 and 3)

T_{dgm} = average temperature of dry gas meter (inlet and outlet) + 460°F

T_{wtm} = average temperature of wet test meter + 460°F

$$P_{wtm} = P_{bar} - \frac{\Delta wtm}{13.6}$$

$$P_{dgm} = P_{bar} + \frac{\Delta H}{13.6}$$

.9984
.9959
.9860
.9934 = .99

Δwtm = pressure on wet test meter in inches of H_2O

Y = meter calibration factor

28.316 =conversion factor when using a wet test meter calibrated in liters

Calculations

$$Y = \frac{(\text{wet final} - \text{wet initial})(T_{dgm})(P_{wtm})}{(\text{dry final} - \text{dry initial})(28.316)(T_{wtm})(P_{dgm})} \text{ or } (1)$$

$$\bar{Y} = \frac{\Sigma Y}{5}$$

Meter Tolerance = 1.00 ± 0.01

If the meter calibration factor is not within the allowable tolerance, the calibration factory Y may be used to mathematically correct the gas meter dial readings to the proper values instead of physically adjusting the dry gas meter dials to correspond to the wet test meter readings.

ORIFICE CALIBRATION FORM

Date 12/30/80 Meter Box No. 900

P_{bar} 30.18 Calibrated By Jim Denton

ΔH	V_1	V_2	θ	t_1	t_2	$V_2 - V_1$	Q_m	K_m
in. H_2O	CF	CF	Sec.	°F	°F	CF		
.5	546.210	552.238	900	82	72	6.028	.4013	.7284
1.0	552.729	561.276	900	94	79	8.547	.5670	.7234
1.5	561.872	572.224	900	102	84	10.352	.6805	.7061
2.0	572.522	584.653	900	103	88	12.131	.8047	.7208
2.5	585.277	599.072	900	105	91	13.795	.9042	.7229
							Average K_m	.7203

V_1 = Dry gas meter reading at the start of each test

V_2 = Dry gas meter reading at the end of each test

ΔH_a = 1.78

t_1 = Dry gas meter inlet temperature

t_2 = Dry gas meter outlet temperature

Calculations

1. Q_m = (for each ΔH) $\frac{V_2 - V_1}{\theta} \left[\frac{t_2 + 460}{\frac{t_1 + t_2}{2} + 460} \right] (60)(Y)$

1.008
1.009
1.002
1.009
.996
1.004 = 1.00

2. K_m = (for each ΔH) $Q_m \sqrt{\frac{P_m M_m}{T_m \Delta H}}$

$M_m = 29$
$T_m = t_2 + 460$
$P_m = P_{bar} + \frac{\Delta H}{13.6}$

Y = meter calibration factor

3. Calculate the average K_m as follows:

$$\bar{K}_m = \frac{\Sigma K_m}{5}$$

4. Calculate ΔH_a as follows:

$$\Delta H_a = \frac{Q@^2 \; P@ \; M@}{T@} \left[\frac{1}{\bar{K}_m^2} \right] = \frac{0.921}{\bar{K}_m^2}$$

Q@ = 0.75 cfm
T@ = 528°R
P@ = 29.92 in.Hg
M@ = 29

5. Orifice Tolerance = 1.84 ± .25

ORIFICE CALIBRATION FORM

Date 1-16-81 Meter Box No. 400

P_{bar} 30.36 Calibrated By LOTZ

ΔH	V_1	V_2	θ	t_1	t_2	$V_2 - V_1$	Q_m	K_m
in. H_2O	CF	CF	Sec.	°F	°F	CF		
1.5			900	92	71	10.358	.6760	.7121
1.5			900	103	78	10.527	.6431	.7148
1.5			900	108	84	10.666	.6860	.7139
							Average K_m	.7136

V_1 = Dry gas meter reading at the start of each test

V_2 = Dry gas meter reading at the end of each test

t_1 = Dry gas meter inlet temperature

t_2 = Dry gas meter outlet temperature

1.81
3

Calculations

1. Q_m = (for each ΔH) $$\frac{V_2 - V_1}{\theta}\left[\frac{t_2 + 460}{\frac{t_1 + t_2}{2} + 460}\right](60)(Y)$$

2. K_m = (for each ΔH) $$Q_m\sqrt{\frac{P_m M_m}{T_m \Delta H}}$$

$M_m = 29$
$T_m = t_2 + 460$
$P_m = P_{bar} + \frac{\Delta H}{13.6}$

Y = meter calibration factor

3. Calculate the average K_m as follows:

$$\bar{K}_m = \frac{\Sigma K_m}{5}$$

4. Calculate ΔH_a as follows:

$$\Delta H_a = \frac{Q@^2\ P@\ M@}{T@}\left[\frac{1}{\bar{K}_m^2}\right] = \frac{0.921}{\bar{K}_m^2}$$

Q@ = 0.75 cfm
T@ = 528°R
P@ = 29.92 in.Hg
M@ = 29

5. Orifice Tolerance = 1.84 ± .25

METER CALIBRATION FORM

Date 12/29/80 Box No. 600

P_{bar} = 30.03 in. Hg Calibrated by Jim Denton Jim Denton

θ (min)	Orifice Manometer Setting ΔH (in. H_2O)	Δ wtm (in. H_2O)	Gas Volume Wet Test Meter Initial	Gas Volume Wet Test Meter Final	Gas Volume Dry Gas Meter Initial	Gas Volume Dry Gas Meter Final	Temperature Wet Test Meter Initial	Temperature Wet Test Meter Final	Avg. Temp. Dry Gas Met Inlet	Avg. Temp. Dry Gas Met Outl
6	.5	-.40	803.400	810.300	888.024	895.023	14.0	14.3	68/80	66/7
5	1.0	-.6	810.794	819.665	895.448	904.444	14.3	14.5	80/90	76/8
5	1.5	-.8	820.247	830.876	905.123	916.124	14.5	14.5	86/96	82/8
5	2.0	-1.0	831.153	843.260	916.416	929.055	14.7	14.8	92/98	86/9
5	2.5	-1.2	843.869	857.361	929.715	943.878	14.8	15.0	94/100	92/9

Pump must be operated for at least 15 minutes at each ΔH setting (.5, 1, 1.5, 2 and 3)

T_{dgm} = average temperature of dry gas meter (inlet and outlet) + 460°F

T_{wtm} = average temperature of wet test meter + 460°F

$$P_{wtm} = P_{bar} - \frac{\Delta wtm}{13.6}$$

$$P_{dgm} = P_{bar} + \frac{\Delta H}{13.6}$$

.9962
1.0113
.9946
.9997
.9897

Δwtm = pressure on wet test meter in inches of H_2O

Y = meter calibration factor

$\bar{Y}$ = .9983

28.316 =conversion factor when using a wet test meter calibrated in liters

Calculations

$$Y = \frac{(\text{wet final} - \text{wet initial})(T_{dgm})(P_{wtm})}{(\text{dry final} - \text{dry initial})(28.316)(T_{wtm})(P_{dgm})} \text{ or } (1)$$

$$\bar{Y} = \frac{\Sigma Y}{5}$$

Meter Tolerance = 1.00 ± 0.01

If the meter calibration factor is not within the allowable tolerance, the calibration factory Y may be used to mathematically correct the gas meter dial readings to the proper values instead of physically adjusting the dry gas meter dials to correspond to the wet test meter readings.

METER CALIBRATION FORM

Date 1-16-81 Box No. 600

P_{bar} = 30.36 in. Hg Calibrated by LOTZ

Orifice Manometer Setting ΔH (in. H_2O)	Δ wtm (in. H_2O)	Gas Volume Wet Test Meter		Gas Volume Dry Gas Meter		Temperature Wet Test Meter		Avg. Temp. Dry Gas Meter	
		Initial	Final	Initial	Final	Initial	Final	Inlet	Outlet
2.0 @ 6" Hg	-1.10	80.000	93.084	106.377	119.624	19.2	19.0	72/92	72/80
2.0 @ 6" Hg	-1.10	93.084	105.667	119.624	132.542	19.0	19.0	92/96	80/86
2.0 @ 6" Hg	-1.10	105.667	118.198	132.542	145.507	19.0	19.0	96/98	86/90

Pump must be operated for at least 15 minutes at each ΔH setting (.5, 1, 1.5, 2 and 3)

T_{dgm} = average temperature of dry gas meter (inlet and outlet) + 460°F

T_{wtm} = average temperature of wet test meter + 460°F

$$P_{wtm} = P_{bar} - \frac{\Delta wtm}{13.6}$$

$$P_{dgm} = P_{bar} + \frac{\Delta H}{13.6}$$

.9822
.9862
.9857

AVG. .9847 = .98

Δwtm = pressure on wet test meter in inches of H_2O

Y = meter calibration factor

28.316 =conversion factor when using a wet test meter calibrated in liters

Calculations

$$Y = \frac{(\text{wet final} - \text{wet initial})(T_{dgm})(P_{wtm})}{(\text{dry final} - \text{dry initial})(28.316 \text{ or } (1))(T_{wtm})(P_{dgm})}$$

$$\bar{Y} = \frac{\Sigma Y}{5}$$

Meter Tolerance = 1.00 ± 0.01

If the meter calibration factor is not within the allowable tolerance, the calibration factory Y may be used to mathematically correct the gas meter dial readings to the proper values instead of physically adjusting the dry gas meter dials to correspond to the wet test meter readings.

ORIFICE CALIBRATION FORM

Date 12/29/70 Meter Box No. 600

P_{bar} 30.03 Calibrated By Jim Denton

ΔH	V_1	V_2	θ	t_1	t_2	$V_2 - V_1$	Q_m	K_m
in. H_2O	CF	CF	Sec.	°F	°F	CF		
.5			960	74	71	6.999	.4635	.7875
1.0			900	85	89	8.996	.6032	.7676
1.5			900	91	85	11.001	.7292	.7540
2.0			900	95	88	12.639	.8327	.7441
2.5			900	97	91	14.163	.9295	.7413
							Average K_m	.7589

V_1 = Dry gas meter reading at the start of each test

V_2 = Dry gas meter reading at the end of each test

t_1 = Dry gas meter inlet temperature

t_2 = Dry gas meter outlet temperature

$\Delta H_a = 1.60$

Calculations

1. Q_m = (for each ΔH)

$$\frac{V_2 - V_1}{\Theta}\left[\frac{t_2 + 460}{\frac{t_1 + t_2}{2} + 460}\right](60)(Y)$$

2. K_m = (for each ΔH)

$$Q_m\sqrt{\frac{P_m M_m}{T_m \Delta H}}$$

$M_m = 29$
$T_m = t_2 + 460$
$P_m = P_{bar} + \frac{\Delta H}{13.6}$
Y = meter calibration factor

3. Calculate the average K_m as follows:

$$\bar{K}_m = \frac{\Sigma K_m}{5}$$

4. Calculate ΔH_a as follows:

$$\Delta H_a = \frac{Q@^2\ P@\ M@}{T@}\left[\frac{1}{\bar{K}_m^2}\right] = \frac{0.921}{\bar{K}_m^2}$$

Q@ = 0.75 cfm
T@ = 528°R
P@ = 29.92 in.Hg
M@ = 29

5. Orifice Tolerance = 1.84 ± .25

ORIFICE CALIBRATION FORM

Date 1-16-81 Meter Box No. 600

P_{bar} 30.36 Calibrated By LOTZ

ΔH	V_1	V_2	θ	t_1	t_2	$V_2 - V_1$	Q_m	K_m
in. H_2O	CF	CF	Sec.	°F	°F	CF		
2.0			930	82	76	13.247	.8347	.7583
2.0			900	94	83	12.918	.8408	.7589
2.0			900	97	88	12.965	.8450	.7592
							Average K_m	.7588

V_1 = Dry gas meter reading at the start of each test

V_2 = Dry gas meter reading at the end of each test

t_1 = Dry gas meter inlet temperature

t_2 = Dry gas meter outlet temperature

1.60

Calculations

1. Q_m = (for each ΔH) $$\frac{V_2 - V_1}{\Theta}\left[\frac{t_2 + 460}{\frac{t_1 + t_2}{2} + 460}\right](60)(Y)$$

2. K_m = (for each ΔH) $$Q_m\sqrt{\frac{P_m M_m}{T_m \Delta H}}$$

$M_m = 29$
$T_m = t_2 + 460$
$P_m = P_{bar} + \frac{\Delta H}{13.6}$

Y = meter calibration factor

3. Calculate the average K_m as follows:

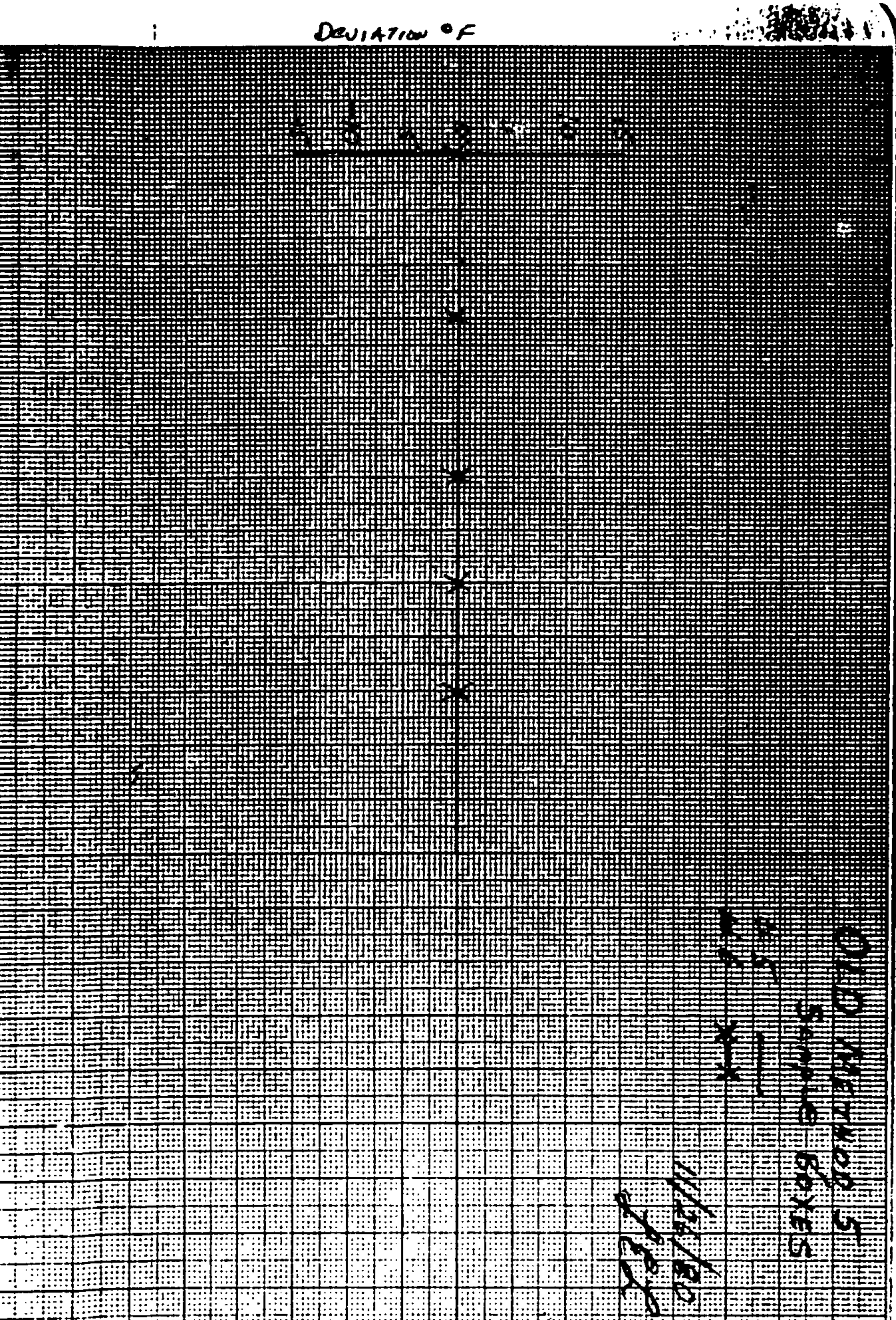
$$\bar{K}_m = \frac{\Sigma K_m}{5}$$

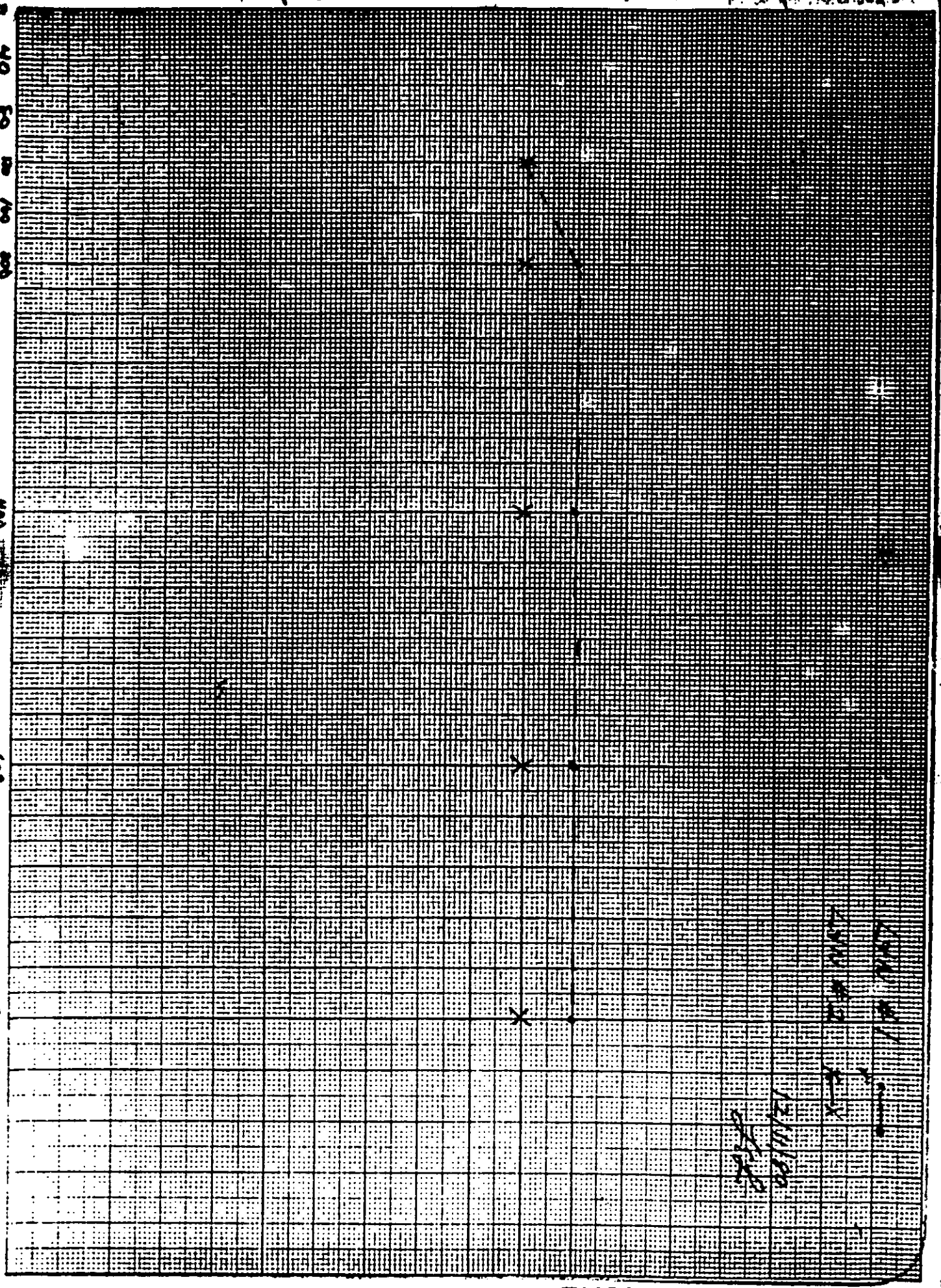
4. Calculate ΔH_a as follows:

$$\Delta H_a = \frac{Q@^2\ P@\ M@}{T@}\left[\frac{1}{\bar{K}_m^2}\right] = \frac{0.921}{\bar{K}_m^2}$$

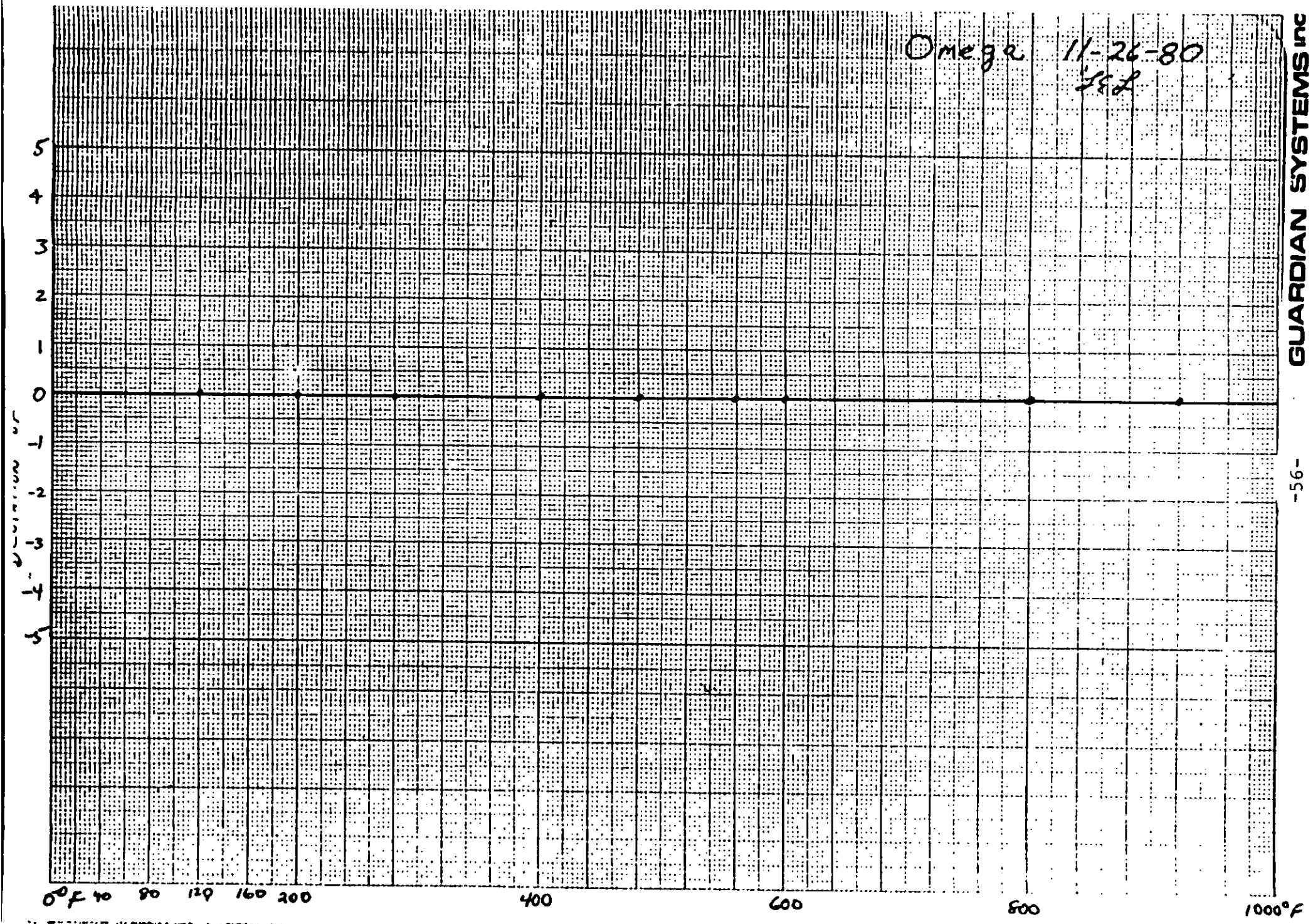
Q@ = 0.75 cfm
T@ = 528°R
P@ = 29.92 in.Hg
M@ = 29

5. Orifice Tolerance = 1.84 ± .25


DEVIATION °F
OLD METHOD 5
Sample Boxes



GUARDIAN SYSTEMS inc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5
4
3
2
1
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0°F 40 80 120 160 200 400 600 800 1000°F
GUARDIAN SYSTEMS inc

GUARDIAN SYSTEMS inc

PITOT CALIBRATION FORM

Date 12/11/80 Probe # 5-2

Calibrated By J.D. - R.S.

Nozzle Size —

SIDE A

Run #	ΔP_{std} (in. H_2O) Standard	$\Delta P(s)$ (in. H_2O) Type "s"	$C_p(s)$	Deviation $C_p(s) - \overline{C}_p(A)$
1	.70	.94	.854	.001
2	.71	.95	.856	.001
3	.71	.95	.856	.001
		$\overline{C}_p(A)$	.855	

SIDE B

Run #	ΔP_{std} (in. H_2O) Standard	$\Delta P(s)$ (in. H_2O) Type "s"	$C_p(s)$	Deviation $C_p(s) - \overline{C}_p(B)$
1	.67	.93	.840	.003
2	.69	.94	.848	.005
3	.67	.93	.840	.003
		$\overline{C}_p(B)$	.843	

CALCULATIONS

$$C_p(s) = C_{p(std)} \text{ (or 0.99)} \sqrt{\frac{\Delta P_{std}}{\Delta P(s)}}$$

$$\text{Average Deviation} = \frac{\Sigma \left| C_p(s) - \overline{C}_p(A \text{ or } B) \right|}{3}$$

A = .003/3 = .001

B = .011/3 = .004

← Must be ≤ 0.01

$\left| \overline{C}_p(A) - \overline{C}_p(B) \right|$ ← Must be ≤ 0.01 .012

GUARDIAN SYSTEMS INC.

PITOT CALIBRATION FORM

Date 12/11/80 Probe # 5-3

Calibrated By JD + RS.

Nozzle Size —

SIDE A

Run #	ΔP_{std} (in. H_2O) Standard	$\Delta P(s)$ (in. H_2O) Type "s"	$C_p(s)$	Deviation $C_p(s) - \overline{C}_p(A)$
1	.66	.87	.862	.003
2	.66	.88	.857	.002
3	.66	.88	.857	.002
		$\overline{C}_p(A)$	.859	

SIDE B

Run #	ΔP_{std} (in. H_2O) Standard	$\Delta P(s)$ (in. H_2O) Type "s"	$C_p(s)$	Deviation $C_p(s) - \overline{C}_p(B)$
1	.67	.91	.849	.000
2	.67	.91	.849	.000
3	.66	.90	.848	.001
		$\overline{C}_p(B)$	.849	

CALCULATIONS

$$C_p(s) = C_{p(std)} \text{ (or 0.99)} \sqrt{\frac{\Delta P_{std}}{\Delta P(s)}}$$

$$\text{Average Deviation} = \frac{\Sigma \left| C_p(s) - \overline{C}_p(A \text{ or } B) \right|}{3}$$

A - $\frac{.007}{3} < .01$

B - $\frac{.001}{3} < .01$

← Must be ≤ 0.01

$$\left| \overline{C}_p(A) - \overline{C}_p(B) \right|$$ ← Must be ≤ 0.01 = .859 - .849 = .01