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/

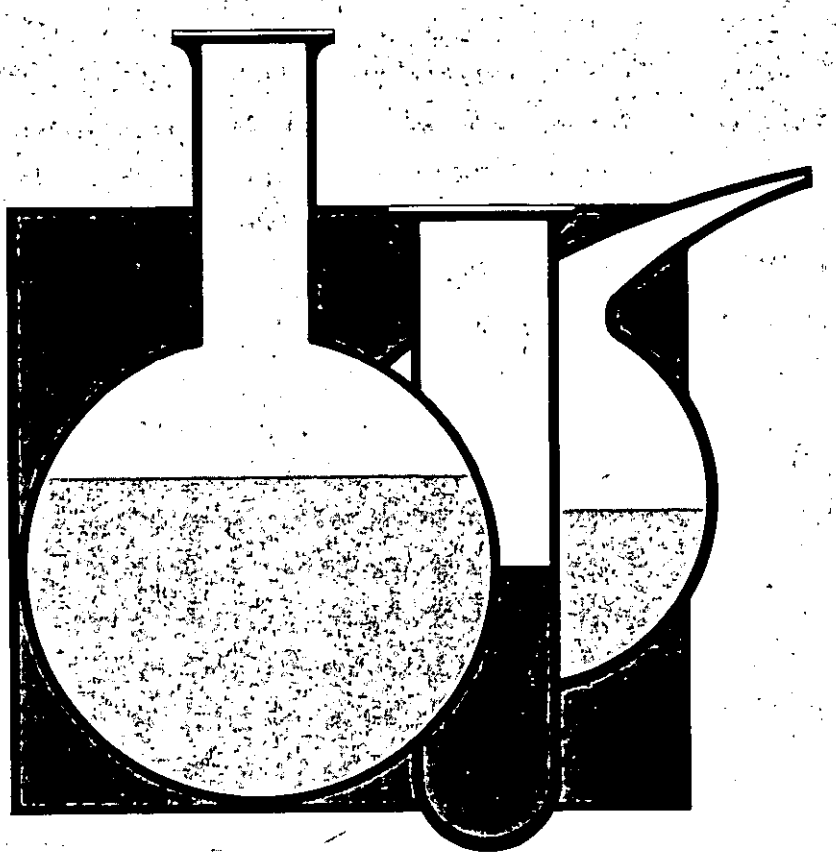
The file name refers to the reference number, the AP42 chapter and section. The file name "ref02_c01s02.pdf" would mean the reference is from AP42 chapter 1 section 2. The reference may be from a previous version of the section and no longer cited. The primary source should always be checked.

AP42 Section:	11.3
Reference:	17
Title:	Mass Emission Tests Conducted On The #7B Tunnel Kiln In Knoxville, TN, For General Shale Products Corporation, Guardian Systems, Inc., Leeds, AL, April 22, 1986.

AP-42 Section 11.3
Reference 17

GUARDIAN SYSTEMS INC.

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



Test Report

MASS EMISSION TESTS

CONDUCTED ON THE

#7B TUNNEL KILN

IN

KNOXVILLE, TENNESSEE

FOR

GENERAL SHALE PRODUCTS CORPORATION

ON

APRIL 22, 1986

Approved by: _____
Tom Lotz
Director
Field Services Division

Approved by: _____
C.B. Robinson, P.E.
Alabama Registration No. 9761

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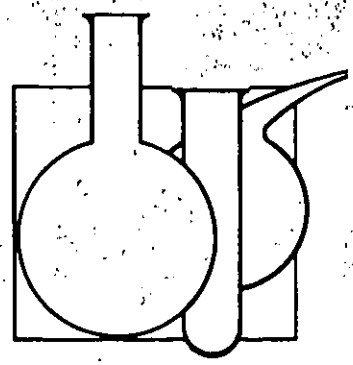
Introduction



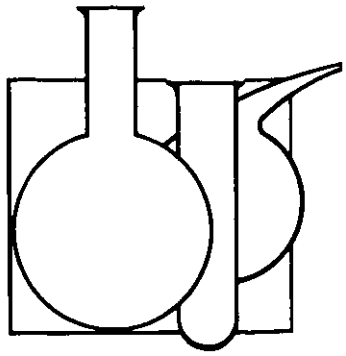
I. INTRODUCTION AND PROCESS DESCRIPTION

On April 22, 1986, Guardian Systems, Inc. performed a series of particulate emissions tests on the #7B Tunnel Kiln Stack of General Shale Products Corporation located near Knoxville, Tennessee. This unit has been modified from a dryer stack and an exhaust to only one stack. These tests were conducted in accordance to the rules and regulations expressed in the Code of Federal Regulations, Title 40, Section 60, Reference Methods 1-5 as amended.

Individual bricks are formed and stacked onto kiln cars measuring approximately 9' x 9'. Cars are inserted on a regular basis into a long, continuous-fired tunnel kiln. As one car is discharged another is inserted. This provides a constant moving mass inside the kiln. Cars are pushed through the kiln at a slow, methodical pace requiring almost three days for the complete travel (see **Plant Operational Data** for complete process information). By means of a coal firing process, heat is increased in each chamber until the total firing is complete. As the car continues through the kiln from the main firing zone the temperatures are reduced to provide necessary cooling.

Mr. Dave McNees, Corporate Representative, and Mr. Ed Bridges Plant Superintendent represented General Shale Products Corporation. Mr. T. Simon deVente, Mr. Rich Smrz, and Ms. Lynne Liddington represented the Knox County Department of Air Pollution Control. Mr. Greg Karstens and Mr. Chuck Turner, of Guardian Systems, Inc. performed these tests.

Test Results



II. SUMMARY OF TEST RESULTS

The following is a summary of the test results for Tunnel Kiln #7B conducted on April 22, 1986

Test #	1	2	3	Average
Date	4-22-86	4-22-86	4-22-86	4-22-86
Process weight, Tons/hr		See Process information		
Particulate Mass Rate, lbs/hr	12.42	14.22	13.95	13.53

INCORRECT
SEE Pg. 9

Source I.D. No. 0035

OBSERVER'S SUMMARY FORM

Source name General Shale Products, Corp.

City and State Knoxville, TN

Type of process Brick Tunnel Kiln 7B

Type of control equipment Innovative combustion and gases flow control

NSPS regulation and effective date N/A

Reference Method(s) and effective date(s) EPA Methods 1-5, 1 July 1985

Process Observation

Form no. N/A

Observer [illegible] Agency Knox County Dept. of Air Pollution Control

Description of process and process operation during testing:

Process is a coal-fired brick tunnel kiln, brick laden carts are inserted at the dryer end, pass through a firing zone and exit out of a cooling zone.

The process was modified from allowing emissions to exit from two stacks to emissions exiting from a single stack.

OBSERVER'S SUMMARY FORM (continued)

Control Equipment Observation

Form no. N/A

Observer [illegible] Agency Knox County Dept. of Air Pollution Control

Description of control equipment and control equipment operation during testing: Emissions are reduced (particulate) by an innovative firing and exhaust control system. SO_2 is controlled by purchasing and burning low sulfur coal. Particulate is controlled in addition by purchasing and burning a low ash coal.

Source Test Observation

Form no. N/A

Observer [illegible] Agency Knox County Dept. of Air Pollution Control

Description of any noteable occurances: None; process and test ran normal without any noteable disruptions or shifts in processing. Tests ran smoothly and in accordance EPA guidelines and approved by this department (KCDAPC) procedures

OBSERVER'S SUMMARY FORM (continued)

Visible Emission Observation

Form no. N/A

Observer LYNNE LINDINGTON Agency Knox County Dept. of Air Pollution Control

Reading ranged from 5% to 20% percent opacity

Maximum average for any test 13.5% percent opacity

The source was/~~was not~~ in compliance with the opacity reading of 20% maximum at the time observations were made.

Was source operating representatively during any or all violation? (If applicable) N/A

Other Observations

List any items that may require attention in the future:

Process operation N/A

Control equipment operation N/A

Test team sampling procedures N/A

Other

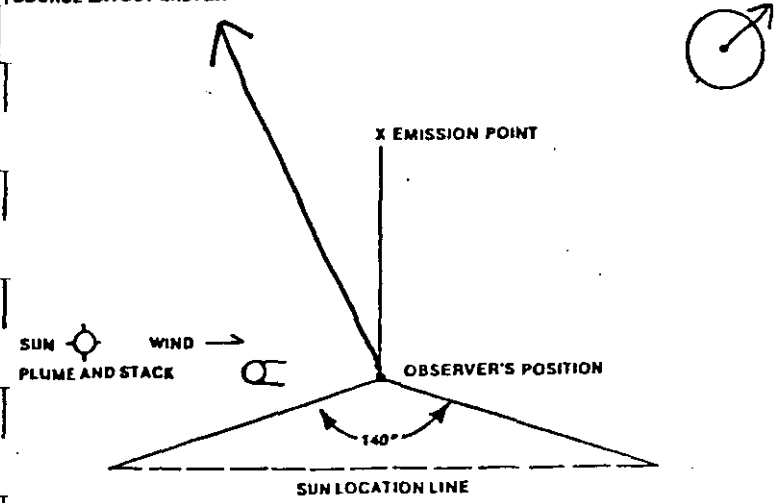
Prepared by A. Sinclair KCDAPC Date 22 APRIL 86

Reviewer Date

SOURCE NAME	General Shale
ADDRESS	1740 Riverside Drive
CITY	Knoxville
STATE	TN
ZIP	37915
PHONE	522-0051
SOURCE ID NUMBER	0035
PROCESS EQUIPMENT	Kiln 7-B
OPERATING MODE	100%
CONTROL EQUIPMENT	NONE
OPERATING MODE	N/A
DESCRIBE EMISSION POINT	START Kiln stack STOP Kiln stack
HEIGHT ABOVE GROUND LEVEL	START 28' STOP 28'
HEIGHT RELATIVE TO OBSERVER	START 24' STOP 24'
DISTANCE FROM OBSERVER	START 60' STOP 60'
DIRECTION FROM OBSERVER	START NW STOP NW
DESCRIBE EMISSIONS	START smoke STOP smoke
EMISSION COLOR	START offwhite STOP offwhite
PLUME TYPE: CONTINUOUS ☒	FUGITIVE ☐ INTERMITTENT ☐
WATER DROPLETS PRESENT:	NO ☒ YES ☐
IF WATER DROPLET PLUME:	ATTACHED ☐ DETACHED ☐
POINT IN THE PLUME AT WHICH OPACITY WAS DETERMINED	START stack exit STOP stack exit
DESCRIBE BACKGROUND	START sky STOP sky
BACKGROUND COLOR	START blue STOP blue
SKY CONDITIONS	START STOP
WIND SPEED	START gusts 5-7mph STOP 5-7mph
WIND DIRECTION	START N STOP N
AMBIENT TEMP.	START 46°F STOP 47°F
WET BULB TEMP.	38°F
RH, percent	45%

SOURCE LAYOUT SKETCH

DRAW NORTH ARROW



COMMENTS

STACK TEST

RWN #1

4-22-86					START TIME 9:30am				10:00am
MIN \ SEC	0	15	30	45	MIN \ SEC	0	15	30	45
1	15	10	10	15	31				
2	10	15	10	10	32	1ST 6 minute			
3	10	10	10	10	33	Average opacity			
4	10	10	10	10	34		=	10.6	%
5	10	10	10	10	35				
6	10	10	10	10	36				
7	15	15	15	15	37				
8	15	15	15	15	38	2nd 6 minute			
9	15	15	15	10	39	Average opacity			
10	10	15	15	15	40		=	13.5	%
11	15	15	15	10	41				
12	10	10	10	10	42				
13	10	10	10	10	43				
14	15	15	15	15	44	3rd 6 minute			
15	10	10	10	10	45	Average opacity			
16	15	15	10	10	46		=	11.9	%
17	10	10	10	15	47				
18	10	10	15	15	48				
19	15	15	10	10	49				
20	10	10	10	10	50	4th 6 minute			
21	10	10	10	15	51	Average opacity			
22	10	10	10	10	52		=	11.3	%
23	10	10	10	10	53				
24	15	15	15	10	54				
25	10	10	10	10	55				
26	10	10	10	10	56	5th 6 minute			
27	10	10	10	10	57	Average opacity			
28	10	15	10	10	58		=	10.6	%
29	5	10	10	10	59				
30	15	10	15	15	60				

AVERAGE OPACITY FOR HIGHEST PERIOD: 6 minute 13.5%

NUMBER OF READINGS ABOVE: 20 % WERE 0

RANGE OF OPACITY READINGS: MINIMUM 5 MAXIMUM 15

OBSERVER'S NAME (PRINT): LYNNE LIDDINGTON

OBSERVER'S SIGNATURE: Lynne Liddington DATE 4-22-86

ORGANIZATION: KCAPC

CERTIFIED BY: Carl Koontz DATE 4-15-86

VERIFIED BY: DATE

SOURCE NAME: General Shale

ADDRESS: 1740 Riverside Drive

CITY: Knoxville | STATE: TN | ZIP: 37915

PHONE: 522-0051 | SOURCE ID NUMBER: 0035

PROCESS EQUIPMENT: Kiln 7-B | OPERATING MODE: 100%

CONTROL EQUIPMENT: None | OPERATING MODE: N/A

DESCRIBE EMISSION POINT: START Kiln stack STOP Kiln stack

HEIGHT ABOVE GROUND LEVEL: START 28' STOP 28' | HEIGHT RELATIVE TO OBSERVER: START 24' STOP 24'

DISTANCE FROM OBSERVER: START 60' STOP 60' | DIRECTION FROM OBSERVER: START NW STOP NW

DESCRIBE EMISSIONS: START Smoke STOP Smoke

EMISSION COLOR: START Off white STOP Off white | PLUME TYPE: CONTINUOUS ☑ FUGITIVE ☐ INTERMITTENT ☐

WATER DROPLETS PRESENT: NO ☑ YES ☐ | IF WATER DROPLET PLUME: ATTACHED ☐ DETACHED ☐

POINT IN THE PLUME AT WHICH OPACITY WAS DETERMINED: START stack exit STOP stack exit

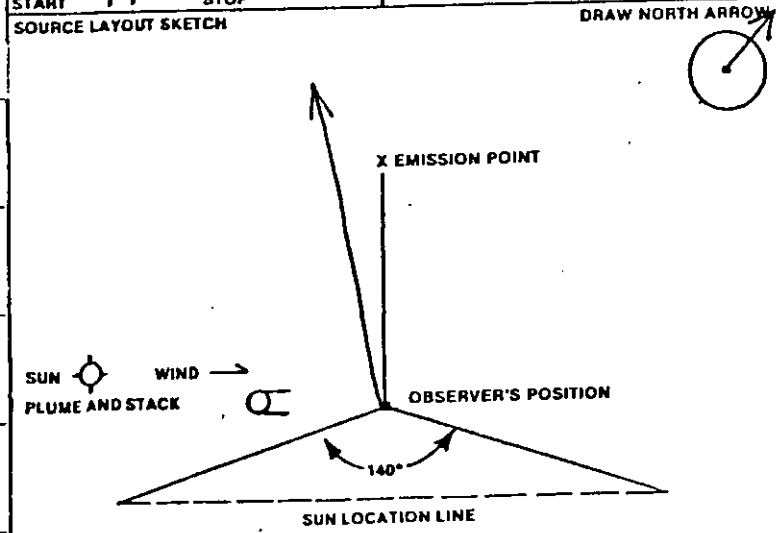
DESCRIBE BACKGROUND: START Sky STOP Sky

BACKGROUND COLOR: START blue STOP blue | SKY CONDITIONS: START Clear STOP Clear

WIND SPEED: START 3-5mph STOP 3-5mph | WIND DIRECTION: START N STOP N

AMBIENT TEMP.: START 49°F STOP 50°F | WET BULB TEMP. 40°F | RH, percent 43%

SOURCE LAYOUT SKETCH



	4-22-86					11:20am			11:50am
MIN \ SEC	0	15	30	45	MIN \ SEC	0	15	30	45
1	10	10	10	10	31				
2	10	10	10	10	32	1st 6 minute			
3	10	10	10	10	33	Average opacity			
4	10	10	10	10	34		= 10%		
5	10	10	10	10	35				
6	10	10	10	10	36				
7	10	10	10	10	37				
8	10	10	10	10	38	2nd 6 minute			
9	10	10	10	10	39	Average opacity			
10	10	10	10	10	40		= 10%		
11	10	10	10	10	41				
12	10	10	10	10	42				
13	10	10	10	10	43				
14	10	10	10	10	44	3rd 6 minute			
15	10	10	15	10	45	Average opacity			
16	10	10	10	10	46		= 10.2%		
17	10	10	10	10	47				
18	10	10	10	10	48				
19	10	10	10	10	49				
20	10	10	10	10	50	4th 6 minute			
21	10	10	5	5	51	Average opacity			
22	10	10	10	10	52		= 9.6%		
23	15	10	10	10	53				
24	10	10	10	5	54				
25	5	5	10	20	55				
26	15	15	15	10	56	5th 6 minute			
27	10	10	10	10	57	Average opacity			
28	10	15	15	15	58		= 11.5%		
29	15	10	10	10	59				
30	10	10	10	10	60				

AVERAGE OPACITY FOR HIGHEST PERIOD: 6 minute 11.5%

NUMBER OF READINGS ABOVE: 20 % WERE 0

RANGE OF OPACITY READINGS: MINIMUM 5 MAXIMUM 20

OBSERVER'S NAME (PRINT): LYNNE LIDDINGTON

OBSERVER'S SIGNATURE: Lynne Liddington | DATE 4-22-86

ORGANIZATION: KCAPC

CERTIFIED BY: Carl Koontz | DATE 4-15-86

VERIFIED BY | DATE

COMMENTS: STACK TEST RUN #2

SOURCE NAME: General Shale

ADDRESS: 1740 Riverside Drive

CITY: Knoxville | STATE: TN | ZIP: 37915

PHONE: 522-0051 | SOURCE ID NUMBER: 0035

PROCESS EQUIPMENT: Kiln 7-B | OPERATING MODE: 100%

CONTROL EQUIPMENT: none | OPERATING MODE: N/A

DESCRIBE EMISSION POINT
START: Kiln stack STOP: Kiln stack

HEIGHT ABOVE GROUND LEVEL
START: 28' STOP: 28'

HEIGHT RELATIVE TO OBSERVER
START: 24' STOP: 24'

DISTANCE FROM OBSERVER
START: 60' STOP: 60'

DIRECTION FROM OBSERVER
START: NW STOP: NW

DESCRIBE EMISSIONS
START: smoke STOP: smoke

EMISSION COLOR
START: off white STOP: off white

PLUME TYPE: CONTINUOUS ☑ FUGITIVE ☐ INTERMITTENT ☐

WATER DROPLETS PRESENT: NO ☑ YES ☐

IF WATER DROPLET PLUME: ATTACHED ☐ DETACHED ☐

POINT IN THE PLUME AT WHICH OPACITY WAS DETERMINED
START: stack exit STOP: stack exit

DESCRIBE BACKGROUND
START: sky STOP: sky

BACKGROUND COLOR
START: blue STOP: blue

SKY CONDITIONS
START: scattered clouds STOP: scattered clouds.

WIND SPEED
START: 5-7mph STOP: 5-7mph

WIND DIRECTION
START: NE STOP: NE

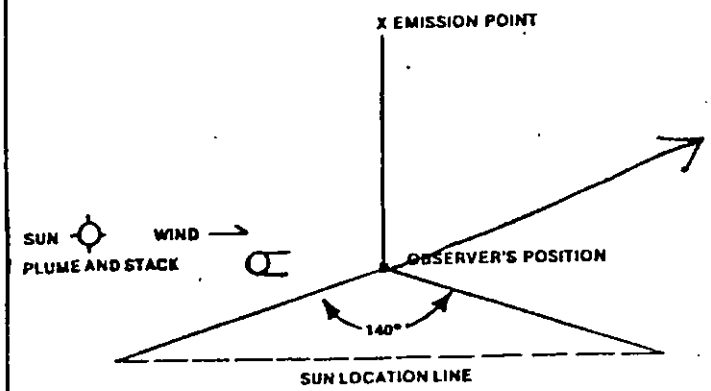
AMBIENT TEMP.
START: 53°F STOP: 54°F

WET BULB TEMP.: 44°F

RH, percent: 46%

SOURCE LAYOUT SKETCH

DRAW NORTH ARROW



	4-22-86			1:26pm			1:56		
MIN \ SEC	0	15	30	45	MIN \ SEC	0	15	30	
1	10	10	5	10	31				
2	10	10	5	10	32	1ST 6 minute			
3	10	10	10	10	33	Average opacity			
4	10	10	10	10	34		= 8.9%		
5	10	10	10	5	35				
6	5	5	10	10	36				
7	10	10	*10	10	37				
8	10	10	15	15	38	2nd 6 minute			
9	15	20	20	20	39	Average opacity			
10	15	10	10	10	40		= 10.4%		
11	5	5	5	5	41				
12	5	5	5	5	42				
13	5	5	10	10	43				
14	5	5	10	10	44	3rd 6 minute			
15	10	10	15	15	45	Average opacity			
16	10	5	5	10	46		= 8.1 %		
17	5	5	5	5	47				
18	5	10	10	10	48				
19	10	10	5	10	49				
20	10	10	10	15	50	4th 6 minute			
21	10	15	10	10	51	Average opacity			
22	15	10	10	15	52		= 11%		
23	10	10	10	10	53				
24	10	10	15	15	54				
25	15	15	10	10	55				
26	15	10	15	10	56	5th 6 minute			
27	10	10	10	10	57	Average opacity			
28	10	10	5	5	58		= 10.8 %		
29	5	5	5	15	59				
30	15	15	15	15	60				

AVERAGE OPACITY FOR HIGHEST PERIOD: 6 minutes 11%

NUMBER OF READINGS ABOVE: 20 % WERE 0

RANGE OF OPACITY READINGS
MINIMUM: MAXIMUM: 20

OBSERVER'S NAME (PRINT): LYNNE LIDDINGTON

OBSERVER'S SIGNATURE: Lynne Liddington | DATE: 4-22-86

ORGANIZATION: KCAPC

CERTIFIED BY: Carl Koontz | DATE: 4-15-86

VERIFIED BY | DATE

COMMENTS
STACK TEST
RUN #3
* Door opened

G U A R D I A N * S Y S T E M S * I N C O R P O R A T E D
P.O. BOX 300
LEEDS, AL 35094
205-699-6647

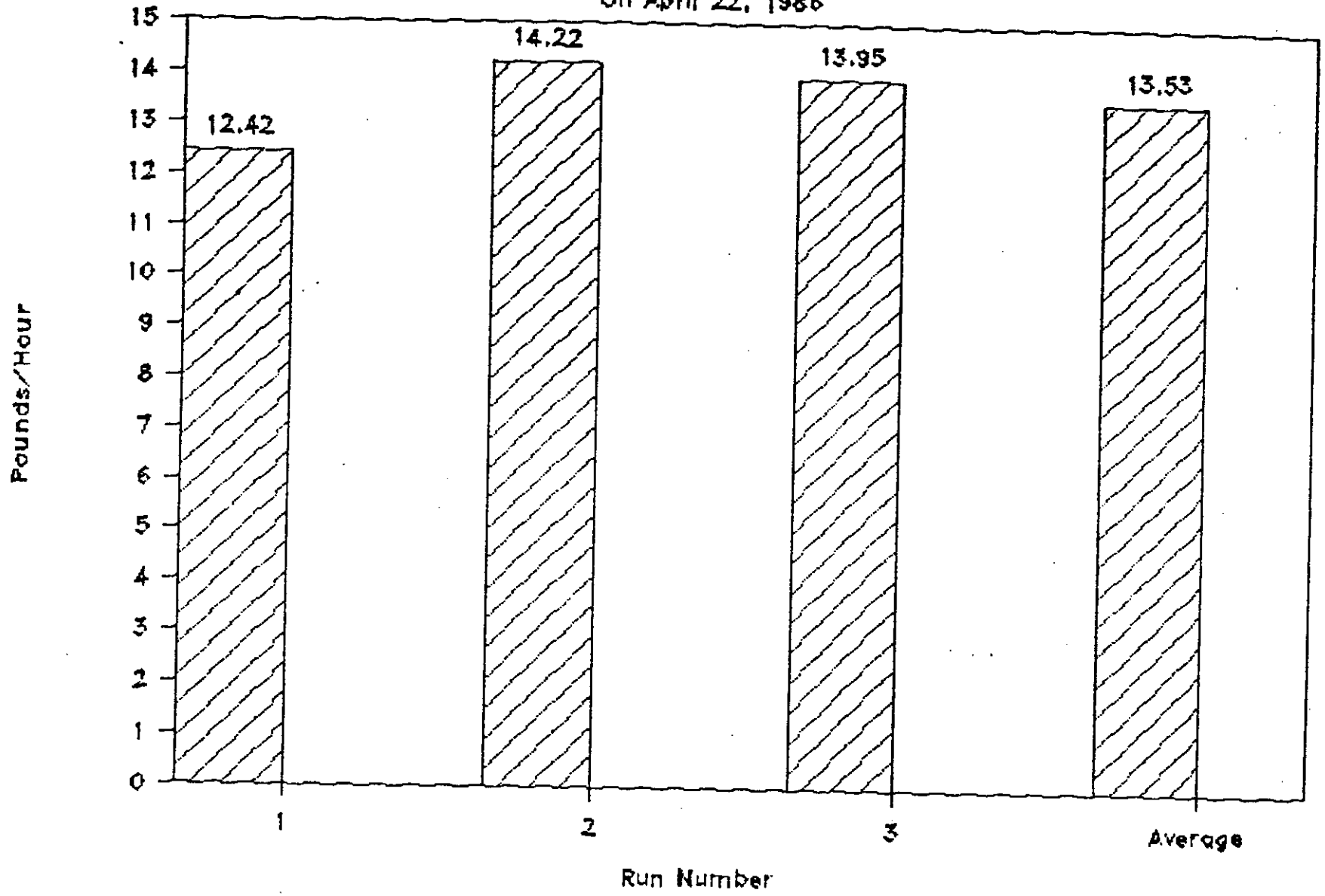
Summarized Air Test Results for General Shale Products

Run Number	1	2	3	Average
Date	4-22-86	4-22-86	4-22-86	4-22-86
Location	Stack	Stack	Stack	Stack
Time	0929-1035	1123-1230	1328-1435	0929-1435
Stack Gas Temperature, F	174	175	164	171
Moisture Content, % v/v	5.29	6.30	6.97	6.20
Oxygen Content, % v/v	18.00	18.00	18.00	18.00
Carbon Dioxide Content, % v/v	2.00	2.00	2.00	2.00
Carbon Monoxide Content, % v/v	0.00	0.00	0.00	0.00
Excess Air, %	576.92	576.92	576.92	576.92
Stack Gas Velocity Feet per Second	66.78	66.97	67.69	67.15
Volumetric Flow Actual Cubic Feet per Minute	28,329	28,407	28,715	28,485
Volumetric Flow Dry Std Cubic Feet per Minute	22,372	22,159	22,629	22,384
Concentration Grains per Actual Cubic Foot	0.065	0.075	0.072	0.071
Concentration Grains per Dry Std Cubic Ft	0.051	0.058	0.057	0.055
Particulate Mass Rate, #/hr	12.42	14.22	13.95	13.53
% Isokinetic	101.54	103.46	103.64	102.90

Gr/ACF * DSCFM
INCORRECT

GENERAL SHALE PRODUCTS MASS EMISSIONS

On April 22, 1986



G U A R D I A N * S Y S T E M S * I N C O R P O R A T E D
P.O. BOX 300
LEEDS, AL 35094
205-699-6647

Computer Input Paramters for General Shale Products

Run Number	1	2	3	Average
Date	4-22-86	4-22-86	4-22-86	4-22-86
Location	Stack	Stack	Stack	Stack
Time	0929-1035	1123-1230	1328-1435	0929-1435
Barometric Pressure, in Hg	29.96	29.96	29.96	29.96
Static Pressure, in H2O	-0.070	-0.070	-0.070	-0.070
Run Time, minutes	60.00	60.00	60.00	180.00
Meter Volume, CF	33.220	33.851	34.756	
Meter Correction factor, MCF	0.9948	0.9948	0.9948	
Meter Volume (Corrected)	33.047	33.675	34.575	101.297
Stack Temperature, F	174	175	164	171
Meter Temperature, F	54	59	61	58
Meter Pressure, in H2O	0.9	0.9	0.96	0.92
Sqr Velocity Pressure	1.090	1.090	1.110	1.097
Mass of Particulate, mg	143.3	167.1	164.2	474.6
Ml of Water Collected	40.4	49.1	56.0	145.5
% Oxygen	18.00	18.00	18.00	18.00
% Carbon Dioxide	2.00	2.00	2.00	2.00
% Carbon Monoxide	0.00	0.00	0.00	0.00
Stack Area, Sq ft	7.070	7.070	7.070	7.070
Pitot Correction Factor	0.831	0.831	0.831	0.831
Nozzle Diameter, in	0.180	0.180	0.180	0.180

G U A R D I A N * S Y S T E M S * I N C O R P O R A T E D
P.O. BOX 300
LEEDS, AL 35094
205-699-6647

Computed Air Test Results for General Shale Products

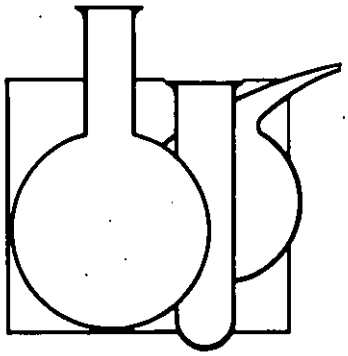
Run Number	1	2	3	Average
Date	4-22-86	4-22-86	4-22-86	4-22-86
Location	Stack	Stack	Stack	Stack
Time	0929-1035	1123-1230	1328-1435	0929-1435
1. Stack Pressure				
Inches Hg	29.95	29.95	29.95	29.95
Millimeters Hg	760.85	760.85	760.85	760.85
2. Meter Pressure				
Inches Hg	30.03	30.03	30.03	30.03
Millimeters Hg	762.66	762.66	762.78	762.70
3. Meter Volume				
Dry Std Cubic Feet	34.068	34.381	35.169	103.625
Dry Std Cubic Meters	0.965	0.974	0.996	2.935
4. Water Volume				
Std Cubic Feet	1.902	2.311	2.636	6.849
Std Cubic Meters	0.054	0.065	0.075	0.194
5. Moisture Content, %	5.29	6.30	6.97	6.20
6. Molecular Weight Dry	29.04	29.04	29.04	29.04
7. Molecular Weight Weight	28.46	28.34	28.27	28.36
8. Stack Velocity				
Feet per Second	66.78	66.97	67.69	67.15
Meters per Second	20.36	20.41	20.63	20.47
9. Volumetric Flow				
Actual Cubic Ft per minute	28,329	28,407	28,715	28,485
Actual Cubic M per second	13.37	13.41	13.55	13.45
10. Volumetric Flow				
Dry Std Cubic Ft per minute	22,372	22,159	22,629	22,384
Dry Std Cubic M per minute	10.56	10.46	10.68	10.57
11. Concentration				
Grains per Dry Std Cubic Ft	0.0648	0.0748	0.0719	0.0705
Grams per Dry Std Cubic M	0.1482	0.1713	0.1645	0.1614
12. Excess Air, %	576.92	576.92	576.92	576.92

G U A R D I A N * S Y S T E M S * I N C O R P O R A T E D
P.O. BOX 300
LEEDS, AL 35094
205-699-6647

Computed Air Test Results for General Shale Products

Run Number	1	2	3	Average
Date	4-22-86	4-22-86	4-22-86	4-22-86
Location	Stack	Stack	Stack	Stack
Time	0929-1035	1123-1230	1328-1435	0929-1435
15. Particulate Mass Rate				
Pounds per Hour, #/hr	12.42	14.22	13.95	13.53
16. Volume at Nozzle				
Actual Cubic Feet	43.142	44.078	44.629	131.875
Actual Cubic Meters	1.222	1.248	1.264	3.735
17. Concentration				
Grains per Actual Cubic Ft	0.0512	0.0584	0.0567	0.0554
Grams per Actual Cubic M	0.1171	0.1336	0.1297	0.1268
18. Isokinetic, %	101.54	103.46	103.64	102.90

Sampling & Analytical Procedures



III. SAMPLING AND ANALYTICAL PROCEDURES

General

All sampling and analytical procedures for 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 equipment used in this test 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 matrix. The dimensions of the stack (see **Figure 1**) indicated that 20 points would be required to sample this source. We sampled 20 points (10 per diameter). Verification of absence of cyclonic flow was determined as requested by Knox County and the results indicated that cyclonic flow did not seem to exist from the stack exhaust.

METHOD 2

Velocity meaurements were taken using a properly calibrated S type pitot tube and a 0-10 inch inclined manometer.

METHOD 3

Gas analysis for CO_2, O_2, and N_2 by difference was performed by using the grab sample technique twice during each test 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 weighing the amount of water collected in the impingers 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

An initial velocity traverse was performed to determine stack temperature, pressure, range of velocity heads, moisture content and stack gas dry molecular weight prior to sampling. A Monroe 1830 programable calculator or a Radio Shack PC-4 computer and a TI55 was 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° 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 three minutes to provide a total sampling time of 60 minutes for each of the three tests. 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 ± 25 °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 ± 25 °F. Theses temperatures were recorded at each point on the data sheets.

The gases were 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 clean and cool gases then entered the meter box where the gas flow and temperature were measured and recorded. (See **Field Data**)

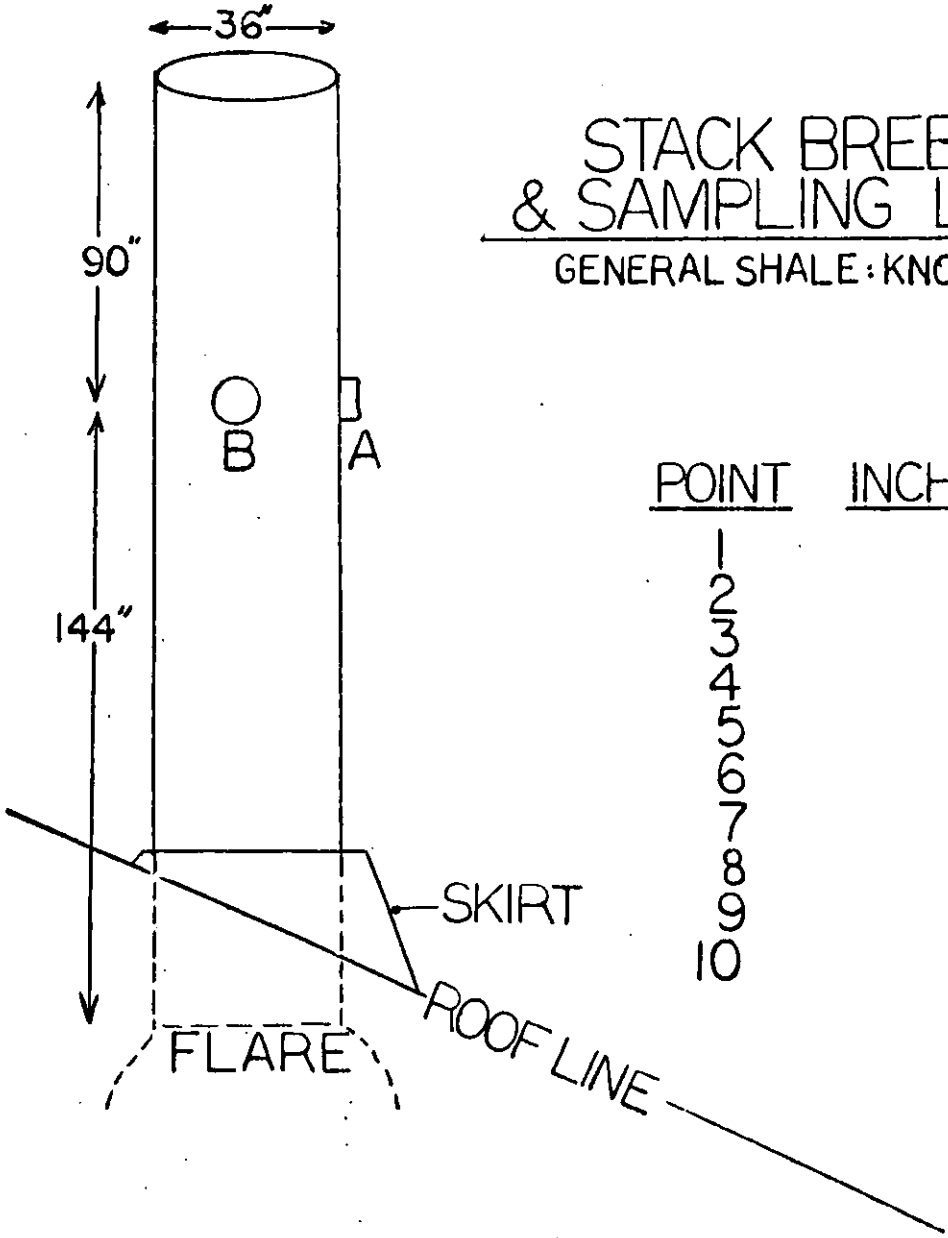
Upon completion of the sampling the sampling probe was removed from the stack and the post-test meter and pitot leakage rates were determined and recorded on the Data Sheets. The complete sampling train was transfered to the cleanup area making sure no sample was lost. The cleanup data was recorded on **Particulate Sample Recovery and Intergrity 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 Filter (Gelman, Class A, without organic binder, minimum 99.9% retention for particules of 0.3 microns as determined by DOP tests) were prepared for the field test by first heating for 2 hours 220 °F then desiccating at 68 ± 10 °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) hour and weighed to a constant weight as describe above.

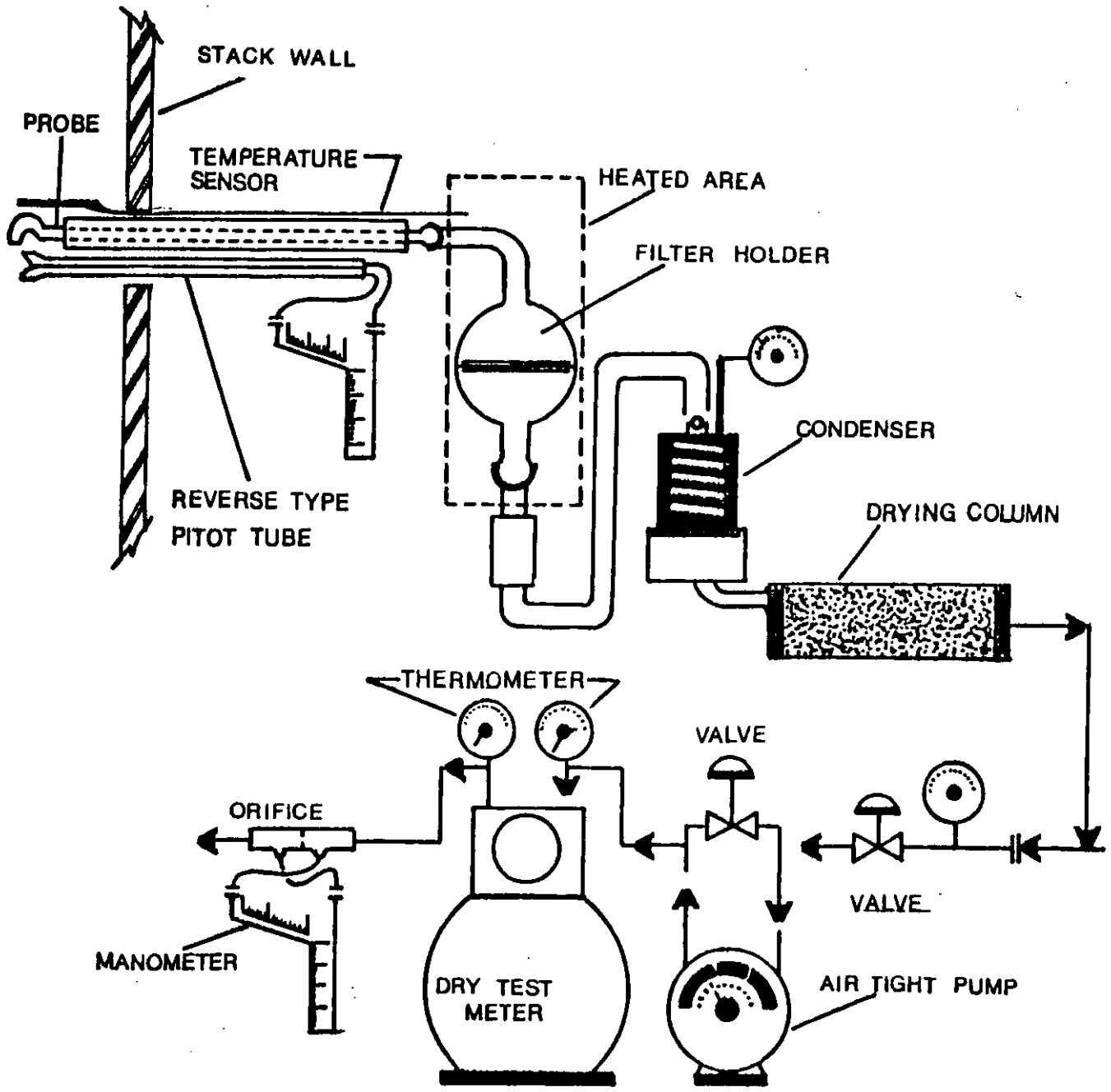


STACK BREECHING & SAMPLING LOCATIONS

GENERAL SHALE: KNOXVILLE, TN.

POINT	INCHES TO WALL
1	6
2	7.9
3	10.3
4	13.1
5	17.3
6	28.7
7	32.9
8	35.7
9	38.1
10	40

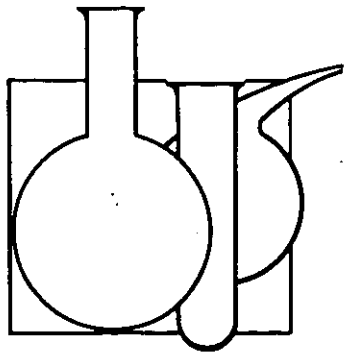
Figure 1



PARTICULATE SAMPLING TRAIN.. METHOD 5

FIGURE 2

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)

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 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, 18.0 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. $P_s = P_{bar} + \frac{Pg}{13.6}$

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. $V_w(std) = 0.04707\ V_{1c}$

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. $$W_a = Ca\ Vaw\ p_a$$

METHOD 2 GAS VELOCITY AND VOLUME DATA

PLANT AND CITY	RUN DATE
1. General Shale / Knoxville	04 / 22 / 86

SAMPLING LOCATION	CLOCK TIME
	0830

RUN NUMBER	OPERATOR	AMB. TEMP. (°F)	BAR. PRESS (in. Hg)	STATIC PRESS (in. H_2O)
2. 1	Turner / Karstens	49°	29.96	-.07

MOLECULAR WT.	STACK INSIDE DIMENSION (in.)		PITOT TUBE Cp
	DIAM OR SIDE 1	SIDE 2	
	36" ID	36" ID	.84

FIELD DATA

TRAVERSE POINT NUMBER	POSITION (in.)	VELOCITY HEAD (Δp_s), in. H_2O	STACK TEMP., °F	CYCLONIC FLOW DETERMINATION	
				Δp_s at 0° REFERENCE	ANGLE (α) WHICH YIELDS A NULL Δp
A 1	5.9	0	172	0	1°
2	7.4	0	172	0	1°
3	10.3	0	173	0	0°
4	13.1	0	173	0	2°
5	17.3	0	175	0	0°
6	28.7	0	176	0	8°
7	32.9	0	177	0	9°
8	35.7	0	177	0	6°
9	38.1	0	176	0	3°
10	40.1	0	176	0	1°
B 1	5.9	0	172	0	6°
2	7.9	0	171	0	3°
3	10.3	0	171	0	2°
4	13.1	0	171	0	2°
5	17.3	0	171	0	3°
6	28.7	0	172	0	0°
7	32.9	0	172	0	0°
8	35.7	0	172	0	0°
9	38.1	0	171	0	0°
10	40.1	0	172	0	1°
				AVERAGE ANGLE (α)	2.4°

Average of (α) must be less than 10 degrees to be acceptable.

11-1

GUARDIAN SYSTEMS inc

FIELD DATA SHEET

GUARDIAN SYSTEMS INC.
BOX 300
LEEDS, ALABAMA 35094

PLANT: GEN SHALE — RUN #: #1
LOCATION: KNOXVILLE — DATE: 4-22-86
BARO. PRES.: 29.96 — TIME: 0929-1035

	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
			475.478									
A												
1	3	3	477.3	162	50	50	50	37	235	.93	1.22	2.1
2		6	478.9	170	54	50	52	38	236	.90	1.20	2.0
3		9	480.4	173	56	51	53	37	238	.81	1.08	1.8
4		12	482.2	175	56	51	53	38	241	.78	1.05	6.5
5		15	483.6	177	57	52	54	38	239	.81	1.08	1.9
6		18	485.4	178	56	50	53	39	238	.92	1.24	5.4
7		21	487.0	178	57	51	53	39	241	.88	1.18	3.4
8		24	488.7	177	57	51	53	38	239	.82	1.10	2.4
9		27	490.3	177	57	52	54	38	238	.90	1.20	2.6
10		30	491.8	173	57	52	54	38	236	.62	.82	2.5
B												
1	3	33	493.4	173	55	51	53	37	231	.86	1.15	2.4
2		36	494.9	170	56	51	53	38	231	.97	1.29	2.4
3		39	496.6	166	56	51	53	38	230	.99	1.30	2.6
4		42	498.5	171	57	52	54	38	230	.96	1.28	2.7
5		45	500.5	172	58	52	~~56~~ 55	38	230	1.00	1.33	2.8
6		48	501.8	176	59	53	56	38	229	.94	1.25	2.4
7		51	504.2	175	60	53	56	38	228	.92	1.23	2.6
8		54	505.5	176	60	53	56	38	230	.98	1.30	3.1
9		57	506.8	177	61	53	57	38	230	.95	1.26	3.1
10		60	508.698	177	61	53	57	38	230	.98	1.31	3.4
20		60	33.220	174			54			.896	1.09	

STATIC PRESSURE "H2O: -.07

PROBE TIP SIZE

BEFORE	AFTER
.180	.180
.180	.180
.180	.180

WATER
#7
ml. 35
gram +5.4
Total 40.4

OPERATOR: KARSTENS-TURNER

Sample Box No. 7002
Meter Box No. 700
Meter ΔH@ 1.66
Pitot, CP .84
Temp. Device SIII
Probe No. 5-N
Probe Liner GLASS
Probe Htr. Set 50%
Ambient Temp. 48°

% O_2	18	18
% CO_2	2	2

NOTES
Orifice ✓ at 18" H_2O
Pitot ✓
Meter ✓ at 18" H_2O
S 5.2 for 15 sec
R 6.8 " "

FINAL
S 5.6 for 15 sec
R 5.7 " "
~~508.744~~ Final leak
508.744 Dry

508.749
.005

FIELD DATA SHEET

GUARDIAN SYSTEMS INC.
BOX 300
LEEDS, ALABAMA 35094

PLANT: GEN SHALE
LOCATION: KNOXVILLE
BARO. PRES.: 29.96
RUN #: #2
DATE: 4-22-86
TIME: 1123-1230

	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 "H2O	VELOCITY PRESSURE "H2O	VACUUM PRESSURE "Hg
			508.825									
B				(1)	(2)	(3)		(4)	(5)			
1	3	3	510.5	167	51	51	51	36	242	.94	1.25	1.0
2		6	512.2	171	52	52	52	40	269	.92	1.23	1.1
3		9	514.0	172	55	53	54	40	265	.98	1.30	1.1
4		12	516.1	173	57	53	55	39	248	.98	1.30	1.2
5		15	517.6	175	58	53	56	40	258	.99	1.32	1.4
6		18	519.2	177	60	54	57	41	231	.92	1.22	1.4
7		21	520.9	178	61	54	57	40	242	.90	1.20	1.5
8		24	522.6	179	61	54	57	41	244	.88	1.18	1.5
9		27	524.2	175	63	55	59	42	248	.92	1.21	1.8
10		30	525.9	175	65	56	60	40	226	.81	1.07	1.4
A												
1	3	33	527.7	165	63	57	60	35	229	.99	1.28	1.9
2		36	529.5	180	65	57	61	41	238	.92	1.21	1.9
3		39	531.1	177	66	59	62	43	246	.89	1.18	2.0
4		42	532.7	179	66	59	62	43	254	.85	1.12	1.8
5		45	534.4	178	65	60	62	44	263	.87	1.15	2.0
6		48	536.3	177	66	61	63	44	257	.97	1.28	2.1
7		51	538.1	177	67	60	63	41	238	.95	1.25	2.1
8		54	539.8	176	65	59	62	40	234	.91	1.20	2.0
9		57	541.2	174	66	60	63	42	237	.74	.97	1.7
10		60	542.676	172	66	60	63	42	241	.64	.84	1.5
20		60	33.851	175			59			.90	1.09	

STATIC PRESSURE "H2O: -.07

PROBE TIP SIZE

BEFORE	AFTER
.180	.180
.180	.180
.180	.180

WATER #3

ml. 43
gram 6.1
Total 49.1

OPERATOR: KARSTENS. TURNER

Sample Box No. 2
Meter Box No. 700
Meter ΔH@ 1.66
Pitot, CP .84
Temp. Device X44
Probe No. 5-N
Probe Liner Glass
Probe Htr. Set 500°
Ambient Temp. 51°

% O_2	18	18
% CO_2	2	2

NOTES

Orifice ✓
Pitot ✓
Meter

3.8 St
5.1 Ram
Leak ✓ at .005

S 3.8
R 4.4 At 3" Hg
542.685 Start
542.689 Finish
.004

G-1

FIELD DATA SHEET

PLANT General Shale RUN # 3
LOCATION Knoxville DATE 4/22/86
BARO. PRES. 29.96 TIME 1328-1425

GUARDIAN SYSTEMS INC.
BOX 300
LEEDS, ALABAMA 35094

	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
				(1)	(2)	(3)		(4)	(5)			
A	3	8	542.748									
1		3	544.5	170	55	55	55	36	230	.97	1.28	2.2
2		6	546.2	176	56	56	56	37	240	.91	1.21	2.3
3		9	548.0	150	58	56	57	38	248	1.02	1.30	2.3
4		12	549.6	164	60	56	58	39	252	.88	1.13	2.2
5		15	551.3	160	60	58	59	39	257	.94	1.21	2.1
6		18	553.2	163	61	57	59	39	256	1.03	1.34	2.1
7		21	554.9	165	63	57	60	40	265	1.04	1.35	3.0
8		24	556.6	167	64	58	61	40	266	1.00 ~~.9~~	1.30	2.9
9		27	558.4	169	64	58	61	40	267	.95	1.24	3.1
10		30	559.7	166	65	58	61 ~~62~~	40	268	.77	1.0	2.9
B	3											
1		33	561.7	165	64	59	61	38	271	1.01	1.31	2.8
2		36	563.5	173	65	59	62	40	263	.99	1.30	2.9
3		39	565.3	174	66	60	63	38	262	.98	1.28	2.9
4		42	566.9	176	66	60	63	39	268	.98	1.29	2.9
5		45	569.0	148	67	61	64	40	252	1.16	1.45	3.6
6		48	570.9	157	68	62	64	41	248	1.02	1.29	3.5
7		51	572.6	161	67	62	65	42	241	.96	1.23	3.5
8		54	574.4	164	67	62	65	40	264	.94	1.21	3.5
9		57	575.9	164	67	63	65	39	271	.76	.98	3.1
10		60	577.504	158	66	62	64	40	263	.83	1.05	3.5
20		60	34.756	164			61			.957	1.11	

STATIC PRESSURE "H2O: -.07

PROBE TIP SIZE

BEFORE	AFTER
.180	.180
.180	.180
.180	.180

WATER
#2
ml. 50
gram 6
Total 56

OPERATOR
Turner / Karstens

Sample Box No. 2
Meter Box No. 700
Meter ΔH@ 1.66
Pitot, CP .84
Temp. Device RTD
Probe No. 5'N
Probe Liner glass
Probe Htr. Set 60%
Ambient Temp. 60°
% O_2 18 | 18
% CO_2 2 | 2

NOTES
Orifice ✓
Pitot ✓
Meter

S-4.5 for 15 sec
R-5.1 " " "
Leak ✓ .004 at 15" Hg

S 3.8
R 4.8 at 4" Hg
577.520 start
577.524
.008

BLANK ANALYTICAL DATA

Plant GENERAL SHALE

Sample location KNOXVILLE

Relative humidity 20%

Type of blank ACETONE

Liquid level at mark and container sealed ✓

Density of blank (ρa) .7847 g/ml

Blank volume (Va) 250 ml

Date and time of wt. 4-25-86 0800 Gross wt. 110752.9 mg

Date and time of wt. 4-25-86 1400 Gross wt. 110752.9 mg

Average gross wt. 110752.9 mg

Tare wt. 110752.7 mg

Weight of blank (ma) .2 mg

$$Ca = \frac{ma}{Va\ \rho a} = \frac{(.2)}{(250)(.7847)} = .00102 \text{ mg/g}$$

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

Remarks:

Signature of analyst Greg J. Karstens

Signature of reviewer

METHOD 5

PARTICULATE SAMPLE RECOVERY AND INTEGRITY SHEET

Plant: GEN SHALE Sample date: 4-22-86

Sample location: KNOXVILLE Run no.: #1

Sample recovery person: KARSTENS Recovery date: SAME

Filter(s) no.: #4

MOISTURE

Impingers			Silica gel		
Final volume (wt)	35	ml (gm)	Final wt.	959.1 g	g
Initial volume (wt)	0	ml (gm)	Initial wt.	953.7 g	g
Net volume (wt)	35	ml (gm)	Net wt.	5.4 g	g

Total moisture 40.4 g

Color of silica gel 1/10 PINK

Description of impinger water CLEAR

RECOVERED SAMPLE

Filter container no. RUN #1 sealed ✓

Description of particulate on filter DK GREY - LT CHARCOAL

Acetone rinse container no. RUN #1 Liquid level marked ✓

Acetone blank container no. BLK Liquid level marked ✓

Samples stored and locked

Remarks:

Date of laboratory custody

Laboratory personnel taking custody

Remarks:

METHOD 5 TRAIN ANALYTICAL PARTICULATE DATA

Plant GEN SHALE Run No. #1

Sample location KNOXVILLE

Relative humidity 20%

Density of acetone (ρa) .7847 g/ml

Sample type	Sample identifiable	Liquid level marked and/or container sealed
Acetone rinse	✓	✓
filter(s)	✓	✓

Acetone rinse container no. #5

Acetone rinse volume (Vaw) 200 ml

Acetone blank residue concentration (Ca) .00102 mg/g

Wa = Ca Vaw ρa = (.00102)(200)(.7847) = .16 mg

Date and time of wt 4-25-86 0800 Gross wt 1003522 mg

Date and time of wt 4-25-86 1400 Gross wt 1003522 mg

Average gross wt 1003522 mg

Tare wt 1002960 mg

Less acetone blank wt (Wa) .2 mg

Weight of particulate in acetone rinse 56.0 mg

Filter(s) container no. #4

Date and time of wt 4-25-86 0800 Gross wt 251.9 mg

Date and time of wt 4-25-86 1400 Gross wt 251.9 mg

Average gross wt 251.9 mg

Tare wt 164.6 mg

Weight of particulate on filter(s) 87.3 mg

Weight of particulate in acetone rinse 56.0 mg

Total weight of particulate 143.3 mg

Note: In no case shall a blank residue greater than (.01 mg/g) or .001% of the weight of acetone used be subtracted from the sample weight.

Remarks:

Signature of analyst L J Kastens

Signature of reviewer

METHOD 5

PARTICULATE SAMPLE RECOVERY AND INTEGRITY SHEET

Plant: GEN SHALE Sample date: 4-22-86

Sample location: KNOXVILLE Run no.: #2

Sample recovery person: KALSTENS Recovery date: SAME

Filter(s) no.: #6

MOISTURE

Impingers			Silica gel		
Final volume (wt)	43	ml(gm)	Final wt.	958.2 g	g
Initial volume (wt)	0	ml(gm)	Initial wt.	958.1 g	g
Net volume (wt)	43	ml(gm)	Net wt.	6.1 g	g

Total moisture 49.1 g

Color of silica gel 1/10 PINK

Description of impinger water CLEAR

RECOVERED SAMPLE

Filter container no. RUN #2 sealed ✓

Description of particulate on filter LT CHARCOAL

Acetone rinse container no. RUN #2 Liquid level marked ✓

Acetone blank container no. BLK Liquid level marked ✓

Samples stored and locked

Remarks:

Date of laboratory custody

Laboratory personnel taking custody

Remarks:

METHOD 5 TRAIN ANALYTICAL PARTICULATE DATA

Plant GEN SHALE Run No. #2

Sample location KNOXVILLE

Relative humidity 20%

Density of acetone (ρa) .7847 g/ml

Sample type	Sample identifiable	Liquid level marked and/or container sealed
Acetone rinse	✓	✓
filter(s)	✓	✓

Acetone rinse container no. #7

Acetone rinse volume (Vaw) 225 ml

Acetone blank residue concentration (Ca) .0010 mg/g

Wa = Ca Vaw ρa = (.00102)(225)(.7847) = .18 mg

Date and time of wt 4-25-86 0800 Gross wt 107137.2 mg

Date and time of wt 4-25-86 1400 Gross wt 107137.2 mg

Average gross wt 107137.2 mg

Tare wt 107073.9 mg

Less acetone blank wt (Wa) .2 mg

Weight of particulate in acetone rinse 63.1 mg

Filter(s) container no. #6

Date and time of wt 4-25-86 0800 Gross wt 271.9 mg

Date and time of wt 4-25-86 1400 Gross wt 271.9 mg

Average gross wt 271.9 mg

Tare wt 167.9 mg

Weight of particulate on filter(s) 104.0 mg

Weight of particulate in acetone rinse 63.1 mg

Total weight of particulate 167.1 mg

Note: In no case shall a blank residue greater than (.01 mg/g) or .001% of the weight of acetone used be subtracted from the sample weight.

Remarks:

Signature of analyst Greg A Karstens

Signature of reviewer

GUARDIAN SYSTEMS inc

METHOD 5

PARTICULATE SAMPLE RECOVERY AND INTEGRITY SHEET

Plant: GEN SHALE Sample date: 4-22-86

Sample location: KNOXVILLE Run no.: #3

Sample recovery person: KARSTENS Recovery date: SAME

Filter(s) no.: #7

MOISTURE

Impingers			Silica gel		
Final volume (wt)	50	ml (gm)	Final wt.	960.7 g	g
Initial volume (wt)	0	ml (gm)	Initial wt.	954.7 g	g
Net volume (wt)	50	ml (gm)	Net wt.	6.0 g	g

Total moisture 56.0 g

Color of silica gel 1/10 PINK

Description of impinger water CLEAR

RECOVERED SAMPLE

Filter container no. RUN #3 sealed ✓

Description of particulate on filter CHARCOAL - WET

Acetone rinse container no. RUN #3 Liquid level marked ✓

Acetone blank container no. BLK Liquid level marked ✓

Samples stored and locked

Remarks:

Date of laboratory custody

Laboratory personnel taking custody

Remarks:

GUARDIAN SYSTEMS inc

METHOD 5 TRAIN ANALYTICAL PARTICULATE DATA

Plant GEN SHALE Run No. #3

Sample location KNOXVILLE

Relative humidity 20%

Density of acetone (ρa) .7847 g/ml

Sample type	Sample identifiable	Liquid level marked and/or container sealed
Acetone rinse	✓	✓
filter(s)	✓	✓

Acetone rinse container no. #12

Acetone rinse volume (Vaw) 225 ml

Acetone blank residue concentration (Ca) .00102 mg/g

Wa = Ca Vaw ρa = (.00102)(225)(.7847) = .18 mg

Date and time of wt 4-25-86 0800 Gross wt 106243.6 mg

Date and time of wt 4-25-86 1400 Gross wt 106243.6 mg

Average gross wt 106243.6 mg

Tare wt 106175.9 mg

Less acetone blank wt (Wa) .2 mg

Weight of particulate in acetone rinse 67.5 mg

Filter(s) container no. #7

Date and time of wt 4-25-86 0800 Gross wt 258.3 mg

Date and time of wt 4-25-86 1700 Gross wt 258.3 mg

Average gross wt 258.3 mg

Tare wt 161.6 mg

Weight of particulate on filter(s) 96.7 mg

Weight of particulate in acetone rinse 67.5 mg

Total weight of particulate 164.2 mg

Note: In no case shall a blank residue greater than (.01 mg/g) or .001% of the weight of acetone used be subtracted from the sample weight.

Remarks:

Signature of analyst Greg A Karstaedt

Signature of reviewer

GUARDIAN SYSTEMS INC

CHAIN OF CUSTODY LOG

Plant GENERAL SHALE - KNOXVILLE Lab Location BIRMINGHAM

SAMPLE RECOVERY

Run #	Date	Time	I.D. Number	Type	Recovered by
1	4-22	9:30	RUN #1	FILTER + ACETONE	G KARSTENS, C TURNER
2	4-22	11:30	RUN #2	"	" "
3	4-22	1:30	RUN #3	"	" "

SAMPLE TRANSFER

From-Whom	To Whom	Date	Time
NO TRANSFER	N/A		

SAMPLE ANALYSIS

Container #	Method of Analysis	Date	Time	Analyst
FILTER #4 RUN1	DESSICATION + REWEIGH	4-25-86	0800, 1400	G Karstens
#6 RUN2	"	4-25-86	"	"
#7 RUN3	"	4-25-86	"	"
ACETONE #5 RUN1	EVAPORATE + REWEIGH	4-25-86	"	"
#7 RUN2	"	4-25-86	"	"
#12 RUN3	"	4-25-86	"	"

Approved by [signature]

GUARDIAN SYSTEMS inc

GUARDIAN SYSTEMS, INC.

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

April 30, 1986

Customer: General Shale Products Corp.
P.O. Box 3547, C.R.S.
Johnson City, TN 37601

Control number: 59591

Report to: Mr. Dave McNees

Sample date: 4/23/86

Sample Mark: Coal

Sample Number:

LABORATORY REPORT

Parameter	Units		Results
	As Received	Dry Basis	
Moisture, %	2.34		
Ash, %	4.21	4.31	
Sulfur, %	1.16	1.18	
Btu	13,707	14,035	
MAF, Btu	14,668		

Method Reference: "Standard Methods", 15th Ed., 1981
ASTM ANNUAL STANDARDS

Approved by: John Sutherland

PROCESS INFORMATION

PLANT: KNOXVILLE 7B

DATE: APRIL 22, 1986

Brick Rate:

Car Schedule	=	36	Minutes	=	1.67	Cars/Hour
Car Count	=	3,840	S/S Brick/Car			
Hourly Rate	=	6,400	S/S Brick/Hour			
Brick Weight	=	4.3	Lbs.			
Brick Rate	=	27,520	Lbs./Hour			

Coal Rate:

Firing Rate	=	14.89	Tons Coal/Day
		1,241	Lbs. Coal/Hour
		193.9	Lbs. Coal/M Brick

Total Process Weight:

	27,520	Lbs. Brick/Hour
+	1,241	Lbs. Coal/Hour
	28,761	Total Lbs./Hour
	14.38	Tons/Hour *

Coal Analysis: (See Attached)

	Btu/Lb.	
	Sulfur	
	Ash	

Allowable Emissions:

* Based on input rate; 11.34 tons/hr. based on output (product) rate.

DAILY BURNING REPORT

PLANT 7 KILN B DAY TUE. DATE 4-22-86

COAL		BTU's		Therms		Cost
29,789 #	@ 14000	= 41704740	=	4170	@ .176	= $ 734.00

Total Therms 4170 $ 734.00 Total Cost

Total Brick Burned 153,600 $ 4.77 Cost per M

Total Therms/M Brick Burned 27.1

SCHEDULE 36 min.

TYPE BRICK 5/s Antiques

BTU's/# 754

PREDRYER SUPPLY 140

KILOWATT HOURS 27164.16

POWER COST 1187.0

POWER COST PER M 5.29

PREDRYER COUNT

NO. CARS 40

[redacted]

U.C.T. 350

SUPERVISOR Charles Quinn

DAILY REPORT
KNOXVILLE, TENN.

.ANT: 7A and B

Day Tuesday Date: 4-22-86

INDING	STD	ACTUAL
nding Room Worked	16	16
nd Operated	15	11.6
s Per/Hour	55	59.2
ads Hauled	24	36
ens Modulus	2.5	-
marks:		

ACHINING Total 285,504	#/Shift	1st	2nd	3rd
ll Room Started				
ck Mach Norm- 20,000 B/HR. 17,733		5.7	4.2	6.2
ck Machine Started				
rted Hacking Cored Brick				
pe Brick Produced M/S Essex Jordan S/S Ft. Loudon	1st 851,824	2nd 761,810	3rd 1221,880	
ck Hacked vs. Brick Made	%		%	
cuum (Absolute)	2.5		2.2	
een Strength	25		33	
en Brick Weight	4.4		4.3	
lumn Temp.	100		98	
id Area 27.0	A: 28.0	B: 27.7		
marks:		27.6		
dryer				
en Cars	a b	a b		
w Joint				
. Sup. Temp. 140	110	140		
marks:				
marks:				

BURNING	A STD	B	A ACTUAL	B
Kiln Schedule	65	36	65	36
Cars Burned	22	40	21	40
Car Count	3360	3840	3360	3840
Brick Burned	78	145	70	153
Type of Brick S/S Antiques				
Rate of Suction "	35		29	20
Key Check Reading A&B	-	-	-	-
Cold Water Absorption		6.0	5.7	5.6
LOADING				
Brick Graded/Man Hour	2000			1913
General Information				
No. Employees 104	98		99	
N.U.B. Produced	12,000		6500	
Remarks:				
BURNED BRICK WT.	3.35 lbs			

FUEL REPORT

'A' KILN			
Nat. Gas		Cu. Ft.	Therm. %
Fuel Oil		Gal.	Therm. %
Coal 15,595		Lb. 2183	Therm. %
Total Therms. Norm- 27.0	30.9		Therms. Per.
BTU/Lbs. Ware Norm-	859		

'B' KILN			
Nat. Gas		Cu. Ft.	Therm. %
Fuel Oil		Gal.	Therm. %
Coal 29,789		Lb. 4170	Therm. %
Total Therms. Norm- 27.0	27.1		Therm. Per.
BTU/Lbs. Ware Norm-	754		

[signature]

8,000 Berkley Iron Spot
Shape A - Hurstbourne

SUPERVISOR CL
KILN SCHEDULE 36 min.
PRODUCTION 153,600
TYPE BRICK 5/8 Antiques
TOTAL KILN HOURS
KEY CHEK AVERAGE

DATE 4-22-86
GREEN BRICK WEIGHT
BURNED BRICK WEIGHT 3.6
CARS BURNED 40
TOTAL BRICK BURNED
TOTAL BRICK WEIGHT

GREEN BRICK AT 8:00 A.M.
STANDARD
SPECIAL
SOLID
PAVER
OTHER

	1	2	3
PUSHER PRESSURE	300		
TURBO PRESSURE	24.5		
GAS PRESSURE			
PREDRYER SUPPLY TEMP.	140		
DRYER EXHAUST DRAFT			
DRYER EXHAUST TEMP.	170		
COLD AIR SUPPLY TEMP.			
KILN EXHAUST DRAFT			
UNDER CAR TEMP.	355		
COAL SCREENING			
COAL DRYER TEMP.	145		
FLASHING SYSTEM			
TURBO BLOWER (amps)			
DRYER SUPPLY (amps)			
DRYER EXHAUST (amps)			
COLD AIR SUPPLY (amps)			
KILN EXHAUST (amps)			
IMP MILL (amps)			
IMP MILL BLOWER (amps)			

	1	2	3
PREDRYER			
WET BULB			
DRY BULB			
HUMIDITY			
DEW POINT			
BRICK BODY			
FANS			
DRYER			
WET BULB			
DRY BULB			
HUMIDITY			
DEW POINT			
BRICK BODY			
FANS			

DRYER RECIRCULATING FANS
NO. 1
NO. 2
NO. 3
NO. 4

ENERGY METERS

	[redacted]	COAL	FLASHING	ELECTRIC
END	370	635		4259
BEGIN	369	055		4129
TOTAL	1580 X 18.7 =			130 X 207.36

CONTROL VALVE PRESSURE
NO. 1 45 %
NO. 2 5 %
NO. 3 36 %
NO. 4

		BTU	THERMS	COST	THERM % OF TOTAL	COST PER M	THERMS PER M
GAS:	____ c.f. @ 1,040 =	____ / 100,000 =	____ @ ____ /therm = $				
COAL:	29546 lb. @ 14000 =	41364400 / 100,000 =	4136 @ .176 /therm = $	728.01	100 %	4.73	26.9
FLASHING:	____ lb. @ ____ =	____ / 100,000 =	____ @ ____ /therm = $				

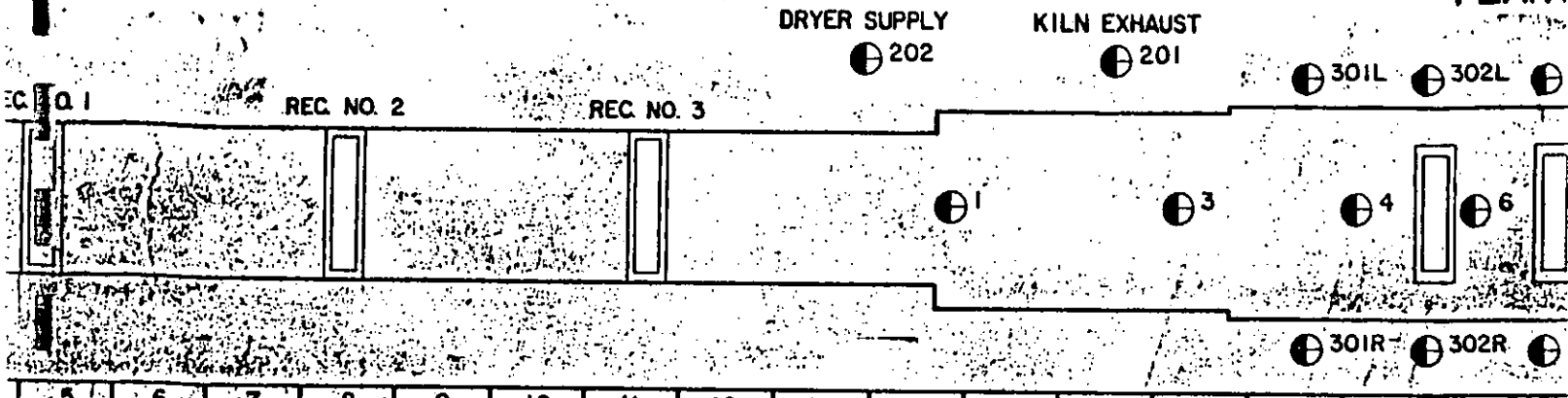
GAS: $ ____ per MCF, ____ ¢ per therm
TOTAL THERMS 4136
TOTAL THERMS PER M BRICK 26.9
KWHR PER M BRICK 26956.80 (.0437)
KWHR COST PER M BRICK 1178.0 (5.17)

COAL: $ ____ per ton, ____ ¢ per therm
BTU PER POUND OF BRICK 747
AVERAGE COST PER THERM
TOTAL COST 728.01
COST PER M BRICK 4.73

1	2	3	4

HOUR	[redacted]	CAR	TYPE	SCH
0800	11	78/11		809/[illegible]
0900	2	1/41		9[illegible]
1000	3	165		1033
1100	2	146/47		1109/[illegible]
1200	2	134/131		12[illegible]
1300	4	105		133
1400	3	124/105		209/[illegible]
1500	4	89/3		321/[illegible]
1600	3	61		433
1700	1	57/91		509/[illegible]
1800	0	134/123		621/65[illegible]
1900	0	187		733
2000	0	114/116		809/[illegible]
2100	0	37/35		921/9[illegible]
2200	0	20		1033
2300	0	28/108		1108/11[illegible]
2400	2	22/27		1221/125[illegible]
0100	5	14		133
0200	4	79/113		209/24[illegible]
0300	6	50/143		321/35[illegible]
0400	3	X		433
0500	4	180/37		509/54[illegible]
0600		154/69		621/65[illegible]
0700	2	32		733

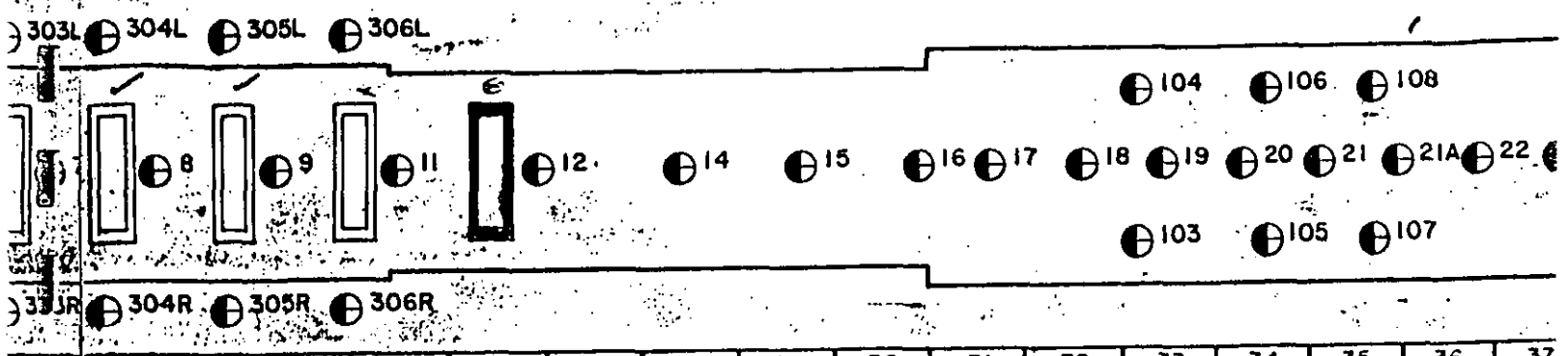
1495 1485
1490 GENERAL SHALE PF
PLANT



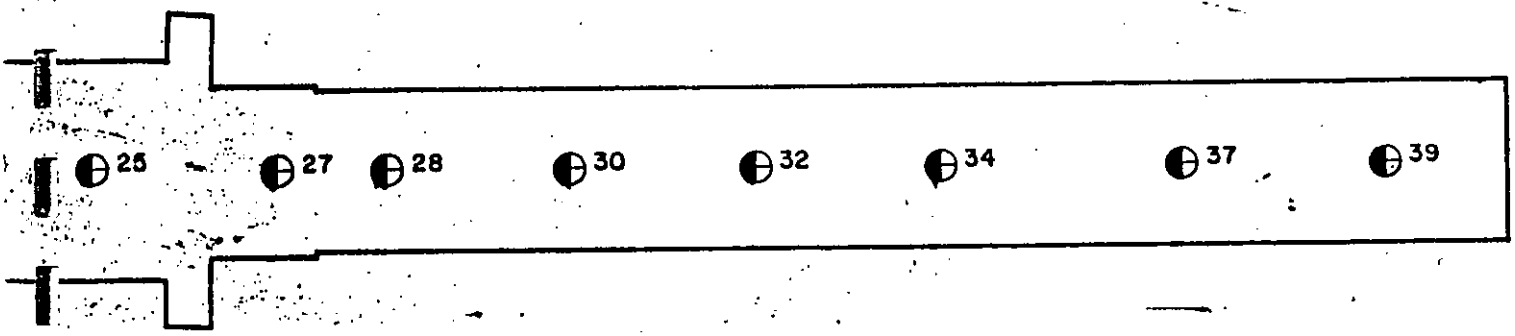
5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20

			DRYER SUPPLY	KILN EXH'T	EXHAUST										RECIRCULATING	
Coal			350	500	700	800	750	750	840	840	840	920	1100	1100	1030	1250
TURBO	[redacted]	DRAFT	202	201	1	3	301-R	301-L	4	302-R	302-L	6	303-R	303-L	7	304-R
24	140	48	340	505	710	810	905	895	850	880	920	960	1160	1125	1040	1210
24	135	47	340	505	720	790	900	890	840	880	960	955	1160	1125	1045	1210
24	140	46	340	515	725	820	920	895	880	880	970	960	1160	1130	1055	1220
24	145	49	340	490	720	830	910	900	865	880	965	970	1165	1130	1045	1210
24	145	46	340	515	730	830	915	905	875	880	970	975	1170	1130	1040	1230
24	145	47	360	520	730	825	905	900	870	875	965	970	1165	1130	1040	1220
24	140	46	345	500	720	810	910	900	875	870	965	960	1170	1130	1045	1225
24	145	41	345	510	715	830	900	895	870	870	960	945	1105	1090	1040	1215
24	145	43	350	510	715	825	900	890	870	870	955	940	1105	1100	1040	1215
24	145	44	350	510	715	830	900	895	870	870	960	940	1110	1105	1040	1220
24	145	42	345	525	700	790	875	875	835	855	950	925	1075	1080	1040	1215
43	140	42	350	525	700	790	880	880	835	855	950	930	1075	1085	1040	1210
45	140	41	350	525	700	795	880	880	840	855	950	930	1080	1080	1040	1210
3	140	41	340	505	685	790	865	860	870	855	940	920	1055	1060	1010	1195
45	140	41	340	510	685	790	865	865	870	850	940	925	1060	1060	1010	1190
43	145	41	340	510	675	785	855	855	825	840	935	910	1055	1060	1015	1205
4.5	145	.40	335	495	670	770	845	845	865	835	925	900	1040	1050	990	1190
4.5	140	.42	335	490	660	765	830	830	800	830	915	890	1035	1040	980	1180
4.5	140	.42	330	515	655	760	830	825	790	870	910	890	1030	1035	975	1180
4.	140	.43	335	485	650	760	825	825	805	870	905	880	1020	1030	990	1175
4.5	145	.42	335	495	660	755	830	830	800	875	905	890	1025	1035	1000	1180
4.5	145	.42	330	505	655	760	830	830	800	835	915	885	1030	1040	1015	1180
	140	.43	325	480	655	765	835	835	790	840	915	890	1030	1040	980	1190
4.6	145	.44	325	490	655	770	830	830	805	850	915	900	1040	1045	1005	1180

PRODCTS CORPORATION
ITEM NO. 7B



21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37
										PREHEAT						
12 20	1150	1350	1350	1335	1360	1360	1520	1580	1650	1670	1750	1790	1820	1820	1820	1860
304-L	8	305-R	305-L	9	306-R	306-L	11	12	14	15	16	17	18	103	104	19
12 0	1155	1370	1350	1330	1350	1360	1500	1575	1650	1655	1730	1780	1825	1835	1810	1855
1270	1145	1370	1355	1325	1350	1365	1520	1600	1655	1660	1740	1775	1825	1825	1800	1865
1265	1155	1380	1365	1335	1365	1370	1515	1590	1665	1650	1730	1775	1825	1845	1810	1860
12	1140	1375	1360	1330	1350	1360	1510	1590	1655	1665	1745	1780	1825	1825	1815	1865
1270	1155	1385	1360	1335	1355	1325	1530	1585	1665	1670	1750	1785	1825	1825	1810	1865
1265	1155	1370	1350	1350	1365	1380	1525	1585	1660	1670	1745	1790	1825	1820	1800	1855
12	1155	1385	1365	1325	1355	1360	1510	1580	1655	1660	1735	1780	1825	1815	1815	1860
1240	1155	1375	1365	1340	1355	1360	1515	1580	1645	1660	1730	1775	1810	1810	1805	1865
1245	1160	1370	1370	1340	1355	1365	1515	1590	1655	1660	1730	1775	1820	1825	1810	1860
1270	1160	1370	1370	1335	1360	1360	1525	1595	1660	1670	1735	1775	1810	1830	1815	1865
1275	1160	1390	1380	1340	1355	1365	1540	1585	1655	1665	1730	1775	1815	1825	1810	1865
1235	1160	1390	1380	1335	1350	1360	1540	1605	1655	1670	1735	1770	1815	1810	1800	1860
12 0	1160	1375	1380	1335	1350	1365	1530	1605	1670	1675	1735	1770	1815	1830	1800	1865
1220	1145	1360	1355	1340	1360	1370	1520	1595	1675	1680	1740	1775	1810	1815	1805	1865
1270	1145	1360	1380	1340	1365	1370	1520	1575	1640	1680	1745	1775	1810	1810	1805	1860
12 5	1145	1365	1355	1335	1360	1365	1520	1570	1640	1665	1740	1780	1820	1825	1810	1865
12 5	1135	1365	1350	1350	1365	1370	1500	1565	1630	1655	1730	1770	1820	1825	1805	1865
1200	1115	1345	1340	1345	1365	1370	1485	1550	1625	1660	1730	1770	1810	1825	1810	1855
1195	1125	1340	1330	1340	1355	1365	1480	1550	1625	1650	1790	1775	1815	1825	1805	1865
11	1095	1350	1335	1340	1350	1360	1500	1560	1630	1640	1735	1770	1820	1825	1810	1865
1195	1135	1355	1340	1335	1350	1360	1510	1565	1640	1645	1760	1760	1810	1798	1790	1850
12 0	1140	1365	1350	1340	1360	1365	1510	1565	1640	1655	1725	1770	1820	1830	1815	1860
12 5	1120	1370	1355	1340	1355	1360	1515	1565	1645	1660	1730	1770	1825	1830	1805	1860
1200	1150	1380	1355	1335	1355	1360	1520	1565	1640	1655	1730	1770	1825	1825	1800	1865



39	40	41	42	43	44	45	46	47	48	49	50	51	52	53

E ZONE — COOLING

20	1860	1820	1820	1855	1810	1800	1750	1550	1300	1200	1100	900	700	100	100	
106	21	107	108	21-A	22	23	24	25	27	28	30	32	34	37	39	
1810	1860	1830	1805	1855	1775	1790	1745	1595	1325	1220	1030	905	665	95	115	1
1820	1860	1800	1820	1855	1775	1795	1740	1595	1320	1205	1040	910	645	100	115	0
1815	1860	1830	1820	1850	1780	1790	1735	1590	1310	1200	1030	920	655	110	130	1
1820	1860	1840	1810	1850	1775	1800	1740	1600	1325	1210	1040	920	665	105	125	1
1820	1855	1825	1820	1855	1780	1800	1735	1590	1315	1200	1020	910	645	105	125	0
1840	1855	1830	1825	1850	1775	1795	1735	1590	1325	1210	1015	910	655	105	145	0
1815	1860	1800	1800	1855	1780	1805	1750	1590	1320	1215	1030	905	650	110	130	1
1875	1860	1830	1835	1855	1780	1805	1745	1595	1325	1210	1035	895	650	105	125	1

FIREMAN

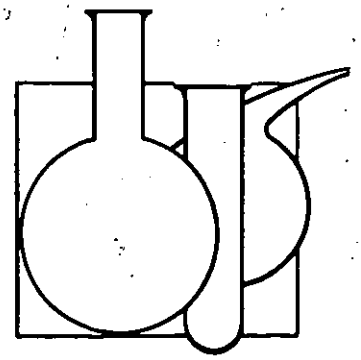
1825	1855	1815	1815	1860	1780	1800	1740	1600	1320	1210	1040	890	650	105	125	1
1815	1860	1830	1815	1860	1785	1800	1740	1600	1320	1215	1045	890	650	105	120	0
1875	1865	1815	1810	1865	1780	1800	1740	1595	1325	1230	1030	915	650	105	125	1
1830	1860	1830	1830	1860	1785	1800	1740	1600	1325	1220	1030	915	655	105	125	2
1875	1865	1830	1830	1865	1785	1800	1740	1600	1320	1220	1030	910	655	105	120	2
1875	1860	1815	1815	1865	1785	1800	1740	1590	1330	1220	1025	915	665	100	120	2
1875	1860	1835	1815	1865	1785	1800	1740	1595	1330	1220	1000	915	660	100	120	1
1810	1865	1820	1810	1855	1780	1800	1740	1590	1325	1215	995	905	620	95	105	1

FIREMAN

1830	1860	1835	1815	1855	1785	1800	1740	1600	1325	1215	1030	895	645	100	125	0
1830	1860	1830	1820	1855	1780	1795	1745	1605	1315	1200	1010	910	640	100	120	4
1840	1855	1835	1820	1855	1780	1800	1740	1595	1320	1205	1015	905	650	100	130	4
1835	1860	1835	1820	1850	1780	1785	1745	1595	1330	1225	1020	910	650	100	120	2
1785	1855	1815	1815	1855	1780	1795	1735	1600	1315	1210	1035	900	660	95	125	3
1825	1855	1805	1810	1850	1775	1790	1730	1590	1310	1200	1010	930	640	95	130	1
1830	1855	1820	1815	1855	1780	1790	1735	1600	1320	1190	1005	900	656	95	125	1
1820	1855	1815	1810	1850	1775	1790	1735	1595	1320	1190	990	890	640	95	115	1

FIREMAN

Calibrations



VI. METHOD 5 CALIBRATIONS

Meter Box

The meter box shall be initially calibrated every 6 months at the fixed settings of 0.5, 1.0, 1.5, 2.0, and 2.5 inches of water. Upon return to the laboratory from this test the meter box was be 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 0.92 a 1.00 "H_2O was used as the recalibration point). These recalibrations produced a single point MCF and a 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 shall be calibrated against a standard pitot tube (C_p = 0.99) in a wind tunnel with a capaciaty to generate a test section velocity of approximately 3000 feet/ minute every 6 months. Additionally the pitot tube shall be measured as to its specifications and alignment. Upon return, the intercomponent spacings and the face opening alignment of the pitot tube assembly shall be rechecked and if no changes are noticed; it shall be assumed that the cofficient of the assembly had not changed.

Temperature measurments

All temperature devices (impinger, meter box, hot box and stack) shall be calibrated every 6 months against an ASTM mercury-in-glass reference therometer 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 temperarure. 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. METHOD 5 CALIBRATIONS CONTINUED

Barometric Pressure

An aneroid barometer capable of measuring atmospheric pressure to within 0.1 inches Hg shall be 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'-N
Meter Box: #700
Stack Temeperature: OMEGA III
Sample Box: #2
Condenser: #1

The average temperature of the stack was 171 °F. The OMEGA III was recalibrated at 170 °F and agreed exactly with an ASTM mercury-in-glass reference thermometer. The intercomponent spacings and the face opening alignment of the Pitot Tube assembly was rechecked and no changes were noticed; therefore, it was assumed that the cofficient 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 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 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 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 @320/cm/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. 500 ml distilled water.
B. Add 15 drops saturated KCl solution
C. Shred one 8"x10" sheet and soak in prepared water for one hour.
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, 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	60
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:

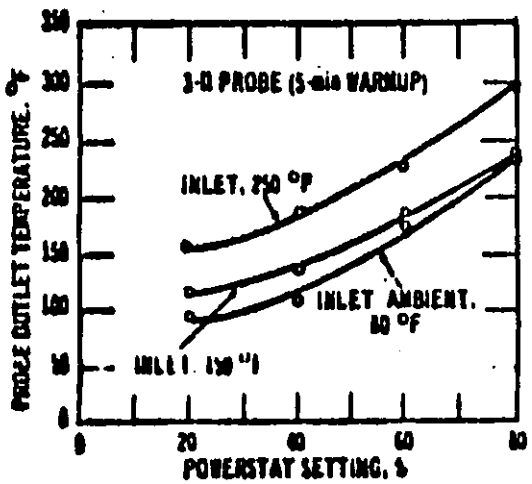
BSO	522	Flow Resistance (Max.) @ 320 cm/min.	80 mm
*pH	9.0	Flow Rate (air) lpm/cm² @ 70 cm Hg	60
DOP @320/cm/min ASTM Methods 2986)	99.9%	Max. Use Temp.	400°C
Tensile Strength (Fed. Spec. UUP31B)	600 gr.	Static Properties	Medium
Weight 8"x10"sheet	4.0±.3 gr.	Ability to Fold	Good

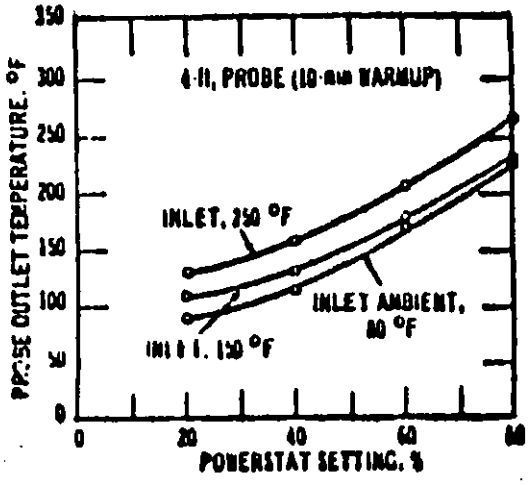
WATER EXTRACTABLE IONS:

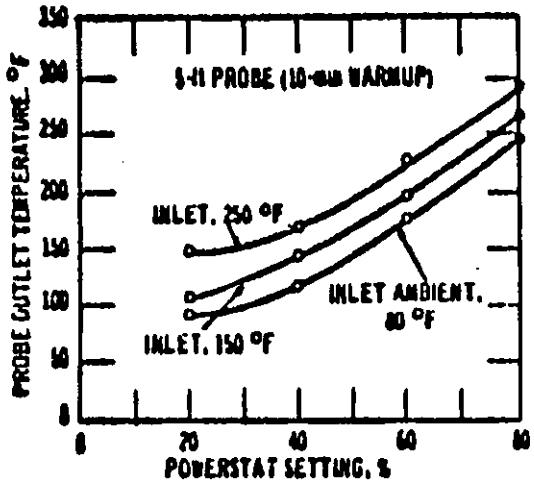
Sulfate	600	Chloride	1500
Nitrate	115	Fluoride	87
Ammonia	13		

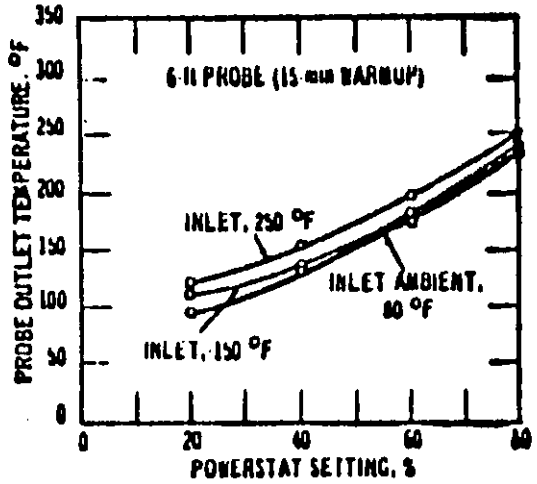
*pH—Gelman Procedure:

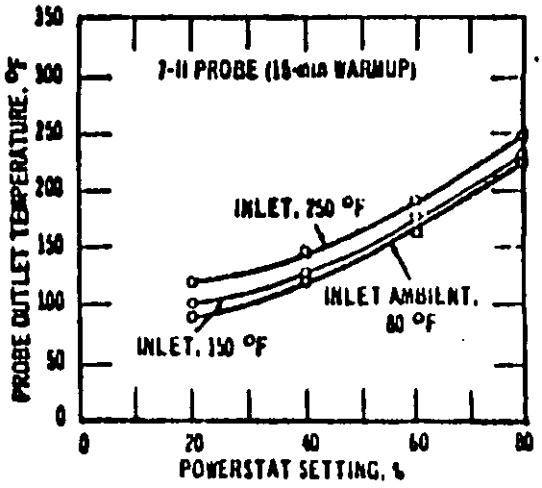
A. 500 ml distilled water.
B. Add 15 drops saturated KCl solution.
C. Shread one 8"x10" sheet and soak in prepared water for one hour.
D. Run pH at ambient temperature.











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

GUARDIAN SYSTEMS INC
Initial Meter Calibration Box 700
on 4/07/86

Run Number	1	2	3	4	5
Barometric Pres, in Hg	30.10	30.10	30.10	30.10	30.10
Orifice pres drop, in H20	0.5	1.0	1.5	2.0	2.5
Pres Wet Test Meter, in H20	-0.42	-0.85	-1.11	-1.40	-1.70
Gas Volume Wet Init, CF	0.000	0.000	0.000	0.000	0.000
Gas Volume Wet Final, CF	6.056	8.883	10.532	12.430	13.986
Gas Volume Dry Init, CF	324.475	330.625	339.672	350.434	363.221
Gas Volume Dry Final, CF	330.625	339.672	350.434	363.221	377.682
Temp Wet Init, C	19.0	19.0	19.0	19.0	19.0
Temp Wet Final, C	19.0	19.0	19.0	19.0	18.8
Vapor Pressure, mm Hg	16.477	16.477	16.477	16.477	16.374
Dry Gas Temp Init In, F	92	91	95	97	99
Dry Gas Temp Final In, F	92	96	98	100	101
Dry Gas Temp Init Out, F	76	82	85	87	89
Dry Gas Temp Final Out, F	82	86	87	90	91
Run Time, sec	900	900	900	900	900
Meter Calibration Factor, Y	0.9966	0.9973	0.9967	0.9921	0.9883
Average Y	0.9942				
Qm	0.4037	0.5963	0.7083	0.8381	0.9442
Km	0.7270	0.7563	0.7325	0.7494	0.7546
Average Km	0.7440				
Delta H@	1.74	1.61	1.72	1.64	1.62
Average H@	1.66				

SIGNATURE G Karstens

GUARDIAN SYSTEMS INC
Recalibration of Meter Calibration Box 700
on 4/23/86

Run Number	1	2	3	Average
Barometric Pres, in Hg	30.15	30.15	30.15	30.15
Orifice pres drop, in H20	1.0	1.0	1.0	1.0
Pres Wet Test Meter, in H20	-0.76	-0.76	-0.76	-0.76
Gas Volume Wet Init, CF	0.000	0.000	0.000	0.000
Gas Volume Wet Final, CF	8.925	9.129	8.943	26.997
Gas Volume Dry Init, CF	707.503	716.675	726.149	2150.327
Gas Volume Dry Final, CF	716.675	726.149	735.503	2178.327
Temp Wet Init, C	16.5	17.0	17.2	16.9
Temp Wet Final, C	17.0	17.2	17.5	17.2
Vapor Pressure, mm Hg	14.303	14.622	14.856	14.594
Dry Gas Temp Init In, F	86	95	102	94.3
Dry Gas Temp Final In, F	95	104	105	101.3
Dry Gas Temp Init Out, F	78	82	92	84.0
Dry Gas Temp Final Out, F	82	92	93	89.0
Run Time, sec	900	930	900	2730
Meter Calibration Factor, Y	0.9928	0.9959	0.9955	0.9948
Qm	0.6012	0.6019	0.6147	0.6059
Km	0.7660	0.7619	0.7742	0.7673
Delta H@	1.57	1.59	1.54	1.56

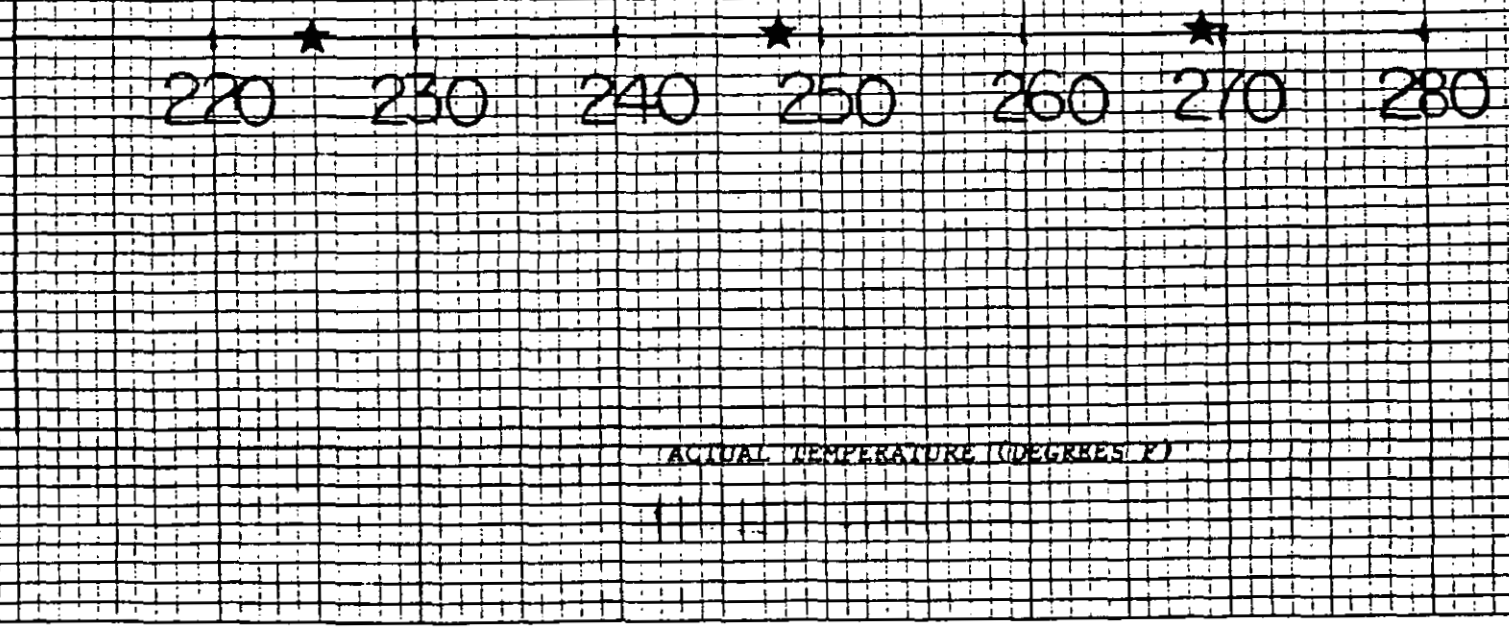
Previous Y	0.9973	% Difference	0.25
Previous H@	1.61	% Difference	2.83

Project General Shoe Stack Knoxville

SIGNATURE Greg Karstenn

TEMPERATURE CALIBRATION
FOR HOT BOX #2

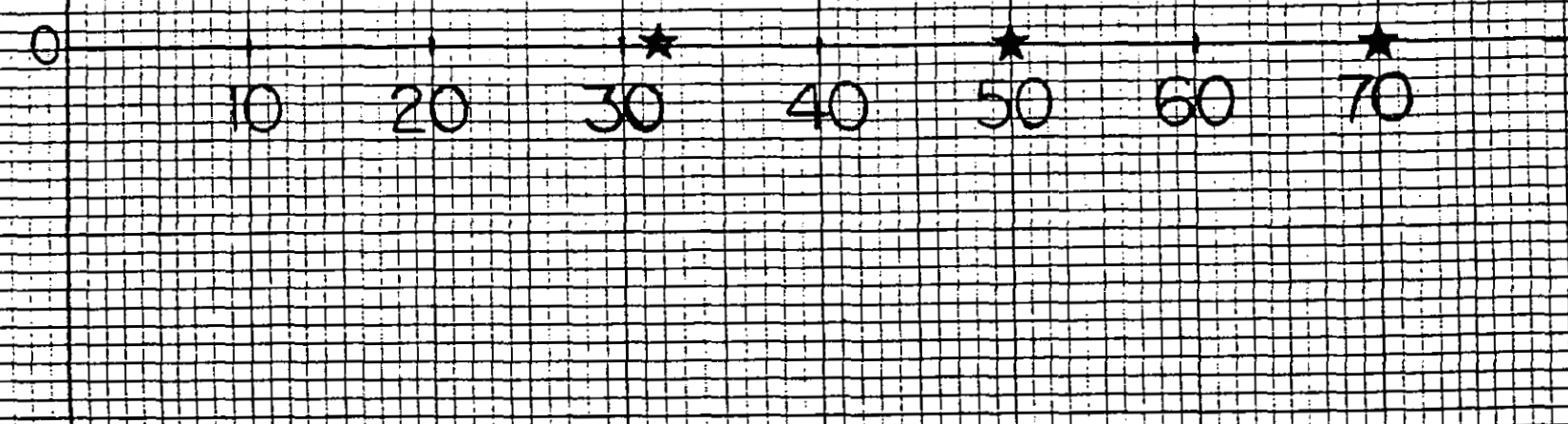
DATE INITIAL 4-14-86 DATE FINAL _____



TEMPERATURE CALIBRATION

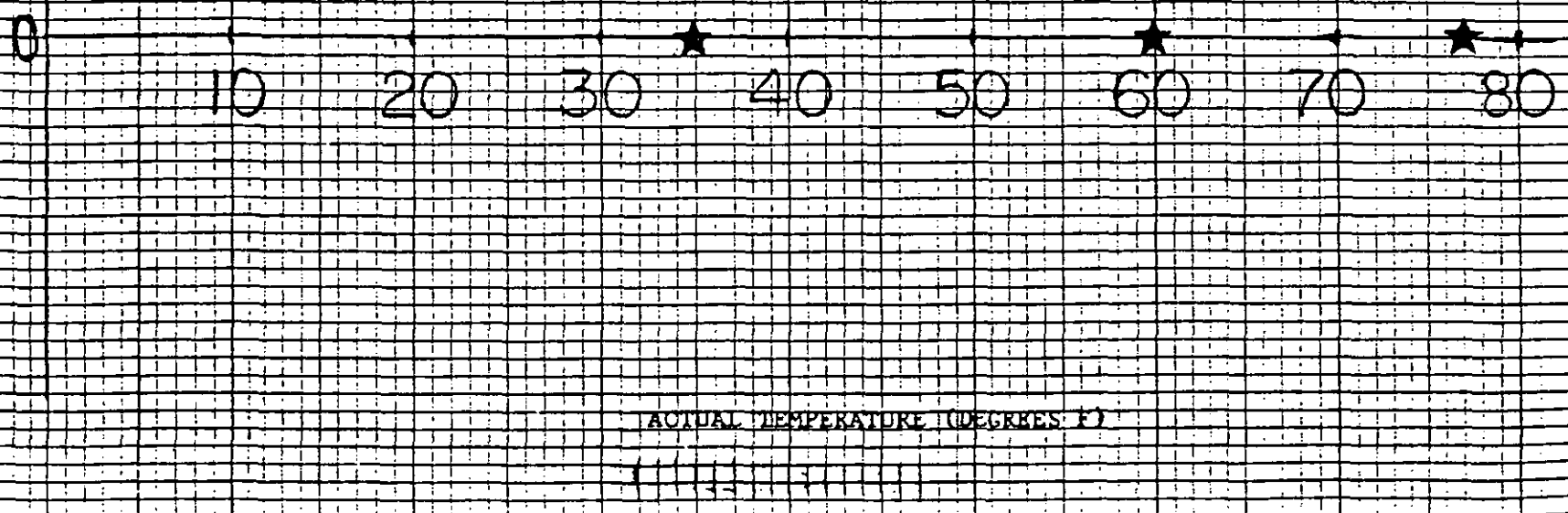
FOR IMPINGER #1

DATE INITIAL 4-14-86 DATE FINAL



TEMPERATURE CALIBRATION
FOR OMEGA 3

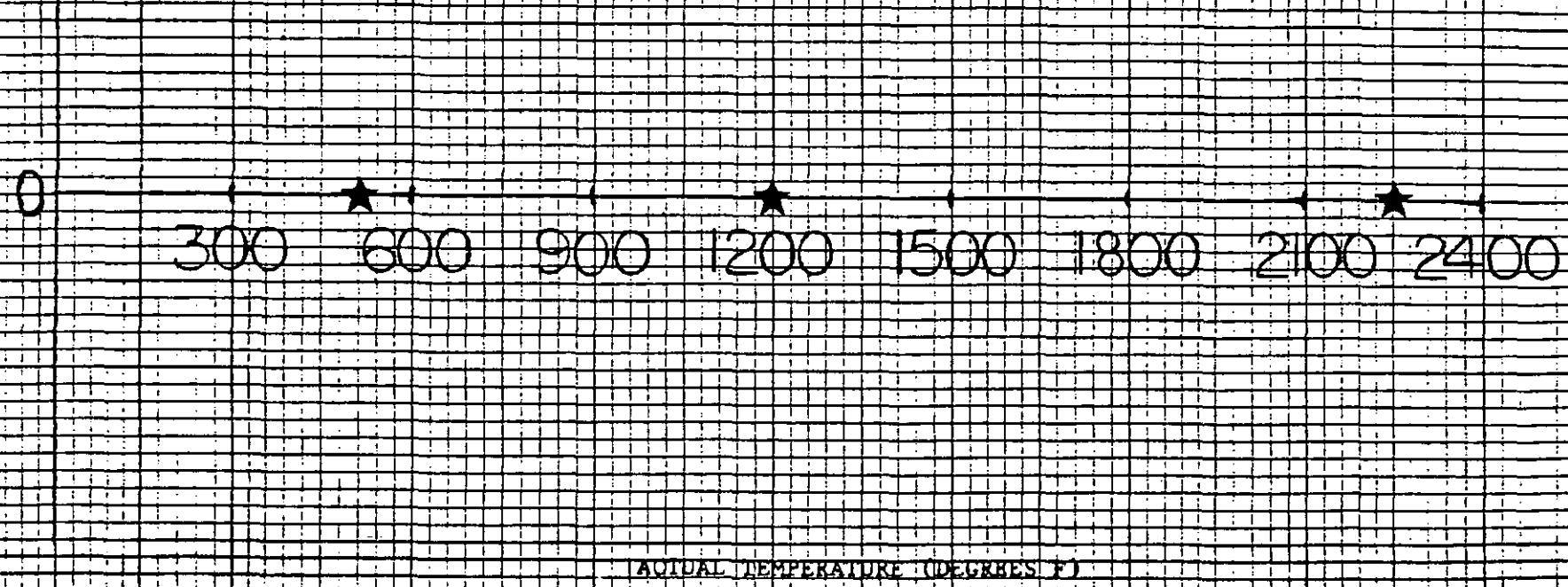
DATE INITIAL 4-11-86 DATE FINAL



GUARDIAN SYSTEMS inc

TEMPERATURE CALIBRATION
FOR OMEGA 3

DATE INITIAL 4-14-86 DATE FINAL



GUARDIAN SYSTEMS INC

PITOT CALIBRATION FORM

Date 3-7-86 Probe # 5'-N

Calibrated By G KARSTENS, C TURNER

Nozzle Size NA

SIDE A

Run #	ΔP_{std} (in. H_2O) Standard	$\Delta P(s)$ (in. H_2O) Type "s"	$C_p(s)$	Deviation $C_p(s) - \bar{C}_p(A)$
1	.335	.465	.840	+.007
2	.34	.485	.829	-.004
3	.345	.49	.831	-.002
		$\bar{C}_p(A)$	.833	

.83

SIDE B

Run #	ΔP_{std} (in. H_2O) Standard	$\Delta P(s)$ (in. H_2O) Type "s"	$C_p(s)$	Deviation $C_p(s) - \bar{C}_p(B)$
1	.335	.486	.822	-.008
2	.34	.48	.833	+.003
3	.345	.485	.835	+.005
		$\bar{C}_p(B)$	.830	

.83

CALCULATIONS

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

$$\text{Average Deviation} = \frac{\Sigma \left| C_p(s) - \bar{C}_p(A \text{ or } B) \right|}{3} \longleftarrow \text{Must be} \leq 0.01$$

$$\left| \bar{C}_p(A) - \bar{C}_p(B) \right| \longleftarrow \text{Must be} \leq 0.01$$