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.

AP-42 Section Number: 11.6

Reference Number: 23

Title: Source Emissions Survey of Oklahoma Cement Company's Kiln Number 3 Stack

Mullins Environmental Testing Co., Inc.

March 1980

Source category: Portland Cement
Plant name : Oklahoma Cement
Test date : 3/28/80
Process : dry

Date: 01/28/93
Location: Pryor, OK
Ref. No.: 16
Basis for process rate : feed/production
Ratio: 1.59

Source	Type of control	Pollutant	Run No.	Emission rate, lb/hr	Process rate, ton/hr	Emission factor kg/Mg	Emission factor lb/ton	Volumetric flow rate, DSCFM	Concen ppm
rotary kiln (coal-fired	cyclone + fabric filter	BASED ON KILN FEED RATE							
		filt. PM	1	6.9	52.5	0.0657	0.131		
		filt. PM	2	6.6	52.5	0.0629	0.126		
		filt. PM	3	6.1	52.5	0.0581	0.116		
					average	0.0622	0.124	Rating:	A
		con. inorg. PM	1	28.0	52.5	0.267	0.533		
		con. inorg. PM	2	28.0	52.5	0.267	0.533		
		con. inorg. PM	3	32.2	52.5	0.307	0.613		
					average	0.280	0.560	Rating:	A
		SO2	1	26.9	52.5	0.256	0.512		
		SO2	2	5.3	52.5	0.0505	0.101		
		SO2	3	5.3	52.5	0.0505	0.101		
					average	0.119	0.238	Rating:	D
		CO2	1	54,702	52.5	521	1,042	70,239	11.0
		CO2	2	61,810	52.5	589	1,177	70,405	12.4
		CO2	3	61,457	52.5	585	1,171	70,003	12.4
					average	565	1,130	Rating:	C
rotary kiln (coal-fired	cyclone + fabric filter	BASED ON CLINKER PRODUCTION RATE							
		filt. PM	1	6.9	33.1	0.104	0.208		
		filt. PM	2	6.6	33.1	0.0997	0.199		
		filt. PM	3	6.1	33.1	0.0921	0.184		
					average	0.0987	0.197	Rating:	A
		con. inorg. PM	1	28.0	33.1	0.423	0.846		
		con. inorg. PM	2	28.0	33.1	0.423	0.846		
		con. inorg. PM	3	32.2	33.1	0.486	0.973		
					average	0.444	0.888	Rating:	A
		SO2	1	26.9	33.1	0.406	0.813		
		SO2	2	5.3	33.1	0.0801	0.160		
		SO2	3	5.3	33.1	0.0801	0.160		
					average	0.189	0.378	Rating:	D
		CO2	1	54,702	33.1	826	1,653	70,239	11.0
		CO2	2	61,810	33.1	934	1,867	70,405	12.4
		CO2	3	61,457	33.1	928	1,857	70,003	12.4
					average	896	1,792	Rating:	C

Notes:
1. SO2 data rated D because of wide range in emission rates is indicative of testing problems.
2. CO2 data rated C because method not specified.

SUMMARY

PLANT: OKC - LONE STAR

LOCATION: ORYOR OKLAHOMA

TEST/IDENTIFICATION 80-32 DATE: [illegible] 1980

TESTING BY: MULLINS EQUIPMENT & TESTING CO.

KILN/COOLER NO. 3

			PERFORMANCE			
Kiln Production	Ton/Hr.	.....	33.1	@	1.767	K.F. Factor
Kiln Feed Rate	Ton/Hr.	.....	58.5			
Fuel Rate (Coal)	Ton/Hr.	.....	[illegible]	@		BTU/lb.
" " (Oil)	Gal/Hr.	.....	—			
Fuel Ash	%	.....	10.3			
Fuel Sulphur	%	.....	2.8	@		Kiln Feed S.

KILN (Stack)				ALLOWABLE
Exhaust Gas Flow	DSCFM	.....	70215	
Part. Concen.	lb/SCF	.....		
Emission Rate	lb/Ton	.....	0.11 6.5#/hr	0.3/17.6 #/hr
SOX (Kiln) (Concentration)	PPM	.....	18	
Emission Rate	lb/Ton	.....	0.19/12.5#/hr	0.3/19.7 #/hr 0.3(58.5 26.0)
Emission Rate	lb/MMBTU	.....	141	
NOX (Kiln) (Concentration)	PPM			
Emission Rate	lb/			

Reference 33 !

COOLER (Stack)		
Exhaust Gas Flow	DSCI	
Part. Concen.	lb/S	
Emission Rate	lb/T	1 50 #/hr

(1) Coal-fired dry process kiln w/ Cyclones + Cooler

REMARKS: * SRA

Data Rating: A

MULLINS ENVIRONMENTAL TESTING CO., INC.
P. O Box 598
Addison, Texas 75001 • (214) 980-1843

METCO

SOURCE EMISSIONS SURVEY
OF
OKLAHOMA CEMENT COMPANY
KILN NUMBER 3 STACK
PRYOR, OKLAHOMA

MARCH 1980

FILE NUMBER 80-38

METCO

TABLE OF CONTENTS

	PAGE NO.
INTRODUCTION	1
SUMMARY OF RESULTS	2
DISCUSSION OF RESULTS	4
DESCRIPTION OF PROCESS OPERATION	6
DESCRIPTION OF SAMPLING LOCATION	15
SAMPLING AND ANALYTICAL PROCEDURES	16
DESCRIPTION OF TESTS	18
APPENDICES	19

A. Location of Sampling Points

B. Source Emissions Calculations

C. Calibration of Equipment

D. Field Testing Data

E. Analytical Data

F. Plant Operational Data

G. Chain of Custody

H. Resumes of Test Personnel

SOURCE EMISSIONS SURVEY
OKLAHOMA CEMENT COMPANY
KILN NUMBER 3 STACK
PRYOR, OKLAHOMA
FILE NUMBER 80-38

INTRODUCTION

Mullins Environmental Testing Co., Inc., Dallas, Texas, conducted a source emissions survey at the Oklahoma Cement Company plant located in Pryor, Oklahoma, on March 28, 1980. The purpose of the survey was to determine the concentrations of particulate matter and sulfur dioxide being emitted to the atmosphere via the baghouse exhaust stack of Kiln Number 3.

The sampling followed the procedures set forth in the Appendix to the Code of Federal Regulations, Title 40, Chapter I, Part 60.

The tests were observed by Mr. Patrick J. Ford of GCA Corporation, representing the Environmental Protection Agency, Region VI and Mr. Roy Click of Oklahoma Cement Company.

SUMMARY OF RESULTS

The principal conclusions are as follows:

1. The emissions of particulate matter from the stack were equal to 0.112 pounds per ton of kiln feed (6.5 pounds per hour), based on averaging the three tests using only the "front-half" collection from the EPA-type sampling train. The allowable emission rate as stated in the Code of Federal Regulations, Title 40, Chapter I, Part 60, Subpart F is equal to 0.30 pounds per ton of kiln feed. The actual emissions were 37.3 percent of the permitted emission rate.

2. The emissions of particulate matter from the stack were equal to 35.9 pounds per hour, based on averaging the three tests using both the "front-half" and "back-half" collections from the EPA-type sampling train. The allowable emission rate as calculated from the process weight table in the Regulations of the Oklahoma State Department of Health is equal to 46.1 pounds per hour. The actual emissions were 77.9 percent of the permitted emission rate.

3. The emissions of sulfur dioxide from the stack were equal to 17.8 parts per million (12.5 pounds per hour), based on averaging the three tests.

SUMMARY OF RESULTS

Kiln Number 3 Stack

Run Number	2	3	4
Stack Flow Rate - ACFM	127,830	128,487	125,015
Stack Flow Rate - DSCFM*	70,239	70,405	70,003
% Water Vapor - % Vol.	6.7	7.0	6.0
% CO_2 - % Vol.	11.0	12.4	12.4
% O_2 - % Vol.	13.7	13.0	13.2
% Excess Air @ Sampling Point	219	192	203
Particulates Probe, Cyclone & Filter Catch grains/dscf*	0.0115	0.0109	0.0102
grains/cf @ Stack Conditions	0.0063	0.0059	0.0057
lbs/hr	6.9	6.6	6.1
Total Catch grains/dscf*	0.0580	0.0574	0.0639
grains/cf @ Stack Conditions	0.0318	0.0313	0.0357
lbs/hr	34.9	34.6	38.3
Kiln Feed Rate as Provided by Oklahoma Cement Company - tons/hr	58.5	58.5	58.5
Allowable Emission Rate State of Oklahoma - lbs/hr	46.1	46.1	46.1
Emission Rate - lbs/ton of kiln feed	0.118	0.113	0.104
Allowable Emission Rate - EPA 40 CFR 60 - lbs/ton of kiln feed	0.30	0.30	0.30
Sulfur Dioxide Emissions - lbs/hr	26.9	5.3	5.3

* 29.92 "Hg, 68°F

DISCUSSION OF RESULTS

At the conclusion of the first test, the tip of the glass probe liner was discovered to be broken and the test was discarded. The last three tests for particulates and sulfur dioxide appeared to be valid representations of the actual emissions during the tests. The indicative parameters calculated from the field data were in close agreement. The moisture percentages for the three tests were within 8.9 percent of the mean value. The measured flow rates (Q_s) for the three tests were within 0.3 percent of the mean value. The rates of sampling for the three tests were well within the specified limits, the greatest deviation being 2.1 percent.

The calculated emissions (pounds per ton of kiln feed) of particulate for the three tests showed a range of from -6.9 percent to +5.7 percent variation from the mean value.

Sulfur dioxide was determined simultaneously with the particulate run. The indicative parameters all indicate that the results were valid. The collection efficiencies between the two sulfur dioxide impingers in these tests were very good, indicating that little, if any, sulfur dioxide was bypassed.

The efficiencies were as follows:

	Run #2	Run #3	Run #4
Impinger #2	98.9	98.0	96.5
Impinger #3	1.1	2.0	3.5

Collection of 90 percent or more of the sampled sulfur dioxide in the first impingers is a verification of a representative sample.

The calculated emissions (pounds per hour) of sulfur dioxide for the three tests showed a range of -57.6 percent to +115.2 percent variation from the mean value due to the results of Run Number 2 being much greater than the other two tests.

DESCRIPTION OF PROCESS OPERATION

Description of Process Operation

The process used to describe the manufacturing of Portland Cement is divided into three process classifications termed wet, semi-dry and dry. The difference being in the amount of water used in the grinding of raw materials. At Oklahoma Cement the dry process system is used.

Raw materials used to manufacture cement at Oklahoma Cement are limestone, shale, and iron ore. After these materials have been crushed to a minimum size, they are fed proportionally to a dry process ball mill. In this mill they are blended and ground to a fine uniform powdered mixture which is called raw mix. As the raw mix is discharged from the mill, it is pumped to the raw mix blend silos. Once these materials have been blended and the mixture is of the desired chemical composition to produce quality cement clinker, the material becomes kiln feed and is transferred to the kiln silos.

From the kiln feed silos the material is fed to a coal-fired rotary kiln. Inside the kiln there are four main processes taking place at temperatures varying from 900°F at the feed end to 2800°F at the firing end. These processes are drying, calcination or decarbonation of limestone, clinkering-liquid formation to form cement compounds and finally the cooling of clinker. The liquid, upon cooling, forms

hard masses 1/8 inch to 1 1/2 inch in size. These hard masses are called clinker and when cooled by passing through a clinker cooler, they are conveyed to a storage area. These hard masses are eventually transferred to a ball mill where they are ground to a fine powder called cement. Exhibit "A" presents a flow diagram of the Pryor plant.

Process Weight

During the past several years a considerable amount of production - process data has been compiled and summarized which enables one to predict and verify production capacities of the various process units.

Under the present method of operation, kiln production is obtained by methods (2) and (3) listed below and may be cross-checked by methods (1) and (4). These are:

(1) Inventory measurements of raw materials in the blend silos and kiln feed silos.

(2) Number of crane buckets of clinker removed from the kiln discharge area. Crane buckets have been calibrated to contain X number of tons of clinker.

(3) Speed of kiln feed screw - and raw weigh feeder - each RPM feeds X number of tons of raw material to the kiln.

(4) Inventory measurement of clinker storage area.

During the course of emission sampling for this period, kiln and feeder data were obtained. From this kiln feed and clinker production were calculated. These data are presented in the following table, PROCESS DATA.

OKLAHOMA PROCESS DATA
FOR
JOY BAGHOUSE COLLECTOR

	KILN #3	TOTAL KILN FEED RATE
Raw Feed Tons/Hr	52.5	52.5
Coal Feed Tons/Hr	6.0	6.0
TOTAL FEED RATE TONS	58.5	58.5
TOTAL FEED METRIC TONS		53.1
Clinker Produced Tons	33.1	33.1

Allowable Emissions-Baghouse

EPA 0.3 lb/ton kiln feed with coal	17.6 lbs/hr
EPA 0.15 Kg per metric ton of feed	7.97 Kg/hr

Oklahoma Allowable 46.1 lbs/hr

Process Weight Table
Total feed to kiln 58.5 tons/hr

Production rates are during time of testing - 11:00 AM to 7:00 PM; 3-28-80.

Representatives present during time of tests were:

GCA	Representing EPA
Oklahoma Air Control	Dr. Joyce Sheedy
Kaiser Engineers	Chris Rayner

PRODUCTION DATA FACTORS

During Joy Baghouse Emission Test

Production Rates - For eight hours operation 11:00 a.m. - 7:00 p.m. (3-28-80)

#3 Kiln

Raw Feeder Counts -

419.1 ÷ 8 = 52.5 tons raw per hour

= 52.5 tons/hr x 0.63 = 33.1 clinker tons/hr

Coal Feeder Counts -

$$47.89 = \frac{47.89}{8} = 6.0 \text{ Tons coal/hr used}$$

Total kiln feed rate 58.5 tons/hr

Identity of Emissions

Emissions from the process are fine particles and combustion gases. Combustion gases are a mixture of water vapor, oxygen, nitrogen, carbon dioxide, and sulfur dioxide.

Plant Operation - Variation during routine operations

A. Variation in operating conditions could be from one or a combination of the following:

1. Problems with raw feed
   a. Not feeding uniformly
   b. Loss of feed
   c. Change in chemical composition
   d. Ring formations, mud or clinker
   e. Excessive coating
   f. Coating falling out

2. Fuel Conditions
   a. Inconsistent coal feed
   b. Improper draft on cooler
   c. Backend temperatures
   d. O_2 low in exit gases

3. Kiln Conditions

   a. Problems during startup and shutdown
   b. Electrical or mechanical equipment failures
   c. Low backend draft
   d. Favoring kiln because of hot spots on kiln shell

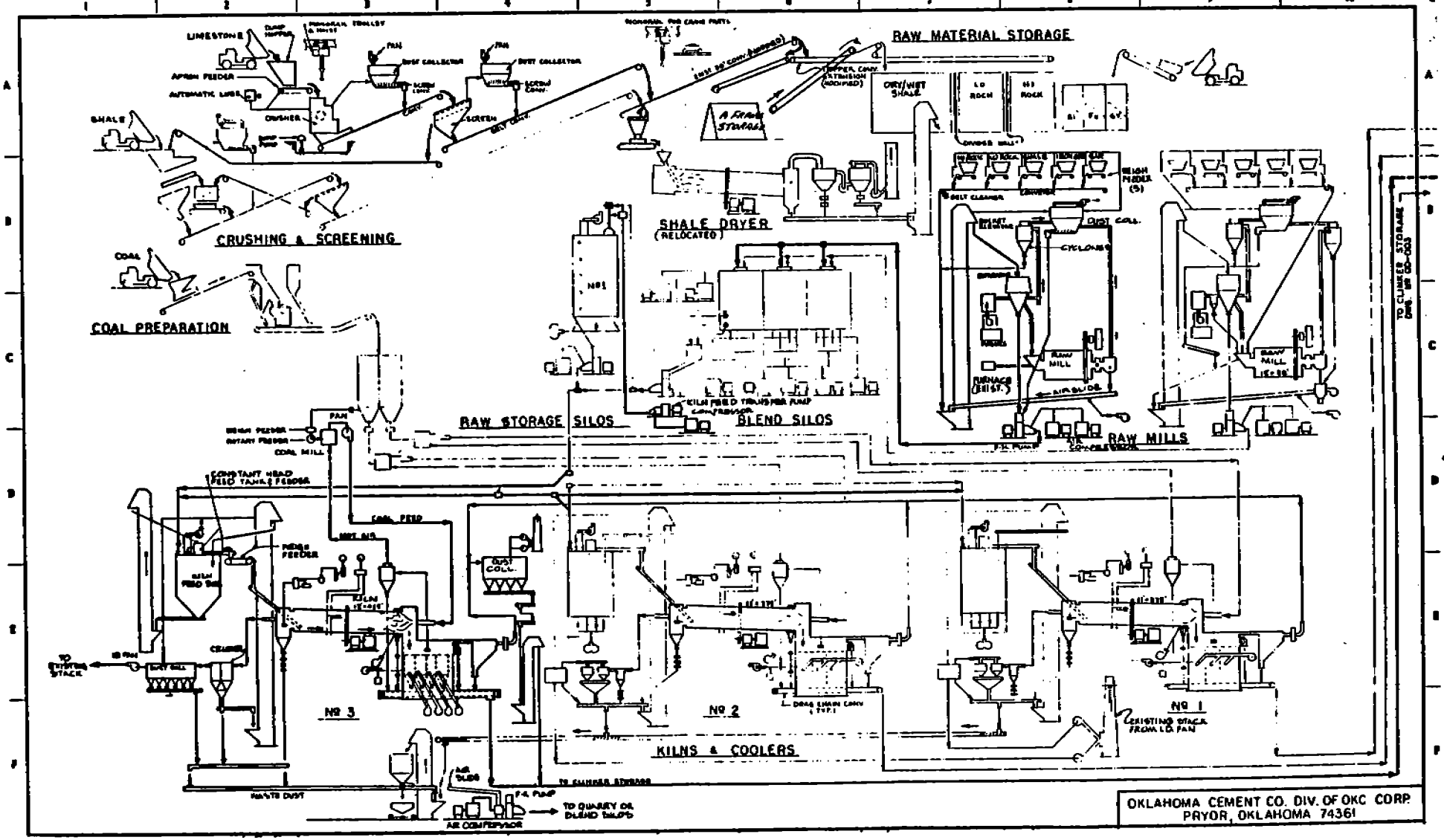
B. Operating conditions during Gravel Bed Tests

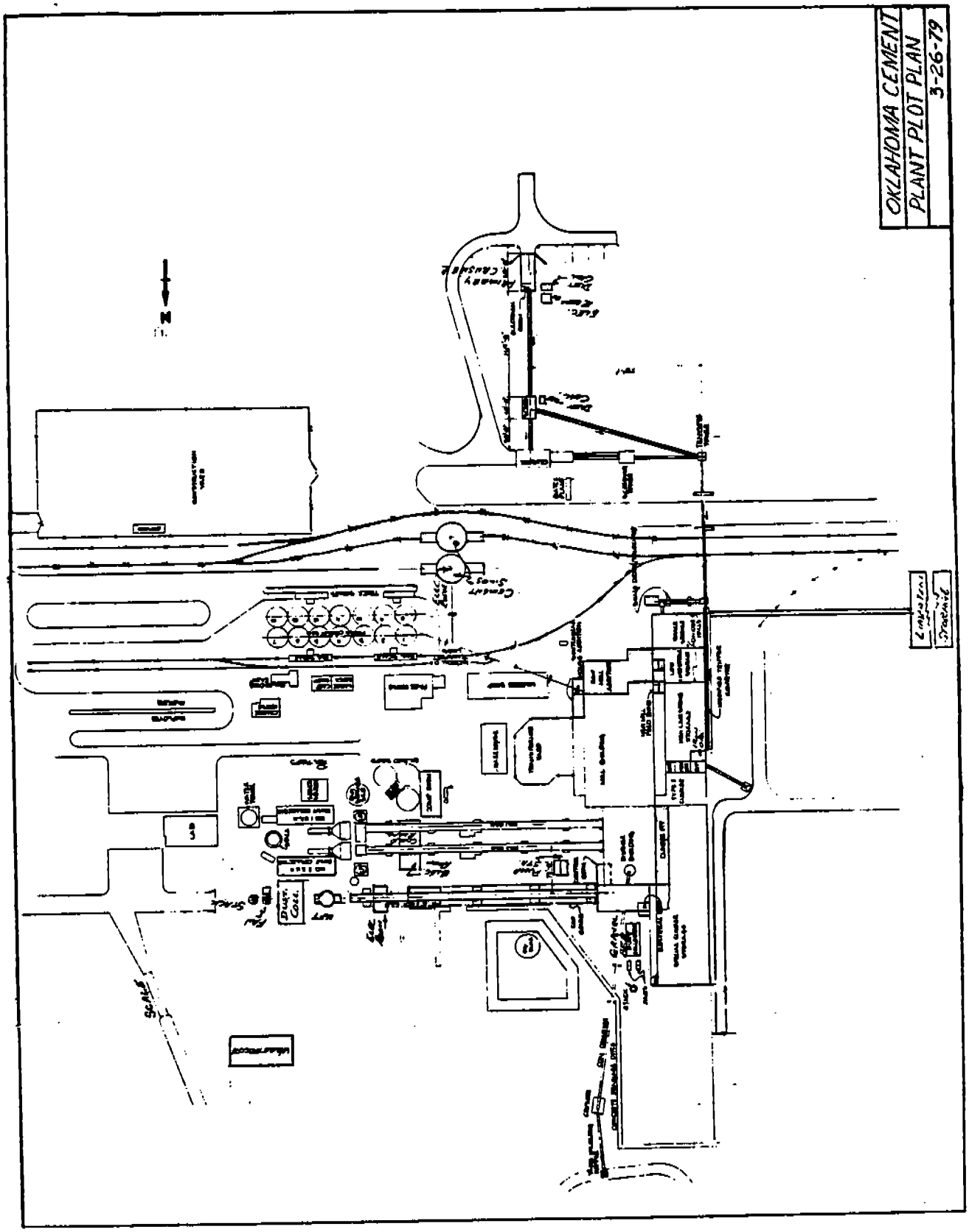
During the time emission tests were being performed on the gravel bed, the kilns and coolers operated normally except for the last 20 to 30 minutes of Number 3 test. At this time a large clinker ring fell into the the Number 3 cooler causing a minor upset condition.

C. Operating conditions during kiln exit emission tests

During the time of emission tests for the Joy Baghouse - kiln exit gases, kiln operating conditions were normal and consistent with operating procedures.

EXHIBIT "A"


LIMESTONE
APRON FEEDER
AUTOMATIC LINER
CRUSHER
SHALE
FAN
DUST COLLECTOR
SCREEN
CRUSHING & SCREENING
COAL
COAL PREPARATION
RAW MATERIAL STORAGE
DRY/WET SHALE
LO ROCK
HI ROCK
SHALE DRYER
(RELOCATED)
CYCLONES
RAW MILL
RAW MILLS
RAW STORAGE SILOS
BLEND SILOS
COAL MILL
CONSTANT HEAD FEED TANK & FEEDER
COAL FEED
KILN FEED
DUST COLL.
TO EXISTING STACK
CLINKER
Nº 3
Nº 2
Nº 1
KILNS & COOLERS
EXISTING STACK FROM LO FAN
WASTE DUST
AIR COMPRESSOR
TO QUARRY OR BLEND SILOS
TO CLINKER STORAGE
OKLAHOMA CEMENT CO. DIV. OF OKC CORP.
PRYOR, OKLAHOMA 74361


OKLAHOMA CEMENT
PLANT PLOT PLAN
3-26-79
Limestone
Gravel
Scale

DESCRIPTION OF SAMPLING LOCATION

The sampling location on the exhaust stack of the baghouse of Kiln Number 3 is approximately 79 feet above the ground. The inlet to the stack is approximately 23 feet above ground level. The sampling ports are located approximately 56 feet (7.98 stack diameters) downstream from the inlet to the stack and 18 feet 11 inches (2.70 stack diameters) upstream from the outlet of the stack.

SAMPLING AND ANALYTICAL PROCEDURES

The sampling followed the procedures outlined in the Appendix to the Code of Federal Regulations, Title 40, Chapter I, Part 60.

A preliminary velocity traverse was made at each of the two ports on the exhaust stack of the baghouse of Kiln Number 3 in order to determine the uniformity and magnitude of the flow prior to testing. Six traverse points were sampled from each of the two ports for a total of twelve traverse points. Several traverse points were checked for cyclonic flow but none was found to be present. Samples of five-minute duration were taken isokinetically at each of the twelve points on the traverse from each port using a heated, glass-lined probe.

On all the tests the sampling train was leak-checked at the nozzle at 15 inches of mercury vacuum before each test, and leak-checked at the nozzle after each test at the highest vacuum reading recorded during the test. This was performed to predetermine the possibility of a diluted sample.

Also before and after each test, the pitot tube lines were checked for leaks under both a vacuum and pressure. The lines were also checked for clearance and the manometer zeroed before each test.

Particulate emissions were calculated from gravimetric analysis using both the "front-half" and "back-half" collections from the EPA-type sampling train. The "back-half" of the sampling train contained an 80 percent isoproply alcohol solution to absorb sulfur trioxide, a six percent hydrogen peroxide solution to absorb sulfur dioxide, and silica gel to absorb moisture. The isopropyl alcohol solution was checked prior to use for hydrogen peroxide contamination and none was found.

At the conclusion of each test, the sampling train was purged with ambient air at the average sampling rate for 15 minutes.

DESCRIPTION OF TESTS

Personnel from Mullins Environmental Testing Co., Inc. arrived at the plant at 8:00 a.m. on Friday, March 28, 1980. The equipment was moved onto the exhaust stack of Kiln Number 3 and the preliminary data were collected. The first test began at 11:35 a.m. and continued until its completion at 12:38 p.m. It was discovered at the conclusion of the first test that the glass probe liner tip was broken. The liner was changed and the second test began at 2:00 p.m. Testing continued without further difficulty until the completion of three additional tests at 6:58 p.m.

The equipment was moved off the stack and loaded into the sampling van. The samples were recovered and taken to Mullins Environmental Testing Co.'s laboratory in Dallas, Texas for analysis and evaluation.

Operations at the Oklahoma Cement Company, Kiln Number 3 in Pryor, Oklahoma were completed at 9:00 p.m. on Friday, March 28, 1980.

Billy J. Mullins, Jr.

Billy J. Mullins, Jr., P.E.
President

APPENDICES

A. Location of Sampling Points

B. Source Emissions Calculations

C. Calibration of Equipment

D. Field Testing Data

E. Analytical Data

F. Plant Operational Data

G. Chain of Custody

H. Resumes of Test Personnel

APPENDIX A

Location of Sampling Points
Kiln Number 3 Stack

The sampling ports located on the Kiln Number 3 Stack are approximately 56 feet (7.98 stack diameters) downstream from the inlet to the stack and 18 feet 11 inches (2.70 stack diameters) upstream from the outlet of the stack. The locations of the sampling points were calculated as follows:

Port and Wall Thickness = 1 7/8 inches
Inside Stack Diameter - 84 3/16 inches

Point No.	Percent of Diameter From Wall	Distance From Wall
1	4.4	3 11/16"
2	14.6	12 5/16"
3	29.6	24 15/16"
4	70.4	59 1/4 "
5	85.4	71 7/8 "
6	95.6	80 1/2 "

METCO

APPENDIX B

Nomenclature and Equations
for
Calculation of Source Emissions

METCO

Nomenclature for Particulate Calculations

Symbol	English Units	Metric Units	Description
A_s	$in.^2$	m^2	Stack Area
C_{an}	gr/dscf	g/dscm	Particulate - probe, cyclone and filter
C_{ao}	gr/dscf	g/dscm	Particulate - total
C_{at}	gr/CF @ stack conditions	g/m^3	Particulate - probe, cyclone and filter
C_{au}	gr/CF @ stack conditions	g/m^3	Particulate - total
C_{aw}	lbs/hr	kg/hr	Particulate - probe, cyclone and filter
C_{ax}	lbs/hr	kg/hr	Particulate - total
C_p			Pitot Tube Calibration Factor
D_n	in.	m	Sampling Nozzle Diameter
%EA			Percent Excess Air at sampling point
g	32.2 ft/sec^2		Acceleration of gravity
%I			Percent isokinetic
%M			Percent moisture in the stack gas by volume
M_d			Mole fraction of dry gas
m_f	mg	mg	Particulate - probe, cyclone and filter
M_{H_2O}	18 lb/lb-mole		Molecular Weight of Water

* 528°R, 29.92 "Hg (20°C, 760 mm Hg)

METCO

Symbol	English Units	Metric Units	Description
m_t	mg	mg	Particulate - total
MW	lb/lb-mole	g/g-mole	Molecular Weight of stack gas
MW_{air}	28.95 lb/ lb-mole		Molecular Weight of air
MW_d	lb/lb-mole	g/g-mole	Molecular Weight of dry stack gas
P_b	"Hg Absolute	mm Hg	Barometric Pressure
P_m	"H_2O	mm H_2O	Orifice Pressure drop
P_s	"Hg Absolute	mm Hg	Stack Pressure
ΔP_s	"H_2O	mm H_2O	Velocity Head of stack gas
P_{std}	29.92 "Hg	760 mm Hg	Standard Barometric Pressure
Q_a	ACFM	m^3/hr	Stack Gas Volume at Actual Stack Conditions
Q_s	DSCFM	dscm/hr	Stack Gas Volume at 29.92 "Hg, 528°R, dry
R	21.83 "Hg-ft^3/lb-mole-°R		Universal Gas Constant
T_m	°F	°C	Average Gas Meter Temperature
T_t	min	min	Net time of test
T_s	°F	°C	Stack Temperature
T_{std}	528°R	293°K	Standard Temperature
V_m	ft^3	m^3	Volume of dry gas sampled @ meter conditions
$V_{m_{std}}$	dscf	dscm	Volume of dry gas sampled @ standard conditions
V_s	fpm	m/sec	Stack velocity @ stack conditions
V_w	ml	ml	Total Water Collected in Impingers and Silica Gel

* 528°R, 29.92 "Hg (20°C, 760 mm Hg)

METCO

Symbol	English Units	Metric Units	Description
$V_{w_{gas}}$	scf	scm	Volume of Water Vapor Collected @ standard conditions
ρ_{air}	0.0748 lbs/ft^3		Density of Air
ρ_{H_2O}	1 g/ml		Density of Water
ρ_{man}	51.63 lbs/ft^3		Density of Manometer Oil

Standard Conditions: 68°F, 29.92 "Hg (20°C, 760 mm Hg)

* 528°R, 29.92 "Hg (20°C, 760 mm Hg)

Example Particulate Calculations

1. Volume of dry gas sampled at standard conditions.*

$$V_{m_{std}} = V_m \left(\frac{T_{std}}{T_m + 460}\right) \left[\frac{P_b + \frac{P_m}{13.6}}{P_{std}}\right]$$

$$V_{m_{std}} = 17.65\ V_m \left[\frac{P_b + \frac{P_m}{13.6}}{T_m + 460}\right] = \text{dscf}$$

$$V_{m_{std}} = \text{dscf} \times 0.028317 = \text{dscm}$$

2. Volume of water vapor collected at standard conditions.*

$$V_{w_{gas}} = \frac{(V_w - \text{gms } SO_2 - \text{gms } H_2S)\ \rho_{H_2O}\ R\ T_{std}}{P_{std}\ M_{H_2O}\ 453.6}$$

$$V_{w_{gas}} = 0.0472\ (V_w - \text{gms } SO_2 - \text{gms } H_2S) = \text{scf}$$

$$V_{w_{gas}} = \text{scf} \times 0.028317 = \text{scm}$$

3. Percent moisture in stack gas.

$$\%M = \frac{V_{w_{gas}}}{V_{m_{std}} + V_{w_{gas}}} \times 100 = \%$$

* 528°R, 29.92 "Hg (20°C, 760 mm Hg)

4. Mole fraction of dry gas.

$$M_d = \frac{100 - \%M}{100}$$

5. Average molecular weight of dry stack gas.

$$MW_d = \left[\%CO_2 \times \frac{44}{100}\right] + \left[\%O_2 \times \frac{32}{100}\right] + \left[\%N_2 \times \frac{28}{100}\right] + \left[\%CO \times \frac{28}{100}\right] = \text{lb/lb-mole}$$

$$= \text{g/g-mole}$$

6. Molecular weight of stack gas.

$$MW = MW_d \times M_d + 18\ (1-M_d) = \frac{\text{lb}}{\text{lb-mole}} = \text{g/g-mole}$$

7. Percent excess air at sampling point.

$$\%EA = \frac{100\ (\%O_2 - 0.5\%\ CO)}{0.265\ (\%N_2) - (\%O_2) + 0.5\ (\%CO)}$$

8. Stack Pressure.

$$P_s = P_b + \frac{\text{stack pressure "}H_2O}{13.6} = \text{"Hg Absolute}$$

$$P_s = \text{"Hg Abs.} \times 25.4 = \text{mm Hg}$$

* 528°R, 29.92 "Hg (20°C, 760 mm Hg)

9. Stack velocity at stack conditions.

$$V_s = C_p\ 60 \left[\frac{2g \times \rho_{man} \times P_{std} \times MW_{air} \times (T_s + 460) \times \Delta P_s}{12 \times \rho_{air} \times P_s \times MW \times T_{std}} \right]^{1/2}$$

$$V_s = 5123.8\ C_p \left[\frac{(T_s + 460) \times \Delta P_s}{P_s \times MW} \right]^{1/2} = \text{fpm}$$

$$V_s = \text{fpm} \times 0.00508 = \text{m/sec}$$

10. Dry stack gas volume at standard conditions.

$$Q_s = \frac{1}{144} V_s \times A_s \times M_d \times \frac{T_{std}}{T_s + 460} \times \frac{P_s}{P_{std}}$$

$$Q_s = \frac{0.123\ V_s \times A_s \times M_d \times P_s}{T_s + 460} = \text{DSCFM}$$

$$Q_s = \text{DSCFM} \times 1.6990 = \text{dscm/hr}$$

11. Actual stack gas volume at stack conditions.

$$Q_a = \frac{V_s \times A_s}{144} = \text{ACFM}$$

$$Q_a = \text{ACFM} \times 1.6990 = \text{m}^3\text{/hr}$$

* 528°R, 29.92 "Hg (20°C, 760 mm Hg)

12. Percent isokinetic.

$$\%I = \frac{V_{m_{std}} \times (T_s + 460) \times P_{std} \times 100 \times 144}{M_d \times T_{std} \times P_s \times T_t \times V_s \times \frac{\pi D_n^2}{4}}$$

$$\%I = \frac{1039\ V_{m_{std}} \times (T_s + 460)}{M_d \times P_s \times T_t \times V_s \times D_n^2}$$

13. Particulate - probe, cyclone and filter.

$$C_{an} = \frac{m_f}{V_{m_{std}}} \times \frac{1\ gr}{64.8\ mg}$$

$$C_{an} = 0.0154 \frac{m_f}{V_{m_{std}}} = gr/dscf$$

$$C_{an} = gr/dscf \times 2.290 = g/dscm$$

14. Particulate total.

$$C_{ao} = 0.0154 \times \frac{m_t}{V_{m_{std}}} = gr/dscf$$

$$C_{ao} = gr/dscf \times 2.290 = g/dscm$$

* 528° R, 29.92 "Hg (20°C, 760 mm Hg)

METCO

15. Particulate - probe, cyclone and filter at stack conditions.

$$C_{at} = C_{an} \times \frac{P_s}{P_{std}} \times \frac{(T_{std})}{(T_s + 460)} \times M_d$$

$$C_{at} = \frac{17.65 \times C_{an} \times P_s \times M_d}{T_s + 460} = gr/CF$$

$$C_{at} = gr/CF \times 2.290 = g/m^3$$

16. Particulate - total, at stack conditions.

$$C_{au} = \frac{17.65 \times C_{ao} \times P_s \times M_d}{T_s + 460} = gr/CF$$

$$C_{au} = gr/CF \times 2.290 = g/m^3$$

17. Particulate - probe, cyclone and filter.

$$C_{aw} = C_{an} \times Q_s \times \frac{60 \text{ min}}{1 \text{ hr}} \times \frac{1 \text{ lb}}{7000 \text{ gr}}$$

$$C_{aw} = 0.00857 \times C_{an} \times Q_s = lbs/hr$$

$$C_{aw} = lbs/hr \times 0.4536 = kg/hr$$

18. Particulate - total.

$$C_{ax} = 0.00857 \times C_{ao} \times Q_s = lbs/hr$$

$$C_{ax} = lbs/hr \times 0.4536 = kg/hr$$

* 528°R, 29.92 "Hg (20°C, 760 mm Hg)

METCO

SOURCE EMISSIONS SURVEY
OKLAHOMA CEMENT COMPANY
PRYOR, OKLAHOMA
FILE NUMBER 80-38

SOURCE EMISSIONS CALCULATIONS

Kiln Number 3 Stack

Symbol	Description	Units			
Run No.			2	3	4
Date			3/28/80	3/28/80	3/28/80
Begin			1400	1600	1755
End			1503	1703	1858
P_b	barometric pressure	"Hg Abs. (mm Hg)	29.10 (739)	29.08 (739)	29.09 (739)
P_m	orifice pressure drop	"H_2O (mm H_2O)	1.073 (27.3)	1.035 (26.3)	1.004 (25.5)
V_m	volume dry gas sampled @ meter conditions	$ft.^3$ (m^3)	37.625 (1.065)	37.053 (1.049)	36.477 (1.033)
T_m	avg. gas meter temp.	°F (°C)	78 (26)	79 (26)	77 (25)
$V_{m_{std}}$	volume dry gas sampled @ standard conditions*	dscf (dscm)	36.017 (1.020)	35.376 (1.002)	34.965 (0.990)
V_w	total H_2O collected, impingers & silica gel	ml	54.9	56.5	47.1
$V_{w_{gas}}$	volume water vapor collected @ standard conditions*	scf (scm)	2.591 (0.073)	2.667 (0.076)	2.223 (0.063)
%M	moisture in stack gas by volume	%	6.71	7.01	5.98

* 68°F, 29.92 "Hg (20°C, 760 mm Hg)

METCO

Source Emissions Calculations
Oklahoma Cement Company
File Number 80-38

Symbol	Description	Units			
M_d	mol fraction of dry gas	---	0.9329	0.9299	0.9402
CO_2		%	11.0	12.4	12.4
O_2		%	13.7	13.0	13.2
N_2		%	75.3	74.6	74.4
%EA	excess air @ sampling point	%	219.0	192.1	202.6
MW_d	molecular weight of dry stack gas	lb/lb-mole (g/g-mole)	30.31 (30.31)	30.50 (30.50)	30.51 (20.51)
MW	molecular weight of stack gas	lb/lb-mole (g/g-mole)	29.48 (29.48)	29.63 (29.63)	29.76 (29.76)
ΔPs	velocity head of stack gas	"H_2O (mm H_2O)	0.576 (14.6)	0.584 (14.8)	0.563 (14.3)
T_s	stack temperature	°F (°C)	414 (212)	413 (212)	404 (207)
P_s	stack pressure	"Hg Abs. (mm Hg)	29.06 (738)	29.04 (738)	29.05 (738)
V_s	stack velocity @ stack conditions	fpm (m/sec)	3,307 (16.80)	3,324 (16.89)	3,234 (16.43)
A_s	stack area	$in.^2$ (m^2)	5,567 (3.59)	5,567 (3.59)	5,567 (3.59)
Q_s	dry stack gas volume @ standard conditions*	DSCFM (dscm/hr)	70,239 (119,336)	70,405 (119,618)	70,003 (118,935)
Q_a	actual stack gas volume @ stack conditions	ACFM (m^3/hr)	127,830 (217,183)	128,487 (218,299)	125,015 (212,400)

* 68°F, 29.92 "Hg (20°C, 760 mm Hg)

METCO

Source Emissions Calculations
Oklahoma Cement Company
File Number 80-38

Symbol	Description	Units			
T_t	net time of test	min.	60	60	60
D_n	sampling nozzle diam.	in. (m)	0.244 (0.006)	0.244 (0.006)	0.244 (0.006)
%I	percent isokinetic	%	102.1	100.1	99.5
m_f	particulate - probe, cyclone and filter	mg	27.0	25.0	23.2
m_t	particulate - total	mg	135.7	131.9	145.1
C_{an}	particulate - probe, cyclone and filter	gr/dscf* (g/dscm)	0.0115 (0.0264)	0.0109 (0.0249)	0.0102 (0.0234)
C_{ao}	particulate - total	gr/dscf* (g/dscm)	0.0580 (0.1329)	0.0574 (0.1315)	0.0639 (0.1463)
C_{at}	particulate - probe, cyclone and filter @ stack conditions	gr/cf (g/m^3)	0.0063 (0.0145)	0.0059 (0.0136)	0.0057 (0.0131)
C_{au}	particulate total @ stack conditions	gr/cf (g/m^3)	0.0318 (0.0727)	0.0313 (0.0718)	0.0357 (0.0817)
C_{aw}	particulate - probe, cyclone and filter	lbs/hr (kg/hr)	6.9 (3.2)	6.6 (3.0)	6.1 (2.8)
C_{ax}	particulate - total	lbs/hr (kg/hr)	34.9 (15.8)	34.6 (15.7)	38.3 (17.4)

* 68°F, 29.92 "Hg (20°C, 760 mm Hg)

Client Oklahoma Cement Company

SO_2 EMISSION DATA

Job Number 80-38

Unit Tested Kiln Number 3 Stack

Run Number	2	3	4			
Date	3/28/80	3/28/80	3/28/80			
Time	1400-1503	1600-1703	1755-1858			
$\underline{N}$ - normality of $BaCl_2$	0.0098	0.0098	0.0098			
ML_I - ml in impinger #1	----	----	----			
ML_I - ml in impinger #2	335	348	310			
ML_I - ml in impinger #3	335	335	317			
ML_A - ml in aliquot #1	----	----	----			
ML_A - ml in aliquot #2	5	5	5			
ML_A - ml in aliquot #3	15	15	15			
ML_B - ml of $BaCl_2$ to titrate #1	----	----	----			
ML_B - ml of $BaCl_2$ to titrate #2	4.95	0.95	1.05			
ML_B - ml of $BaCl_2$ to titrate #3	0.20	0.10	0.15			
ML_{BB} - ml of $BaCl_2$ to titrate blank	0.05	0.05	0.05			
T_m - average gas meter temp., °F	78	79	77			
V_m - volume of dry gas sampled @ meter conditions, $ft.^3$	37.625	37.053	36.477			
P_b - barometric pressure, "Hg Abs.	29.10	29.08	29.09			
Q_s - Stack gas volume dry @ standard conditions, *SCFM	70,239	70,405	70,003			
C_I - SO_2 in Impinger #1, mgs	----	----	----			
C_I - SO_2 in Impinger #2, mgs	103.0	19.6	19.4			
C_I - SO_2 in Impinger #3, mgs	1.1	0.4	0.7			
C_T - total SO_2 in Impingers, mgs	104.1	20.0	20.1			
ppm SO_2	38.4	7.5	7.6			
C_{SO_2} - emission rate of SO_2, lbs/day	645.1	126.5	128.0			
C_s - emission rate of S, lbs/day	322.5	63.3	64.0			

*68°F, 29.92 "Hg (20°C, 760 mm Hg)

$$C_I = \frac{ML_I \times (ML_B - ML_{BB}) \times \underline{N} \times 32}{ML_A}$$

$$C_T = C_I\ \#1 + C_I\ \#2 + C_I\ \#3$$

$$\text{ppm } SO_2 = \frac{0.7513 \times C_T \times (T_m + 460)}{V_m\ P_b}$$

$$C_{SO_2} = \text{ppm } SO_2 \times Q_s \times 239.2 \times 10^{-6}$$

$$C_s = \frac{C_{SO_2}}{2}$$

METCO

SULFUR TRIOXIDE EMISSION DATA

Kiln Number 3 Stack

Run Number	2	3	4	
Date	3/28/80	3/28/80	3/28/80	
N - normality of $BaCl_2$	0.0098	0.0098	0.0098	
ML_I - ml in impinger	270	200	270	
ML_A - ml in aliquot	15	15	15	
ML_B - ml of $BaCl_2$ to titrate	2.10	1.20	3.65	
ML_{BB} - ml of $BaCl_2$ to titrate blank	0.05	0.05	0.05	
T_m - average gas meter temp., °F	78	79	77	
V_m - volume of dry gas sampled @ meter conditions, $ft.^3$	37.625	37.053	36.477	
P_b - barometric pressure, "Hg Abs.	29.10	29.08	29.09	
Q_s - stack gas volume dry @ standard conditions, *SCFM	70,239	70,405	70,003	
C_I - SO_3 in impinger, mgs	14.5	6.0	25.4	
ppm SO_3	4.3	1.8	7.7	
C_{SO_3} - emission rate of SO_3, lbs/day	89.9	38.1	162.1	

* 68°F, 29.92 "Hg (20°C, 760 mm Hg)

$$C_I = \frac{ML_I \times ML_B \times N \times 40}{ML_A}$$

$$\text{ppm } SO_3 = \frac{0.6021 \times C_I \times (T_m + 460)}{V_m P_b}$$

$$C_{SO_3} = \text{ppm } SO_3 \times Q_s \times 299.1 \times 10^{-6}$$

APPENDIX C

Calibration of Equipment

Equipment	Calibration Factor	Calibration Date
Pitot Tube #10	0.844	2/20/80
Probe Tip #I-4	0.244	3/17/80
Dry Gas Meter #3	1.002	3/24/80
Stack Unit Orifice #3		10/12/79
Digital Temperature Indicator #3		3/24/80
Barometer #4		3/14/80

METCO

DRY GAS METER CALIBRATION

Meter Number: 3 Calibrator: Douglas R Southworth

Date: 3/24/80

$$\text{Calibration Factor } (C_{DG}) = \frac{\text{Wet Test Meter } V_{m_{std}}}{\text{Dry Gas Meter } V_{m_{std}}}$$

Run No: 1 P_b: 29.36 "Hg

		Wet Test Meter			Dry Gas Meter			
						Temp.		
	Time	Meter Reading		Temp.	Meter Reading	In	Out	P_m
-7.4	End	1019	21.878	1	66.5 °F	378.224 cf	82 °F	72 °F	+1.40 "H_2O
-7.8	Start	0948	0.0	1	66.0 °F	356.251 cf	75 °F	72 °F	+1.40 "H_2O
-7.6			21.878	1	66.5 °F	21.973 cf	78.5 °F	72 °F	1.40 "H_2O

$$\text{Wet Test Meter } V_{m_{std}} = 17.65 \times \frac{21.878}{28.317} \left(\frac{29.36 + \frac{-7.6}{13.6}}{66.5 + 460} \right) \times \underset{(C_f)}{1.012} = 21.377 \text{ dscf}$$

$$\text{Dry Gas Meter } V_{m_{std}} = 17.65 \times 21.973 \left(\frac{29.36 + \frac{+1.40}{13.6}}{75 + 460} \right) = 21.358 \text{ dscf}$$

1-4 Ave 1.002

$$C_{DG} = \frac{21.377}{21.358} = \boxed{1.001}$$

METCO

DRY GAS METER CALIBRATION

Meter Number: 3

Calibrator: Douglas R Scathoff

Date: 3/24/80

$$\text{Calibration Factor } (C_{DG}) = \frac{\text{Wet Test Meter } V_{m_{std}}}{\text{Dry Gas Meter } V_{m_{std}}}$$

Run No: 2

P_b: 29.38 "Hg

	Wet Test Meter			Dry Gas Meter			
					Temp.		
	Time	Meter Reading	Temp.	Meter Reading	In	Out	P_m
-7.4 End	1059	21.530 1	67 °F	399.925 cf	81 °F	75 °F	1.40 "H_2O
-7.6 Start	1029	0.0 1	67 °F	378.224 cf	81 °F	79 °F	+1.40 "H_2O
-7.5		21.530 1	67 °F	21.701 cf	81 °F	78 °F	+1.40 "H_2O

$$\text{Wet Test Meter } V_{m_{std}} = 17.65 \times \frac{21.530}{28.317} \left(\frac{29.38 + \frac{-7.5}{13.6}}{67 + 460} \right) \times \underset{(C_f)}{1.012} = 21.037 \text{ dscf}$$

$$\text{Dry Gas Meter } V_{m_{std}} = 17.65 \times 21.701 \left(\frac{29.38 + \frac{+1.40}{13.6}}{80 + 460} \right) = 20.912 \text{ dscf}$$

$$C_{DG} = \frac{21.037}{20.912} = \boxed{1.006}$$

METCO

DRY GAS METER CALIBRATION

Meter Number: 3

Calibrator: Douglas R. Smith

Date: 3/24/80

$$\text{Calibration Factor } (C_{DG}) = \frac{\text{Wet Test Meter } V_{m_{std}}}{\text{Dry Gas Meter } V_{m_{std}}}$$

Run No: 3

P_b: 29.40 "Hg

	Wet Test Meter				Dry Gas Meter			
						Temp.		
	Time	Meter Reading		Temp.	Meter Reading	In	Out	P_m
-7.2	End	1136	22.483	1	~~68~~.5 °F	422.624 cf	79 °F	75 °F	+1.40 "H_2O
-7.3	Start	1104	0.0	1	67.5 °F	399.925 cf	80 °F	78 °F	+1.40 "H_2O
			22.483	1	68 °F	22.699 cf	80 °F	77 °F	+1.40 "H_2O

$$\text{Wet Test Meter } V_{m_{std}} = 17.65 \times \frac{22.483}{\cancel{28.3}17} \left(\frac{29.40 + \frac{-7.3}{13.6}}{68 + 460} \right) \times \underset{(C_f)}{1.012} = 21.953 \text{ dscf}$$

$$\text{Dry Gas Meter } V_{m_{std}} = 17.65 \times 22.699 \left(\frac{29.40 + \frac{+1.40}{13.6}}{79 + 460} \right) = 21.930 \text{ dscf}$$

$$C_{DG} = \frac{21.953}{21.930} = \boxed{1.001}$$

METCO

DRY GAS METER CALIBRATION

Meter Number: 3

Calibrator: Douglas R. Scott

Date: 3/24/80

$$\text{Calibration Factor } (C_{DG}) = \frac{\text{Wet Test Meter } V_{m_{std}}}{\text{Dry Gas Meter } V_{m_{std}}}$$

Run No: 4

P_b: 29.40 "Hg

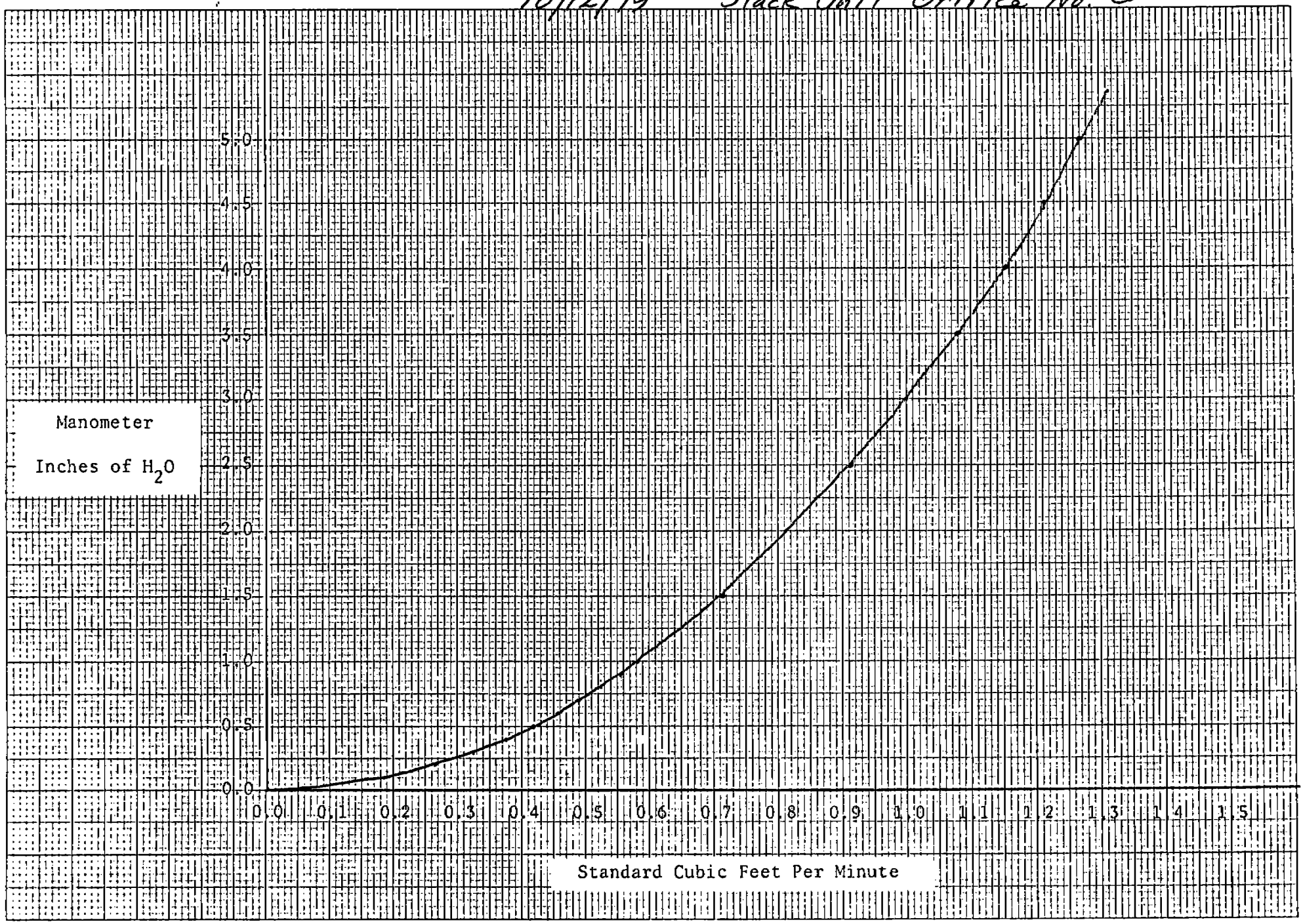
		Wet Test Meter			Dry Gas Meter	Temp.		P_m
		Time	Meter Reading	Temp.	Meter Reading	In	Out	
-7.0	End	1330	24.211	70.0 °F	447.025 cf	80 °F	75 °F	+1.40 "H_2O
-7.2	Start	1259	0.0	69.5 °F	422.624 cf	78 °F	77 °F	+1.40 "H_2O
-7.1			24.211	70 °F	24.401 cf	79 °F	76 °F	"H_2O

$$\text{Wet Test Meter } V_{m_{std}} = 17.65 \times \frac{24.211}{\cancel{28.317}} \left(\frac{29.40 + \frac{-7.1}{13.6}}{70 + 460} \right) \times \underset{(C_f)}{1.012} = 23.563 \text{dscf}$$

$$\text{Dry Gas Meter } V_{m_{std}} = 17.65 \times 24.401 \left(\frac{29.40 + \frac{+1.40}{13.6}}{78 + 460} \right) = 23.617 \text{ dscf}$$

$$C_{DG} = \frac{23.563}{23.617} = \boxed{0.998}$$

10/12/79 Stack Unit Orifice No. 3



METCO

DIGITAL TEMPERATURE INDICATOR NO. 3

CALIBRATION DATA

Date: 3/24/80

Media	Time	Mercury Thermometer(°F)	DTI(°F)
Ice Bath	1047	32	31
Ambient Air	1045	76	74
Boiling Water	1110	211	213
Oven	1129	225	230
Oven	1146	316	320
Oven	1246	384	378
Oven	1320	423	428

Meter Adjusted? Yes _____ No X

Douglas R Sewell

Signature of Calibrator

PITOT TUBE CALIBRATION

Date: 20 FEB 1980

Time: 1400

Pitot No. 10

P_b: 29.02 "Hg P_s: 0.11 "H_2O

T_s: 79 °F C_{pstd}: 0.99

Motor Setting	fps mark	CALIBRATOR STANDARD START	END	$\sqrt{\text{STANDARD AVERAGE}}$	HIGH	$\sqrt{\text{HIGH}}$	CAL. FACTOR	LOW	$\sqrt{\text{LOW}}$	CAL. FACTOR
31	10	—	—	—	—	—	—	—	—	—
39	20	0.10	0.10	0.316	0.14	0.374	0.837	0.15	0.387	0.808
48	30	0.23	0.23	0.480	0.33	0.574	0.826	0.34	0.583	0.814
55	40	0.39	0.38	0.620	0.54	0.735	0.836	0.54	0.735	0.836
63	50	0.62	0.63	0.791	0.86	0.927	0.844	0.86	0.927	0.844
70	60	0.88	0.88	0.938	1.20	1.095	0.848	1.20	1.095	0.848
76	70	1.20	1.20	1.095	1.60	1.265	0.857	1.50	1.225	0.885
84	80	1.60	1.60	1.265	2.15	1.466	0.854	2.10	1.449	0.864
100	90	1.85	1.85	1.360	2.50	1.581	0.852	2.45	1.565	0.860
Average							0.844			0.845

Summary of Results:

Normal high side calibration factor 0.844
variation -2.1, +1.3

Normal low side calibration factor 0.845
variation -4.4, +4.7

Signature of Calibrator

METCO

NOZZLE CALIBRATION
SET I

Date: 3/7 MARCH 80 Calibrator: Don C Alexander

	1	2	3	4	5
Reading 1	0.169	0.186	0.248	0.245	0.306
Reading 2	0.171	0.185	0.245	0.243	0.304
Reading 3	0.169	0.185	0.246	0.245	0.305
Reading 4	0.169	0.187	0.244	0.243	0.307
Reading 5	0.171	0.186	0.248	0.244	0.305
Reading 6	0.172	0.186	0.245	0.244	0.306
Reading 7	0.170	0.186	0.247	0.244	0.307
Reading 8	0.169	0.187	0.244	0.242	0.306
Reading 9	0.170	0.184	0.246	0.242	0.304
Reading 10	0.170	0.186	0.245	0.243	0.305
Average	0.170	0.186	0.246	0.244	0.306

	6	7	8	9	10
Reading 1	0.306	0.363	0.372	0.432	0.499
Reading 2	0.309	0.363	0.375	0.433	0.498
Reading 3	0.310	0.364	0.374	0.436	0.499
Reading 4	0.310	0.363	0.375	0.433	0.498
Reading 5	0.310	0.363	0.374	0.436	0.495
Reading 6	0.306	0.365	0.373	0.433	0.499
Reading 7	0.310	0.363	0.374	0.433	0.496
Reading 8	0.308	0.364	0.376	0.435	0.499
Reading 9	0.308	0.363	0.374	0.434	0.499
Reading 10	0.309	0.365	0.375	0.435	0.498
Average	0.309	0.364	0.374	0.434	0.498

METCO

BAROMETER CALIBRATION
Barometer # 4

Date: 14 March 1980

Time: 8:30

Barometric Pressure @ Addison Field @ 719 ft.	=	30.320
	-	0.719
Absolute Pressure at Addison Field	=	29.601
	+	0.076
Absolute Pressure @ METCO @ 643 ft.	=	29.677
Barometer Reading	=	29.68
Variation	=	+ 0.003

Barometer Adjusted? Yes_____ No ✓

Don C Alexander
Signature of Calibrator

APPENDIX D

Field Testing Data

Job No. 80-38 Part, SO_2 FIELD DATA

Job Name Oklahoma Cement Co.

Run No. 2

Location Kiln No. 3 Stack

Date 3/28/80

Operator Mullins, Saathoff

Sample Box No. 2 Meter Box No. 3

Read and record at the start of each test point.

Purge to: 946.375

Purge time: 1506-1527

Ambient Temp. °F 64

Assumed Moisture % 5

Probe Length 10'

C Factor — 18.5 to reference

Initial Leak @ 15.0 "Hg = 0.005 cfm

Final Leak @ 6.9 "Hg = 0.009 cfm

Point	Clock Time	Dry Gas Meter, CF	Pitot in. H_2O (ΔP_s)	Orifice ΔH in. H_2O (P_m) Desired	Orifice ΔH in. H_2O (P_m) Actual	Pump Vacuum In. Hg Gauge	Stack Temp. °F (T_s)	Probe Temp. °F	Oven Temp. °F	Effluent Temp. °F	Dry Gas Temp. °F (T_m) Inlet	Dry Gas Temp. °F (T_m) Outlet	Remarks
B-6	1400	898.096	0.47	0.88	0.88	4.9	407	264	267	72	75	74	
5	1405	900.98	0.59	1.10	1.10	5.0	413	265	278	57	75	73	
4	1410	904.14	0.61	1.15	1.15	5.2	416	272	279	54	76	73	
3	1415	907.40	0.69	1.25	1.25	5.6	417	274	269	53	78	73	
2	1420	910.78	0.69	1.25	1.25	5.6	415	272	259	53	80	72	
1	1425	914.20	0.51	0.95	0.95	4.9	408	272	254	53	80	73	
End	1430	917.188	—	—	—	—	—	—	—	—	—	—	—
A-6	1433	917.188	0.59	0.93	0.93	4.9	416	272	243	72	82	77	
5	1438	920.12	0.61	1.15	1.15	5.2	416	273	242	63	83	77	
4	1443	923.28	0.58	1.10	1.10	5.1	417	276	258	59	84	76	
3	1448	926.48	0.66	1.25	1.25	5.5	417	274	256	60	85	76	
2	1453	929.78	0.56	1.05	1.05	5.0	412	270	245	65	84	76	
1	1458	932.87	0.44	0.82	0.82	4.2	409	273	260	61	86	77	
End	1503	935.646	—	—	—	—	—	—	—	—	—	—	—
All													

Pitot Tube Calibration Factor C_p 0.844

Volume Collected V_m 37.625 ft^3

Water Collected V_w 54.9 ml

Time of Test T_t 60 min.

Stack Pressure P_s −0.58 "H_2O

Baro. Press. P_b 29.10 "Hg

Probe Tip Dia. D_n 0.244 in.

% CO_2 11.0 % CO 0.0

% O_2 13.7 % N_2 75.3

Area Stack A_s 5567 in^2

Pitot Tube No. 10

Probe Tip No. I-4

V_m = Dry Gas Meter Calibration Factor 1.002 X 37.550

[Dry Gas Meter Reading ____ ft^3 - (T_t ____ min X Leak Rate ____ cfm)]

M_F = ____ M_T = ____

Impinger Box No. 2

Impinger 1	Final Weight	630.6
	Initial Weight	646.5
	Increase	-15.9
Impinger 2	Final Weight	739.0
	Initial Weight	689.8
	Increase	49.2
Impinger 3	Final Weight	684.9
	Initial Weight	674.2
	Increase	10.7
Impinger 4	Final Weight	493.6
	Initial Weight	491.9
	Increase	1.7
Impinger 5	Final Weight	775.6
	Initial Weight	766.4
	Increase	9.2
Impinger 6	Final Weight	
	Initial Weight	
	Increase	

Filter # _____ Final Weight _____ Initial Weight _____ Increase _____

Water Weight Gain

Impinger 1	-15.9
Impinger 2	49.2
Impinger 3	10.7
Impinger 4	1.7
Impinger 5	9.2
Impinger 6	
Total	54.9 = V_w

P_b =	29.10	$\%CO_2$ =	11.0
V_m =	37.625	$\%O_2$ =	13.7
V_w =	54.9	%CO =	0.0
P_m =	1.073	$\%N_2$ =	75.3
Avg ΔP =	0.576	A_s =	5567
Avg $\sqrt{\Delta P}$ =	0.757	D_n =	0.244
C_p =	0.844	T_t =	60
P_s =	-0.58 "H_2O	29.06	"Hg
T_m =	78 °F	538	°R
T_s =	414 °F	874	°R

Moisture Content: %M = 6.71 M_d = 0.9329 MW_d = 30.308 MW = 29.48

$$V_{m_{std}} = 17.65\ V_m \left(\frac{P_b + \frac{P_m}{13.6}}{T_m + 460}\right) = 17.65 \times 37.625 \left(\frac{29.10 + \frac{1.073}{13.6}}{78 + 460}\right) = 36.017\ sft^3$$

0.600 scfm

$$V_{w_{gas}} = 0.0472 \times V_w = 0.0472 \times 54.9 = 2.591\ sft^3$$

$$\text{Moisture} = \frac{V_{w_{gas}}}{V_{m_{std}} + V_{w_{gas}}} \times 100 = \frac{2.591}{36.017 + 2.591} \times 100 = 6.71\ \%$$

$$V_s = 5123.8 \times 0.844 \sqrt{\frac{874}{29.06 \times 29.48}} \times 0.757 = 3307\ fpm$$

ACFM: 127,830

$$\%I = \frac{1039 \times 36.017 \times 874}{0.9329 \times 29.06 \times 3307 \times 60 \times (0.244)^2} = 102.1\ \%$$

SCFM: 70,239

%EA: 219.0

0.588

[redacted] [redacted] [redacted] [redacted] Part, SO_2 [redacted] FIELD DATA [redacted] [redacted] [redacted] [redacted] [redacted]

Job No. 00-38

Job Name Oklahoma Cement Co.

Run No. ~~2~~ 3

Location Kiln No. 3 Stack

Date 3/28/80

Operator Mullins, Saathoff

Sample Box No. 3 Meter Box No. 3

Read and record at the start of each test point.

Purge to: 994.272

Purge time: ~~1506-15~~ 1706-1721

Ambient Temp. °F 74

Assumed Moisture % 6.7

Probe Length 10'

C Factor — 17.8 to reference

Initial Leak @ 15.0 "Hg = 0.003 cfm

Final Leak @ 8.5 "Hg = 0.006 cfm

Point	Clock Time	Dry Gas Meter, CF	Pitot in. H_2O (ΔP_s)	Orifice ΔH in. H_2O (P_m) Desired	Orifice ΔH in. H_2O (P_m) Actual	Pump Vacuum In. Hg Gauge	Stack Temp. °F (T_s)	Probe Temp. °F	Oven Temp. °F	Effluent Temp. °F	Dry Gas Temp. °F (T_m) Inlet	Dry Gas Temp. °F (T_m) Outlet	Remarks
A-6	1600	947.439	0.52	0.97	0.97	6.9	405	273	250	76	79	77	
5	1605	950.55	0.60	1.05	1.05	6.5	414	268	258	65	78	76	
4	1610	953.60	0.63	1.10	1.10	6.9	417	266	259	64	80	75	
3	1615	956.79	0.60	1.05	1.05	6.5	416	267	246	64	80	75	
2	1620	959.87	0.59	1.05	1.05	6.5	413	262	251	66	82	75	
1	1625	962.96	0.48	0.86	0.86	6.0	405	254	245	66	82	76	
End	1630	965.799	—	—	—	—	—	—	—	—	—	—	—
B-6	1633	965.799	0.51	0.91	0.91	6.0	408	260	259	75	84	79	
5	1638	968.70	0.62	1.10	1.10	7.0	416	266	256	63	84	78	
4	1643	971.82	0.59	1.05	1.05	6.8	419	267	255	64	84	78	
3	1648	974.90	0.66	1.15	1.15	7.1	421	260	264	63	84	77	
2	1653	978.14	0.66	1.15	1.15	7.1	416	256	270	60	84	77	
1	1658	981.41	0.55	0.98	0.98	6.2	404	259	270	61	85	77	
End	1703	984.418	—	—	—	—	—	—	—	—	—	—	—
All													

Pitot Tube Calibration Factor C_p 0.844

Volume Collected V_m 37.053 ft^3

Water Collected V_w 56.5 ml

Time of Test T_t 60 min.

Stack Pressure P_s −0.55 "H_2O

Baro. Press. P_b 29.08 "Hg

Probe Tip Dia. D_n 0.244 in.

% CO_2 12.4 % CO 0.0

% O_2 13.0 % N_2 74.6

Area Stack A_s 5567 in^2

Pitot Tube No. 10

Probe Tip No. I-4

V_m = Dry Gas Meter Calibration Factor 1.002 X 36.979

[Dry Gas Meter Reading ____ ft^3 - (T_t ____ min X Leak Rate ____ cfm)]

M_F = ____ M_T = ____

Impinger Box No. 3

Impinger 1	Final Weight	636.8
	Initial Weight	647.3
	Increase	−10.5
Impinger 2	Final Weight	734.6
	Initial Weight	690.4
	Increase	44.2
Impinger 3	Final Weight	693.5
	Initial Weight	682.4
	Increase	11.1
Impinger 4	Final Weight	478.6
	Initial Weight	477.5
	Increase	1.1
Impinger 5	Final Weight	758.4
	Initial Weight	747.8
	Increase	10.6
Impinger 6	Final Weight	
	Initial Weight	
	Increase	

Filter # _____ Final Weight _____ Initial Weight _____ Increase _____

Water Weight Gain

Impinger 1	−10.5
Impinger 2	44.2
Impinger 3	11.1
Impinger 4	1.1
Impinger 5	10.6
Impinger 6	
Total	56.5 = V_w

P_b =	29.08	$\%CO_2$ =	12.4
V_m =	37.053	$\%O_2$ =	13.0
V_w =	56.5	%CO =	0.0
P_m =	1.035	$\%N_2$ =	74.6
Avg ΔP =	0.584	A_s =	5567
Avg $\sqrt{\Delta P}$ =	0.763	D_n =	0.244
C_p =	0.844	T_t =	60
P_s =	−0.55 "H_2O		29.04 "Hg
T_m =	79 °F		539 °R
T_s =	413 °F		873 °R

Moisture Content: %M = 7.01 M_d = 0.9299 MW_d = 30.504 MW = 29.63

$$V_{m_{std}} = 17.65\ V_m \left(\frac{P_b + \frac{P_m}{13.6}}{T_m + 460}\right) = 17.65 \times 37.053 \left(\frac{29.08 + \frac{1.035}{13.6}}{79 + 460}\right) = 35.376\ sft^3$$

0.590 scfm

$$V_{w_{gas}} = 0.0472 \times V_w = 0.0472 \times 56.5 = 2.667\ sft^3$$

$$\%\ Moisture = \frac{V_{w_{gas}}}{V_{m_{std}} + V_{w_{gas}}} \times 100 = \frac{2.667}{35.376 + 2.667} \times 100 = 7.01\ \%$$

$$V_s = 5123.8 \times 0.844 \sqrt{\frac{873}{29.04 \times 29.63}} \times 0.763 = 3324\ fpm$$

ACFM: 128,487

$$\%I = \frac{1039 \times 35.376 \times 873}{0.9299 \times 29.04 \times 3324 \times 60 \times (0.244)^2} = 100.1\ \%$$

SCFM: 70,405

%EA: 192.1

MULLINS ENVIRONMENTAL TESTING

Job No. 80-38 Part, SO_2 FIELD DATA

Job Name Oklahoma Cement Co.

Run No. 4

Location Kiln No. 3 Stack

Date 3/28/80

Operator Mullins, Saathoff

Sample Box No. 1 Meter Box No. 3

Read and record at the start of each test point.

Purge to: 1040.11

Purge time: 1900 – 1915

Ambient Temp. °F 64

Assumed Moisture % 6.7

Probe Length 10'

C Factor — 17.8 to reference

Initial Leak @ 15.0 "Hg = 0.005 cfm

Final Leak @ 8.1 "Hg = 0.013 cfm

Point	Clock Time	Dry Gas Meter, CF	Pitot in. H_2O (ΔP_s)	Orifice ΔH in. H_2O (P_m) Desired	Orifice ΔH in. H_2O (P_m) Actual	Pump Vacuum In. Hg Gauge	Stack Temp. °F (T_s)	Probe Temp. °F	Oven Temp. °F	Effluent Temp. °F	Dry Gas Temp. °F (T_m) Inlet	Dry Gas Temp. °F (T_m) Outlet	Remarks
B-6	1755	994.595	0.45	0.81	0.81	6.0	395	251	240	77	77	76	
5	1800	997.41	0.56	1.00	1.00	6.2	402	258	250	72	76	75	
4	1805	1000.41	0.61	1.10	1.10	6.8	411	260	247	68	76	74	
3	1810	1003.54	0.69	1.20	1.20	7.1	410	259	245	67	77	74	
2	1815	1006.83	0.61	1.10	1.10	7.0	407	253	235	69	79	73	
1	1820	1010.04	0.44	0.79	0.79	5.2	395	254	244	72	80	75	
End	1825	1012.783	—	—	—	—	—	—	—	—	—	—	—
A-6	1828	1012.783	0.50	0.90	0.90	6.0	398	253	262	77	81	78	
5	1833	1016.01	0.60	1.05	1.05	6.7	402	250	273	69	81	76	
4	1838	1018.75	0.64	1.15	1.15	7.1	407	250	290	63	81	76	
3	1843	1021.93	0.64	1.15	1.15	7.1	410	246	274	61	81	74	
2	1848	1025.18	0.60	1.05	1.05	6.5	408	243	258	63	81	75	
1	1853	1028.29	0.42	0.75	0.75	5.2	401	238	264	66	81	75	
End	1858	1030.999	—	—	—	—	—	—	—	—	—	—	—
All													

Pitot Tube Calibration Factor C_p 0.844

Volume Collected V_m 36.477 ft^3

Water Collected V_w 47.1 ml

Time of Test T_t 60 min.

Stack Pressure P_s −0.56 "H_2O

Baro. Press. P_b 29.09 "Hg

Probe Tip Dia. D_n 0.244 in.

% CO_2 12.4 % CO 0.0

% O_2 13.2 % N_2 74.4

Area Stack A_s 5567 in^2

Pitot Tube No. 10

Probe Tip No. I-4

V_m = Dry Gas Meter Calibration Factor 1.002 x 36.404

[Dry Gas Meter Reading ____ ft^3 - (T_t ____ min X Leak Rate ____ cfm)]

M_F = _____ M_T = _____

Impinger Box No. 1

Impinger 1	Final Weight	624.7
	Initial Weight	635.7
	Increase	-11.0
Impinger 2	Final Weight	733.7
	Initial Weight	691.4
	Increase	42.3
Impinger 3	Final Weight	682.1
	Initial Weight	674.4
	Increase	7.7
Impinger 4	Final Weight	492.0
	Initial Weight	491.6
	Increase	0.4
Impinger 5	Final Weight	793.9
	Initial Weight	786.2
	Increase	7.7
Impinger 6	Final Weight	
	Initial Weight	
	Increase	

Filter # G-40 Final Weight _____
Initial Weight _____
Increase _____

Water Weight Gain

Impinger 1	-11.0
Impinger 2	42.3
Impinger 3	7.7
Impinger 4	0.4
Impinger 5	7.7
Impinger 6	
Total	47.1 = V_w

P_b =	29.09	$\%CO_2$ =	12.4
V_m =	36.477	$\%O_2$ =	13.2
V_w =	47.1	%CO =	0.0
P_m =	1.004	$\%N_2$ =	74.4
Avg ΔP =	0.563	A_s =	5567
Avg $\sqrt{\Delta P}$ =	0.748	D_n =	0.244
C_p =	0.844	T_t =	60
P_s =	-0.56 "H_2O		29.05 "Hg
T_m =	77 °F		537 °R
T_s =	404 °F		864 °R

Moisture Content: %M = 5.98 M_d = 0.9402 MW_d = 30.512 MW = 29.76

$$V_{m_{std}} = 17.65\ V_m \left(\frac{P_b + \frac{P_m}{13.6}}{T_m + 460}\right) = 17.65 \times 36.477 \left(\frac{29.09 + \frac{1.004}{13.6}}{77 + 460}\right) = 34.965\ sft^3$$

0.583 scfm

$$V_{w_{gas}} = 0.0472 \times V_w = 0.0472 \times 47.1 = 2.223\ sft^3$$

$$\text{Moisture} = \frac{V_{w_{gas}}}{V_{m_{std}} + V_{w_{gas}}} \times 100 = \frac{2.223}{34.965 + 2.223} \times 100 = 5.98\ \%$$

$$V_s = 5123.8 \times 0.844 \sqrt{\frac{864}{29.05 \times 29.76}} \times 0.748 = 3234\ fpm$$

$$\%I = \frac{1039 \times 34.965 \times 864}{0.9402 \times 29.05 \times 3234 \times 60 \times (0.244)^2} = 99.5\ \%$$

ACFM: 125,015

SCFM: 70,003

%EA: 202.6

APPENDIX E

Analytical Data

Mullins Environmental Testing Co., Inc.

Particulate Analysis Summary

Job Number 80-38

Job Name Oklahoma Cement

Location Pryor, OK

Date Analysis Completed 4/3/80

Unit Tested #3 Kiln Stack

Run No.	2	3	4		
Particulate on Filter (mg)	8.9	9.3	8.0		
Particulate in Front Wash (mg)*	18.1	15.7	15.2		
MF (mg)	27.0	25.0	23.2		
Particulate in Impinger #1 (mg)**	108.7	106.9	121.9		
MT (mg)	135.7	131.9	145.1		

J R Mondia

Analyst

* Less Acetone Residue

** Less Ammonium Sulfate

Mullins Environmental Testing Co., Inc.

Particulate Analysis EPA Method 5

Stack Filters

Job Number 80-38 Location Pryor, OK

Job Name OKC Unit Tested #3 Kiln Stack

Desiccator Time In	1100 3/5/80	844 4/3/80			
Desiccator Time Out	4/5/80 826	1451 4/3/80			

Run No. 2	Filter No. G-28				
Filter & Particulate + Tare Weight (g)	2.6254	2.6250			
Tare Weight (g)	1.8480	1.8476	✓		
Filter & Particulate (g)	0.7774	0.7774			

Filter & Particulate Average (g) 0.7774

Initial Filter Weight (g) 0.7685

Total Particulate (mg) 8.9 ✓

Run No. 3	Filter No. G-29				
Filter & Particulate + Tare Weight (g)	2.6282	2.6276			
Tare Weight (g)	1.8480	1.8475	✓		
Filter & Particulate (g)	0.7802	0.7801			

Filter & Particulate Average (g) 0.7802

Initial Filter Weight (g) 0.7709

Total Particulate (mg) 9.3 ✓

Run No. 4	Filter No. G-40				
Filter & Particulate + Tare Weight (g)	2.6187	2.6181			
Tare Weight (g)	1.8481	1.8474	✓		
Filter & Particulate (g)	0.7706	0.7707			

Filter & Particulate Average (g) 0.7707

Initial Filter Weight (g) 0.7627

Total Particulate (mg) 8.0 ✓

J.R. Monfrin

Analyst

Mullins Environmental Testing Co., Inc.

Particulate Analysis EPA Method 5

Front Wash

Job Number 80-38 Location Pryor, OK

Job Name OK C Unit Tested #3 Kiln Stack

Desiccator Time In	1630 4/1/80	810 4/3/80			
Desiccator Time Out	0801 4/3/80	1413 4/3/80			

Run No. 2	Volume (ml) 240				
Final Weight (g)	144.9896	144.9899			
Initial Weight (g)	144.9898	144.9698	—		
Particulate Weight (g)	0.0198	0.0201			

Particulate Average (mg) 20.0
Less Acetone Blank (mg) -1.9
Total Particulate (mg) 18.1

Run No. 3	Volume (ml) 222				
Final Weight (g)	149.9705	149.9708			
Initial Weight (g)	149.9532	149.9532	✓		
Particulate Weight (g)	0.0173	0.0176			

Particulate Average (mg) 17.5
Less Acetone Blank (mg) -1.8
Total Particulate (mg) 15.7

Run No. 4	Volume (ml) 220				
Final Weight (g)	145.2239	145.2241			
Initial Weight (g)	145.2071	145.2071	✓		
Particulate Weight (g)	0.0168	0.0170			

Particulate Average (mg) 16.9
Less Acetone Blank (mg) -1.7
Total Particulate (mg) 15.2

Acetone Blank	Volume (ml) 510				
Final Weight (g)	145.2082	145.2087			
Initial Weight (g)	145.1980	145.1980	✓		
Difference (g)	0.0102	0.0107			

Average (mg) 10.5
* mg/l 20.6

* Note: If greater than 7.9 mg/l, use 7.9 mg/l.

J R Morfino
Analyst

Mullins Environmental Testing Co., Inc.

Particulate Analysis EPA Method 5

Back Half Analysis

Job Number 80-38

Job Name OKC

Location Pryor, OK

Unit Tested #3 Kiln Stack

Desiccator Time In	1630 4/1/80	810 4/3/80			
Desiccator Time Out	0801 4/3/80	1413 4/3/80			

Run No. 2	Volume (ml) 270				
Final Weight (g)	145.4809	145.4803			
Initial Weight (g)	145.3480	145.3480	✓		
Particulate Weight (g)	0.1329	0.1323			

Particulate Average (mg) 132.6
Less Ammonium Sulfate (mg) 23.9
Total Particulate (mg) 108.7

Run No. 3	Volume (ml) 200				
Final Weight (g)	153.1624	153.1617			
Initial Weight (g)	153.0453	153.0453	✓		
Particulate Weight (g)	0.1171	0.1164			

Particulate Average (mg) 116.8
Less Ammonium Sulfate (mg) -9.9
Total Particulate (mg) 106.9

Run No. 4	Volume (ml) 270				
Final Weight (g)	147.7014	147.7007			
Initial Weight (g)	147.5373	147.5373	✓		
Particulate Weight (g)	0.1641	0.1634			

Particulate Average (mg) 163.8
Less Ammonium Sulfate (mg) -41.9
Total Particulate (mg) 121.9

J R Monfries
Analyst

Unit Tested #3 Kiln Stack

Run Number	2	3	4			
Date	3-28-80	3-28-80	3-28-80			
Time	1400-1503	1600-1703	1755-1858			
N - normality of $BaCl_2$	0.0098	0.0098	0.0098			
ML_I - ml in impinger #1	—	—	—			
ML_I - ml in impinger #2	335	348	310			
ML_I - ml in impinger #3	335	335	317			
ML_A - ml in aliquot #1	—	—	—			
ML_A - ml in aliquot #2	5	5	5			
ML_A - ml in aliquot #3	15	15	15			
ML_B - ml of $BaCl_2$ to titrate #1	—	—	—			
ML_B - ml of $BaCl_2$ to titrate #2	4.95	0.95	1.05			
ML_B - ml of $BaCl_2$ to titrate #3	0.20	0.10	0.15			
ML_{BB} - ml of $BaCl_2$ to titrate blank	0.05	0.05	0.05			
T_m - average gas meter temp., °F	78	79	77			
V_m - volume of dry gas sampled @ meter conditions, $ft.^3$	37.625	37.053	36.477			
P_b - barometric pressure, "Hg Abs.	29.10	29.08	29.09			
Q_s - Stack gas volume dry @ standard conditions, *SCFM	70,239	70,405	70,003			
C_I - SO_2 in Impinger #1, mgs	—	—	—			
C_I - SO_2 in Impinger #2, mgs	103.0 ✓	19.6	19.4			
C_I - SO_2 in Impinger #3, mgs	1.1	0.4	0.7			
C_T - total SO_2 in Impingers, mgs	104.1	20.0	20.1			
ppm SO_2	38.4	7.5	7.6			
C_{SO_2} - emission rate of SO_2, lbs/day	645.1	126.5	128.0			
C_s - emission rate of S, lbs/day	322.5	63.3	64.0			

* 68°F, 29.92 "Hg (20°C, 760 mm Hg)

$$C_I = \frac{ML_I \times (ML_B - ML_{BB}) \times \underline{N} \times 32}{ML_A}$$

$$C_T = C_I\ \#1 + C_I\ \#2 + C_I\ \#3$$

$$\text{ppm } SO_2 = \frac{0.7513 \times C_T \times (T_m + 460)}{V_m\ P_b}$$

$$C_{SO_2} = \text{ppm } SO_2 \times Q_s \times 239.2 \times 10^{-6}$$

$$C_s = \frac{C_{SO_2}}{2}$$

METCO

SULFUR TRIOXIDE EMISSION DATA

Kiln No. 3 Stack

Run Number	2	3	4	
Date	3-28-80	3-28-80	3-28-80	
N - normality of $BaCl_2$	0.0098	0.0098	0.0098	
ML_I - ml in impinger	270	200	270	
ML_A - ml in aliquot	15	15	15	
ML_B - ml of $BaCl_2$ to titrate	2.10	1.20	3.65	
ML_{BB} - ml of $BaCl_2$ to titrate blank	0.05	0.05	0.05	
T_m - average gas meter temp., °F	78	79	77	
V_m - volume of dry gas sampled @ meter conditions, $ft.^3$	37.625	37.053	36.477	
P_b - barometric pressure, "Hg Abs.	29.10	29.08	29.09	
Q_s - stack gas volume dry @ standard conditions, *SCFM	70,239	70,405	70,003	
C_I - SO_3 in impinger, mgs	14.5	6.0	25.4	
ppm SO_3	4.3	1.8	7.7	
C_{SO_3} - emission rate of SO_3, lbs/day	89.9	38.1	162.1	

* 68°F, 29.92 "Hg (20°C, 760 mm Hg)

$$C_I = \frac{ML_I \times ML_B \times N \times 40}{ML_A}$$

$$\text{ppm } SO_3 = \frac{0.6021 \times C_I \times (T_m + 460)}{V_m P_b}$$

$$C_{SO_3} = \text{ppm } SO_3 \times Q_s \times 299.1 \times 10^{-6}$$

OKLAHOMA CEMENT COMPANY

DAILY METER READINGS

No. 3 KILN

Burner Baghouse Test 11AM - 7PM

Date 3-28-80

Shift Day

Hour	12 / 8 / 4	1 / 9 / 5	2 / 10 / 6	3 / 11 / 7	4 / 12 / 8	5 / 1 / 9	6 / 2 / 10	7 / 3 / 11
Coal Mill Inlet Press								
Fan Outlet Pressure								
Coal Air Temp								
Mill Inlet Damp Posit								
Hot Air Temp								
Hot Air Damp Posit								
Mill Inlet Temp								
Coal Feeder Tons/Hour	6.0	5.8	5.9	5.9	5.9	5.9	5.8	5.9
Coal Bunker Freeboard								
Coal Mill Amps								
Feed Screw RPM								
Primary Air Damp Posit								
Coal Crusher Amps								
I. D. Fan Speed	990	990	990	990	990	990	990	1000
Water Spray Valve Posit								
Bleed Air Damp Posit								
Kiln Condition								
Gas Turbine Reading								
Gas Chart Reading								
Kiln Feeder Reading	608819	611227	614110	619190	621957	624405	627045	629690
Kiln Revolutions								
Coal Totalizer Reading	868727	869952	869377	869954	870266	870543	870842	871142
Coal —200								
Liter Weights								
Alkalies								
Diff Press Baghouse	6.6	6.6	6.8	6.5	6.6	6.6	6.6	6.6
	11AM	11:30	12:00	1:00 PM	1:30	2:00	2:30	3:00

Hour	12 / 8 / 4	1 / 9 / 5	2 / 10 / 6	3 / 11 / 7	4 / 12 / 8	5 / 1 / 9	6 / 2 / 10	7 / 3 / 11
Cooler Speed								
Cooler Vent Damper								
Undergrate Damper								
Gas Press At Pipe								
Vertical Screw Amps								
Mid Kiln Temp								
Aux Cooler Temp								
Paddle-Wheel RPM								
Kiln Speed	62	62	1	1	1	62	62	62
Feeder Speed	528	528	528	529	528	528	528	528
Baghouse Inlet Temp	540	540	540	530	530	520	530	520
Reverse Air Fan Amps								
No. 1 Chain Inlet Temp								
No. 2 Matr. Temp								
No. 3 Kiln Exit Temp								
No. 4 Dust Chamb Temp	700	700		700	720	700	700	680
Hood Press								
Oxygen Analyzer %	3.0	2.6	2.0	2.3	2.3	2.4	2.6	1.0
No. 5 Temp								
Buell Damp Position								
Outer Shell Temp								
Footage								
Cooler Blower Amps								
Cooler Stack Fan Amps								
Cooler Grate RPM								
Clinker Breaker Amps								
Clinker Elev Amps								
I. D. Fan Amps	750	750	760	780	740	760	760	780
Kiln Drive Amps								
2nd Compt Blower Amps								
1st Compt Blower Amps								
	11AM	11:30	12:00	1:00 PM	1:30	2:00	2:30	3:00

REMARKS:

OP-10-A

OKLAHOMA CEMENT COMPANY

DAILY METER READINGS

No. 3 KILN

Burner Baghouse Test

Date 3-29-80

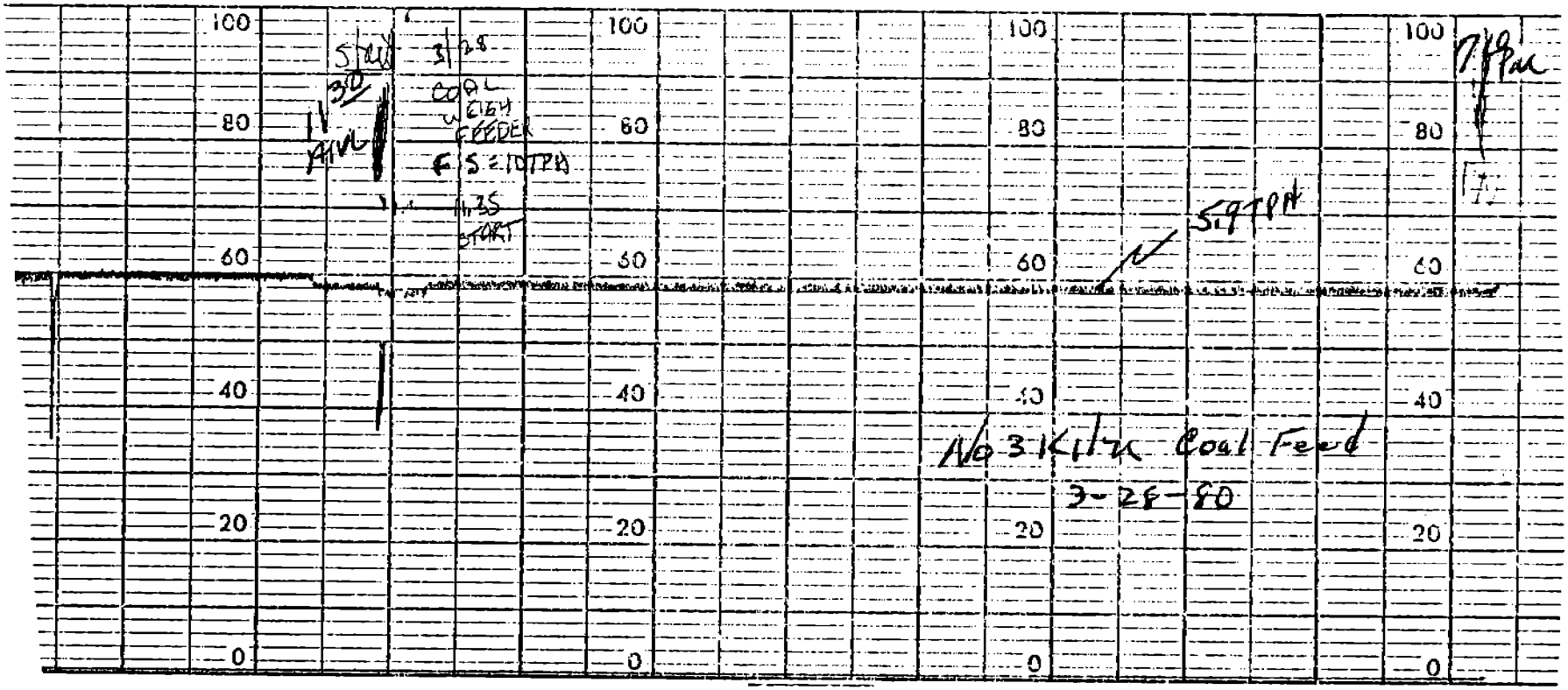
Shift Day

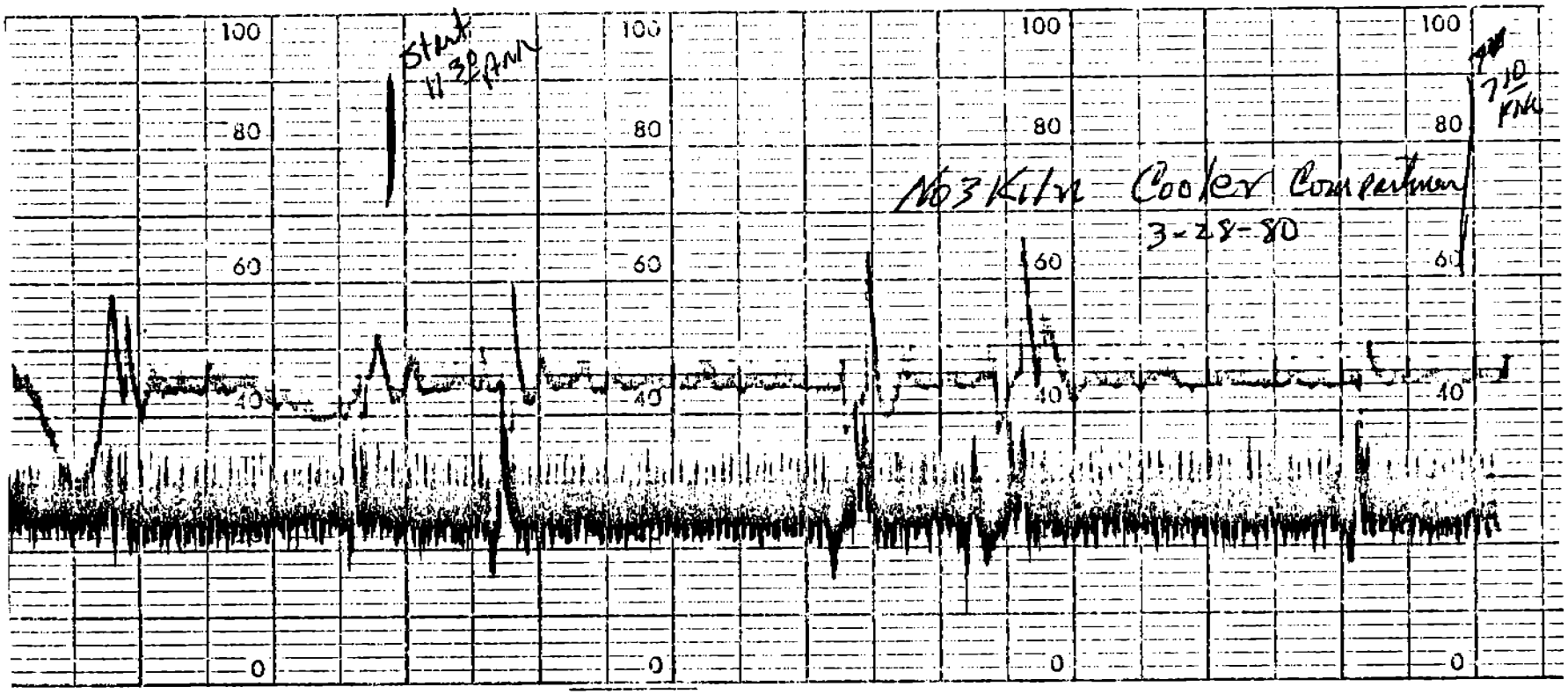
Hour	12 / 8 / 4	1 / 9 / 5	2 / 10 / 6	3 / 11 / 7	4 / 12 / 8	5 / 1 / 9	6 / 2 / 10	7 / 3 / 11
Coal Mill Inlet Press								
Fan Outlet Pressure								
Coal Air Temp								
Mill Inlet Damp Posit								
Hot Air Temp								
Hot Air Damp Posit								
Mill Inlet Temp								
Coal Feeder Tons/Hour	57.9	57.9	57.9	57.9	57.9	57.9	57.9	57.9
Coal Bunker Freeboard								
Coal Mill Amps								
Feed Screw RPM								
Primary Air Damp Posit								
Coal Crusher Amps								
I. D. Fan Speed	1000	1000	1000	1000	1000	1000	1000	1000
Water Spray Valve Posit								
Bleed Air Damp Posit								
Kiln Condition								
Gas Turbine Reading								
Gas Chart Reading								
Kiln Feeder Reading	632430	634910	637575	640300	642829	645500	648147	650727
Kiln Revolutions								
Coal Totalizer Reading	871449	871733	872025	872341	872632	872931	873230	873525
Coal —200								
Liter Weights								
Alkalies								
Diff Press	6.6	6.8	6.6	6.6	6.5	6.5	6.6	6.4
	3:30	4:30	4:30	5:30	5:30	6:30	7:30	8:30

Hour	12 / 8 / 4	1 / 9 / 5	2 / 10 / 6	3 / 11 / 7	4 / 12 / 8	5 / 1 / 9	6 / 2 / 10	7 / 3 / 11
Cooler Speed								
Cooler Vent Damper								
Undergrate Damper								
Gas Press At Pipe								
Vertical Screw Amps								
Mid Kiln Temp								
Aux Cooler Temp								
Paddle-Wheel RPM								
Kiln Speed	62	62	1	1	1	62	62	62
Feeder Speed	52.8	52.8	52.8	52.8	52.8	52.8	52.8	52.8
Baghouse Inlet Temp	530	530	520	530	520	520	520	530
Reverse Air Fan Amps								
No. 1 Chain Inlet Temp								
No. 2 Matr. Temp								
No. 3 Kiln Exit Temp								
No. 4 Dust Chamb Temp	680	680	670	680	680	680	680	680
Hood Press								
Oxygen Analyzer	2.0	2.2	2.4	2.0	1.7	1.6	2.0	2.0
No. 5 Temp								
Buell Damp Position								
Outer Shell Temp								
Footage								
Cooler Blower Amps								
Cooler Stack Fan Amps								
Cooler Grate RPM								
Clinker Breaker Amps								
Clinker Elev Amps								
I. D. Fan Amps	780	760	780	780	780	780	680	680
Kiln Drive Amps								
2nd Compt Blower Amps								
1st Compt Blower Amps								
	3:30	4:30	4:30	5:30	5:30	6:30	7:30	7:30

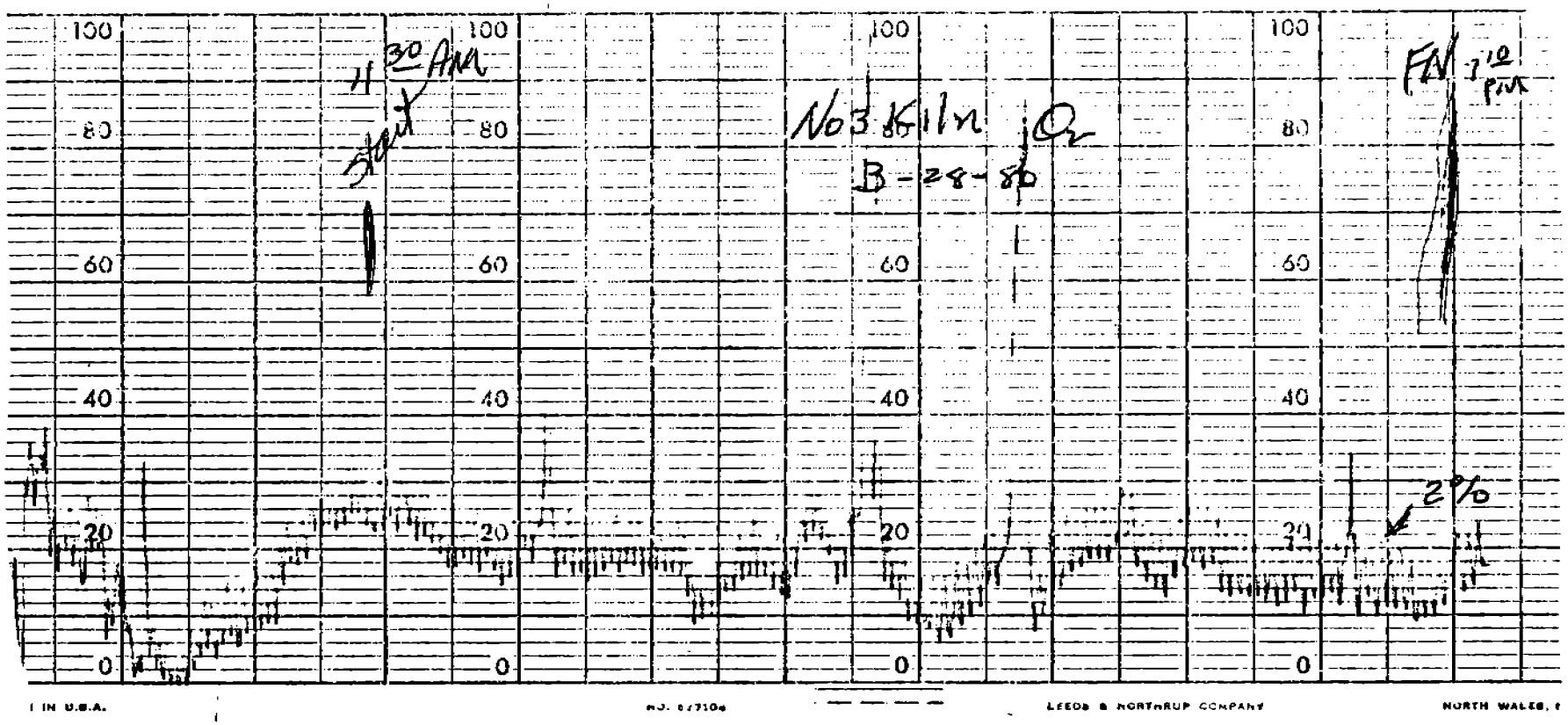
REMARKS: _____

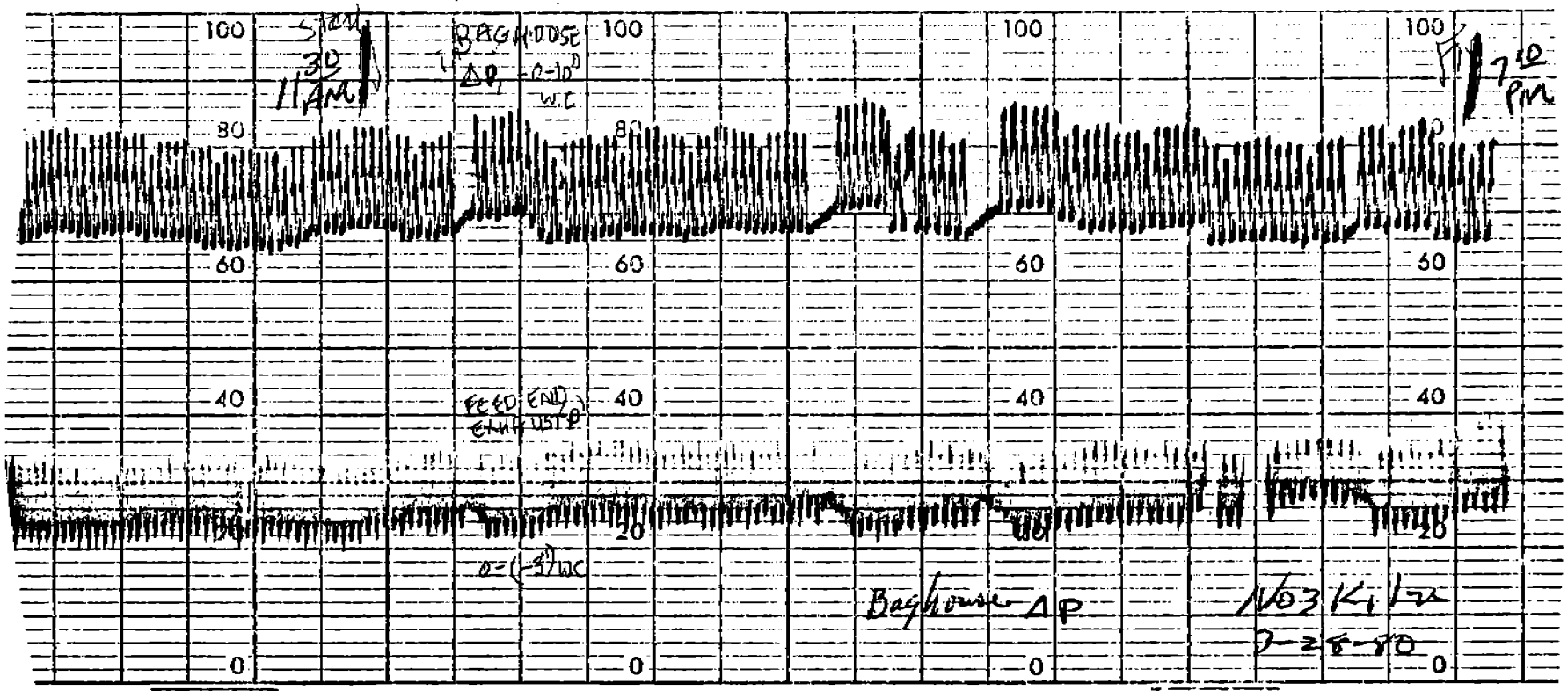
OP-10-A

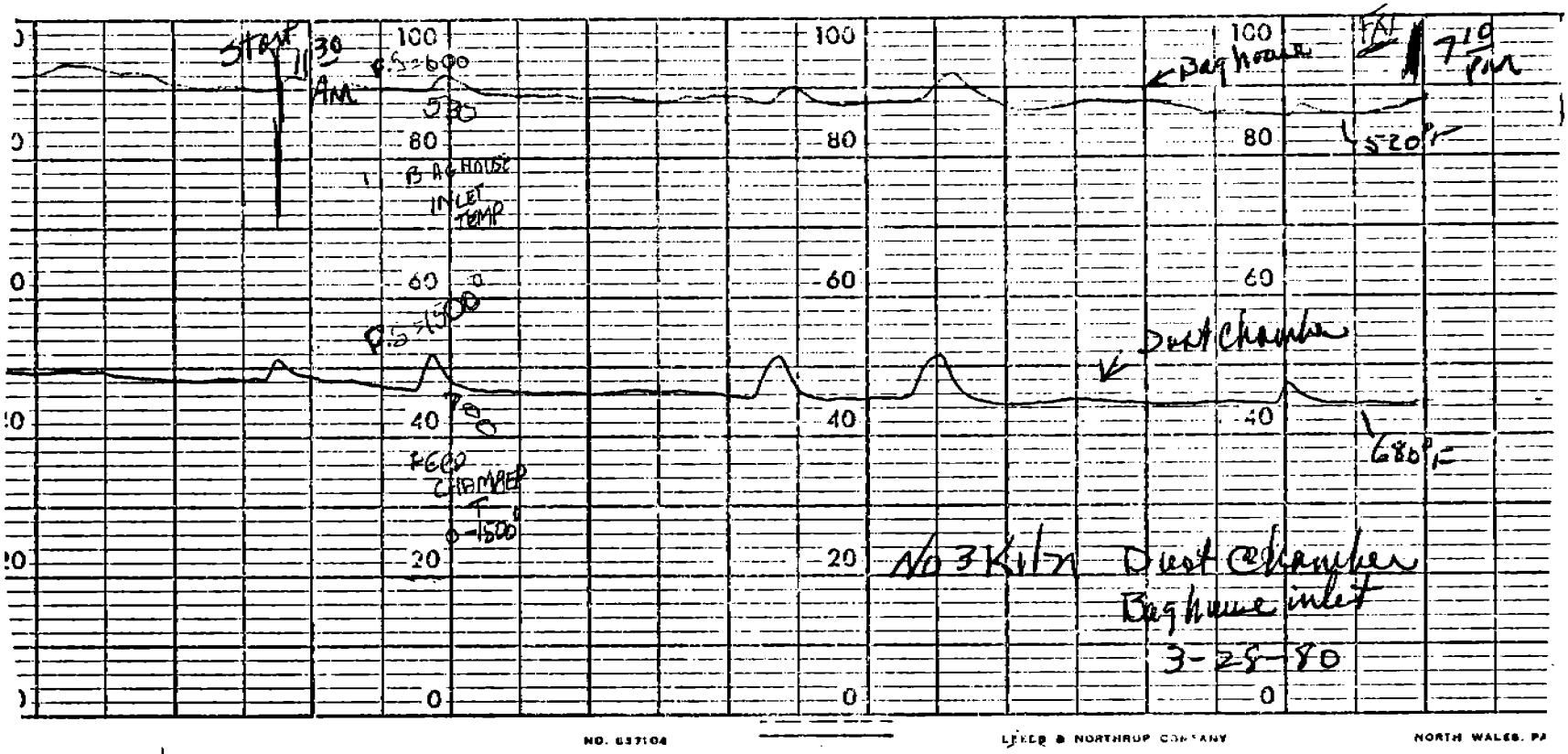

100
80
60
40
20
0
3/28
COAL
WEIGH
FEEDER
F.S. 10TPH
11:35
START
57TPH
No 3 Kiln Coal Feed
3-28-80
NORTHRUP COMPANY
NORTH WALES, PA.
MADE IN U.S.A.

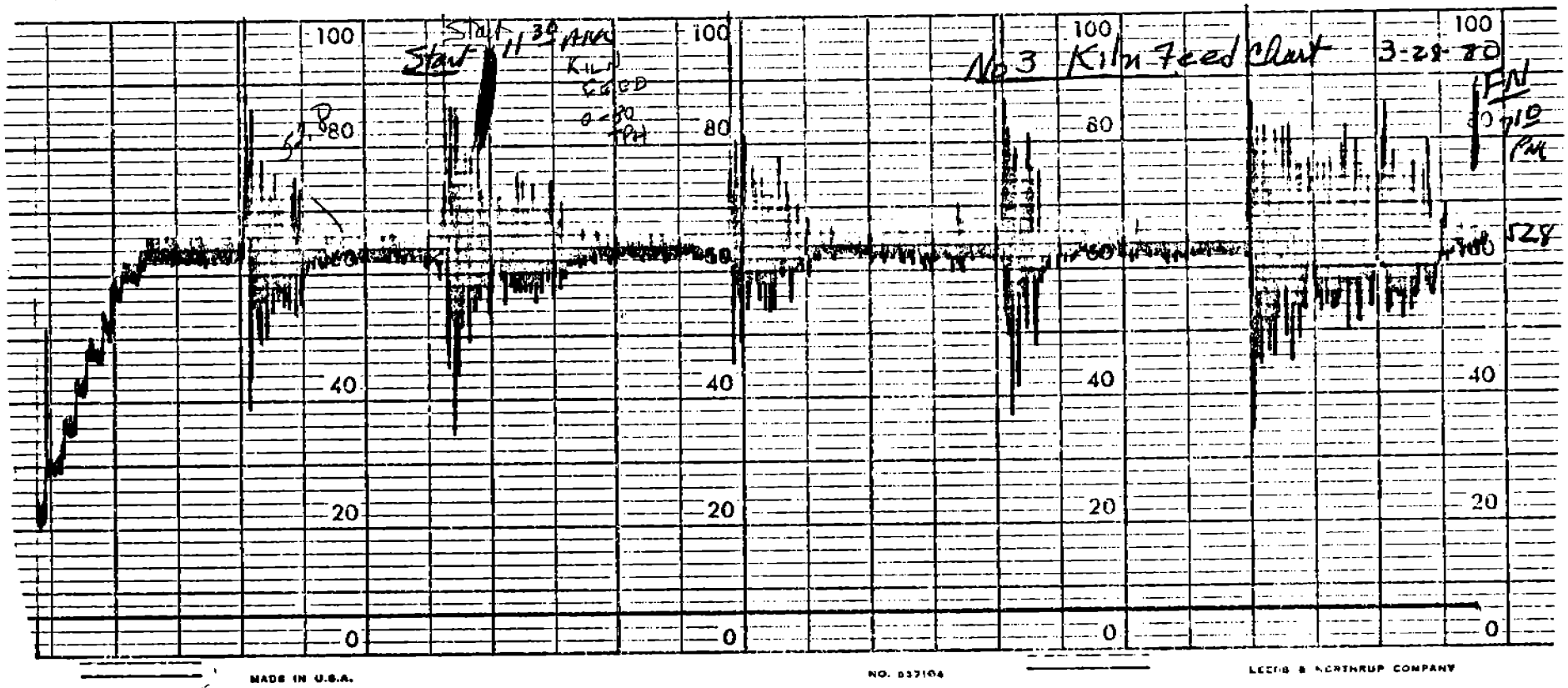


NO. 837104 LEEDS & NORTHRUP COMPANY NORTH WALES, PA.


100
80
60
40
20
0
11 30 AM
Start
No 3 Kiln O2
B-28-80
FN 7 10 PM
2%
1 IN U.S.A.
LEEDS & NORTHRUP COMPANY
NORTH WALES, P


100
80
60
40
20
0
Start 30 11AM
BAGHOUSE ΔP 0-10" W.C
FEED END EXHAUST P
0-(-5") WC
Baghouse ΔP
1/03 K1/2
2-28-80
7:10 PM


START
11:30 AM
100
80
60
40
20
0
BAGHOUSE INLET TEMP
Baghouse
Dust Chamber
7:10 PM
520°F
680°F
No 3 Kiln Dust Chamber
Baghouse inlet
3-25-80
NO. 637104
LEEDS & NORTHRUP COMPANY
NORTH WALES, PA


No 3 Kiln Feed Chart 3-28-80
Start 11:30 AM
Kiln Feed
0-80
Pct
100
80
60
40
20
0
FN
10 PM
528
MADE IN U.S.A.
NO. 037104
LEEDS & NORTHRUP COMPANY

APPENDIX G

Chain of Custody

MULLINS ENVIRONMENTAL TESTING CO., INC.

Chain of Custody

Job Number 80-38

Date(s) Sampled 3/28/80

Job Name Oklahoma Cement Co.

Number of Tests 3

Location Pryor, Okla.

Unit Tested Kiln No. 3 Stack

Sample Containers

Description	No. of Containers	Remarks
Front Wash	111	
Back Wash		
Impinger No. 1	111	
Impinger No. 2	111	
Impinger No. 3	111	
Filter Container	111	
Acetone Blank	1	

Sample No. 2 Recovered by: Billy J. Mullins Jr. Date: 3/28/80 Time: 2005 Location: Van

Sample No. 3 Recovered by: Billy J. Mullins Jr. Date: 3/28/80 Time: 2015 Location: Van

Sample No. 4 Recovered by: Billy J. Mullins Jr. Date: 3/28/80 Time: 2020 Location: Van

Samples Received by: Billy J. Mullins Jr. for Transport Date: 3/28/80 Time: 2030

Samples Received at Lab by: Douglas R. Scott Date: 3/29/80 Time: 1215

Samples Analyzed by: J R Moodhouse Date: 4/3/80 Time: 1520

JRM

APPENDIX H

Resumes of Test Personnel

MULLINS ENVIRONMENTAL TESTING CO., INC.
11105 Shady Trail • Suite 120
Dallas, Texas 75229 • (214) 243-7971

METCO

BILLY J. MULLINS, JR., President

Education

Post Graduate Study in Environmental Engineering at Southern Methodist University, Dallas, Texas, 1970.

M.S. 1969, New York University, New York, New York, in Civil Engineering (Air Resources).

B.S. 1968, Texas Tech University, Lubbock, Texas, in Civil Engineering (Water Resources).

Studies in Engineering at U.S. Naval Academy, Annapolis, Maryland, 1963-1964.

Professional Training Courses

Attended Short Course on Air Pollution Engineering at the University of Texas at Austin, February 1970.

Attended four-week management course presented by the American Management Association, 1976.

Certification

Registered Professional Engineer
Certified Visible Emissions Evaluator
Certified Fallout Shelter Analyst
Licensed Private Pilot (Single Engine-Land)

Professional Memberships

Air Pollution Control Association - Past Chairman, Southwest Section
Source Evaluation Society
American Society of Civil Engineers
Texas Society of Professional Engineers
National Society of Professional Engineers
American Management Association
Technical Association of the Pulp and Paper Industry

Technical Experience

Directed and performed stack sampling on over 600 sources of which over 60 were sampled simultaneously using more than one sampling train at several points in the flue gas stream. 1972-present.

Directed and performed over 70 short-term ambient air studies using mobile sampling vans and various ambient air sampling equipment. 1972-present.

METCO

Mullins

Designed, directed and operated over 20 permanent ambient air networks of various size and duration for a variety of parameters. 1972-present.

Designed surface and underground drainage systems for residential subdivisions, public works projects, and shopping centers. 1969-1972.

Designed several residential subdivisions including lot layout, street design, drainage design, and utility design. 1969-1972.

Research Projects

Supervised and conducted a study made by the Hawaiian Sugar Planters' Association to characterize the emissions for several bagasse-fired boilers. April-May 1976.

Supervised and conducted a study made by the Rio Grande Valley Sugar Growers, Inc. to determine the area affected by the burning of sugarcane fields prior to harvesting. November 1974-April 1975.

Supervised and conducted a study by a lightweight aggregate manufacturer to develop a material balance around the process through sampling and analysis of several parameters. November 1973.

Conducted a study in New York City to attempt to develop a correlation in the ambient air between carbon dioxide and sulfur dioxide to provide a tool for predicting air pollution episodes. January-May 1969.

Publications

Co-authored "Sulfur Compound Emissions of the Petroleum Production Industry," December 1974.

Co-authored "Field Procedure for Stabilizing Hydrogen Sulfide Samples to be Analyzed Using Modified Methylene Blue Technique," presented at the Conference on Ambient Air Quality Measurements, Austin, Texas, March 1975.

Co-authored "Atmospheric Emissions Survey of the Sour Gas Industry," October 1975.

Co-authored "Technique for Insuring the Validity of Samples for High Concentrations of Sulfur Dioxide Using the EPA Method 5 Sampling Train," presented at the Third National Conference on Energy and the Environment, College Corner, Ohio, September 1975.

METCO

Mullins

Teaching Experience

Served as a lecturer in the Environmental Protection Agency's training course number 450, "Source Sampling for Particulate Pollutants" for two years from January 1974 to October 1975.

Conducted a two-day training course entitled "Technical Assistance in Source Sampling" at Iowa State University, Ames, Iowa for the Environmental Protection Agency, October 1974.

Conducted EPA's training course number 450, "Source Sampling for Particulate Pollutants" for the EPA at Research Triangle Park, North Carolina, September 1975.

Conducted a two-day short course entitled "Performing and Observing Source Sampling" at Dallas, Texas, July 1976, May 1977, October 1977; at Lake Charles, Louisiana, May 1977; and at Casper, Wyoming, May 1977.

Served as a lecturer in the Environmental Protection Agency's two-day seminar entitled "Asphalt Industry Environmental Solutions," presented in Dallas, Texas on March 21 and 22, 1979.

MULLINS ENVIRONMENTAL TESTING CO., INC.
11105 Shady Trail • Suite 120
Dallas, Texas 75229 • (214) 243-7971

METCO

DOUGLAS RAY SAATHOFF, Environmental Technician

Education

B.S. 1978, The University of Texas at Austin, Austin, Texas, in Biology with a minor in Chemistry.

Technical Experience

Research Assistant at The University of Texas at Port Aransas, Summers 1976 and 1977.

Laboratory Technician for The Texas State Department of Health, Dallas, Texas.

Participated in the sampling and analysis of several sources with EPA and Texas Air Control Board methods of both source and ambient air samples for particulates, SO_3, H_2SO_4, H_2S, HCl, Cl_2, and NO_x. Both laboratory and on-site field analysis performed.