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 11.6
Reference 29
Report Sect. 4
Reference 23

Source category: Portland Cement
Plant name : Lehigh Portland Cement Co.
Test date : 8/1 - 8/3/83
Process : not specified
Date: 01/28/93
Location: Waco, TX
Ref. No.: 23
Basis for process rate : production

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	fabric filter	BASED ON PRODUCTION RATE							
		filt. PM	1	41.80	53.5	0.391	0.781		
		filt. PM	2	39.90	56	0.356	0.713		
		filt. PM	3	39.40	59.4	0.332	0.663		
				AVERAGE		0.360	0.719	RATING:	B
		con. inorg. PM	1	11.50	53.5	0.107	0.215		
		con. inorg. PM	2	9.10	56	0.0813	0.163		
		con. inorg. PM	3	7.20	59.4	0.0606	0.121		
				AVERAGE		0.0831	0.166	RATING:	B
		SO2	1	408.70	53.5	3.82	7.64		
		SO2	2	410.00	56	3.66	7.32		
		SO2	3	334.00	59.4	2.81	5.62		
				AVERAGE		3.43	6.86	RATING:	B
		NOx	1	313.20	53.5	2.93	5.85		
		NOx	2	341.30	56	3.05	6.09		
		NOx	3	324.50	59.4	2.73	5.46		
				AVERAGE		2.90	5.80	RATING:	B
		CO2	1	57,810	53.5	540	1,081	127,609	6.6
		CO2	2	66,771	56	596	1,192	123,136	7.9
		CO2	3	59,714	59.4	503	1,005	126,080	6.9
				AVERAGE		546	1,093	RATING:	C
clinker cooler	gravel bed filter	BASED ON PRODUCTION RATE							
		filt. PM	1	7.70	53.5	0.0720	0.1439		
		filt. PM	2	6.60	56	0.0589	0.1179		
		filt. PM	3	3.78	59.4	0.0318	0.0636		
				AVERAGE		0.0542	0.1085	RATING:	B
		con. inorg. PM	1	0.32	53.5	0.0030	0.0060		
		con. inorg. PM	2	0.30	56	0.0027	0.0054		
		con. inorg. PM	3	0.73	59.4	0.0061	0.0123		
				AVERAGE		0.0039	0.0079	RATING:	B

Notes: 1. CO2 data rated C due to uncertainty of test method.

MULLINS ENVIRONMENTAL TESTING CO., INC.
P.O. Box 598
Addison, Tx 75001
(214) 931-7127

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AUG 29 1983
MONITORING

SOURCE EMISSIONS SURVEY
OF
LEHIGH PORTLAND CEMENT COMPANY
WACO, TEXAS

AUGUST 1983

Reference 48:
(2) Unspecified coal-fired kiln w/ baghouse (common) Delete!
(1) Unspecified clinker cooler w/ gravel bed filter → ER 83-69

Data Rating: B

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SOURCE EMISSIONS SURVEY
LEHIGH PORTLAND CEMENT COMPANY
WACO, TEXAS
FILE NUMBER 83-69

INTRODUCTION

Mullins Environmental Testing Co., Inc., Dallas, Texas, conducted a source emissions survey for Lehigh Portland Cement Company at its plant near Waco, Texas, on August 1, 2 and 3, 1983. The purpose of these tests was to determine the concentrations of particulate matter, sulfur dioxide, and oxides of nitrogen being emitted to the atmosphere via the Kiln Baghouse Exhaust Stack and to determine the concentration of particulate matter being emitted to the atmosphere via the Clinker Cooler Exhaust Stack.

The sampling followed the procedures set forth in the Appendix to the Code of Federal Regulations, Title 40, Chapter I, Part 60, and in the "Sampling Procedures Manual, Texas Air Control Board, January 1983.

SUMMARY OF RESULTS

The principal conclusions are as follows:

Kiln Baghouse Stack

1. The emissions of particulate matter from the stack were equal to 49.6 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 stated in the Texas Air Control Board Permit, is equal to 107.0 pounds per hour. The actual emissions were 46.4 percent of the permitted emission rate.

2. The emissions of sulfur dioxide from the stack were equal to 384.2 pounds per hour (307.1 parts per million), based on averaging the three tests. The allowable emission rate, as stated in the Texas Air Control Board Permit, is equal to 983.0 pounds per hour. The actual emissions were 39.1 percent of the permitted emission rate.

3. The emissions of oxides of nitrogen from the stack were equal to 326.3 pounds per hour (363 parts per million), based on averaging the three tests. The allowable emission rate, as stated in the

Texas Air Control Board Permit, is equal to 97.5 pounds per hour. The actual emissions were 334.7 percent of the permitted emission rate.

Clinker Cooker Stack

The emissions of particulate matter from the stack were equal to 6.5 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 stated in the Texas Air Control Board Permit, is equal to 26.7 pounds per hour. The actual emissions were 24.2 percent of the permitted emission rate.

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SUMMARY OF RESULTS

Kiln Baghouse Stack

Run Number	1	2	3
Stack Flow Rate - ACFM	214,115	213,523	216,242
Stack Flow Rate - DSCFM*	127,609	123,136	126,080
% Water Vapor - % Vol.	6.9	9.1	8.3
% CO_2 - % Vol.	6.6	7.9	6.9
% O_2 - % Vol.	15.7	15.1	15.6
% Excess Air @ Sampling Point	321	285	316
Particulates Probe, Cyclone & Filter Catch grains/dscf*	0.0382	0.0378	0.0365
grains/cf @ Stack Conditions	0.0227	0.0217	0.0212
lbs/hr	41.8	39.9	39.4
Total Catch grains/dscf*	0.0487	0.0464	0.0432
grains/cf @ Stack Conditions	0.0289	0.0267	0.0251
lbs/hr	53.3	49.0	46.6
Allowable Particulate Emission Rate- TACB Permit - lbs/hr	107.0	107.0	107.0
Sulfur Dioxide Emissions - ppm	321	334	266
Sulfur Dioxide Emissions - lbs/hr	408.7	410.0	334.0
Allowable Sulfur Dioxide Emission Rate - TACB Permit - lbs/hr	983.0	983.0	983.0
Opacity - %	6.5	9.6	7.3

* 29.92 "Hg, 68°F (760 mm Hg, 20°C)

SUMMARY OF RESULTS

Kiln Baghouse Stack

Oxides of Nitrogen
(parts per million)

Run Number	1	2	3	Average
Flask Number 1	287	378	371	
Flask Number 2	344	379	367	
Flask Number 3	356	407	342	
Flask Number 4	382	383	358	
Average	343	387	359	363

Run Number		1	2	3	Average
Emission Rate of NO_x -	lbs/dscf*	4.09×10^{-5}	4.62×10^{-5}	4.29×10^{-5}	4.33×10^{-5}
Emission Rate of NO_x -	lbs/hr	313.2	341.3	324.5	326.3
Allowable Emission Rate -	lbs/hr	97.5	97.5	97.5	97.5

* 29.92 "Hg, 68°F (760 mm Hg, 20°C

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SUMMARY OF RESULTS

Clinker Cooler Stack

Run Number	1	2	3
Stack Flow Rate - ACFM	55,941	56,955	55,515
Stack Flow Rate - DSCFM*	41,604	43,249	40,424
% Water Vapor - % Vol.	2.5	2.3	2.9
% CO_2 - % Vol.	0.0	0.0	0.0
% O_2 - % Vol.	20.8	20.8	20.8
% Excess Air @ Sampling Point	------	------	------
Particulates Probe, Cyclone & Filter Catch grains/dscf*	0.0216	0.0178	0.0109
grains/cf @ Stack Conditions	0.0160	0.0135	0.0079
lbs/hr	7.7	6.6	3.8
Total Catch grains/dscf*	0.0225	0.0186	0.0130
grains/cf @ Stack Conditions	0.0167	0.0141	0.0094
lbs/hr	8.0	6.9	4.5
Allowable Particulate Emission Rate - TACB Permit - lbs/hr	26.7	26.7	26.7
Opacity - %	5.0	------	------

* 29.92 "Hg, 68°F (760 mm Hg, 20°C)

DISCUSSION OF RESULTS

Kiln Baghouse Stack

The 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 14.9 percent of the mean value. The measured flow rates (Q_s) for the tests were within 2.0 percent of the mean value. The rates of sampling for the three tests were well within the specified limits, the greatest deviation being 3.2 percent.

The calculated emissions (pounds per hour) of particulate for the three tests showed a range of from -6.1 percent to +7.4 percent variation from the mean value.

Sulfur dioxide was determined simultaneously with each 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 #1	Run #2	Run #3
Impinger #2	99.0	99.0	98.8
Impinger #3	1.0	1.0	1.2

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

The calculated emissions (pounds per hour) of sulfur dioxide for the three tests showed a range of -13.1 percent to +6.7 percent variation from the mean value.

The three tests for oxides of nitrogen involved twelve flasks. The samples appeared to be valid representations of the actual emissions during the tests. The calculated emissions (pounds per hour) of oxides of nitrogen for the three tests showed a range of -4.0 percent to +4.6 percent variation from the mean value.

Clinker Cooler Stack

The three tests for particulates on the Clinker Cooler Stack appeared to be valid representations of the actual emissions during the testing

period. The indicative parameters calculated from the field data were in close agreement. The moisture percentages for the three tests were within 12.5 percent of the mean value. The measured flow rates (Q_s) for the three tests were within 3.6 percent of the mean value. The rates of sampling for the three tests were well within the specified limits, the greatest deviation being 2.5 percent.

The calculated particulate emissions (pounds per hour) indicated a range of from -30.4 percent to +23.7 percent variation from the mean value.

DESCRIPTION OF SAMPLING LOCATIONS

The sampling location on the Kiln Baghouse Stack is approximately 95 feet above the ground. The sampling ports are located 20 feet 6 1/2 inches (2.05 stack diameters) downstream from the inlet to the stack and 30 feet (3.00 stack diameters) upstream from the outlet of the stack.

The sampling location on the Clinker Cooler Stack is approximately 44 feet above the ground. The sampling ports are located 31 feet 5 1/2 inches (5.30 stack diameters) downstream from the inlet to the stack and 12 feet 1/8 inch (2.02 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, and in the "Sampling Procedures Manual, Texas Air Control Board, January 1983."

A preliminary velocity traverse was made at each of the two ports on each stack in order to determine the uniformity and magnitude of the flow prior to testing. All traverse points on each stack were checked for cyclonic flow. The Kiln Baghouse Stack indicated an average of 4.7 degrees cyclonic flow, and the Clinker Cooler Stack indicated an average of 7.0 degrees cyclonic flow. On the Kiln Baghouse Stack, twenty-four traverse points were sampled from each of the two ports for a total of forty-eight traverse points. Samples of two-minute duration were taken isokinetically at each of the forty-eight traverse points using an EPA-type, heated, glass-lined probe. On the Clinker Cooler Stack, sixteen traverse points were sampled from each of the two ports for a total of thirty-two traverse points. Samples of two-minute duration were taken isokinetically at each of the thirty-two traverse points using an EPA-type, heated, glass-lined probe.

On all 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 tests. This was done 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. On the Kiln Baghouse Stack, the "back-half" of the sampling train contained an 80 percent isopropyl alcohol solution to absorb sulfur trioxide, a six percent hydrogen peroxide solution to absorb sulfur dioxide, and silica gel to absorb moisture. On the Clinker Cooler Stack, the "back-half" of the sampling train contained deionized water and silica gel to absorb moisture.

At the conclusion of each test for sulfur dioxide, the sampling train was purged with two cubic feet of ambient air at the same rate as during the sampling.

The oxides of nitrogen samples on the Kiln Baghouse Stack were taken according to the procedures outlined in EPA Method 7.

DESCRIPTION OF TESTS

Personnel from Mullins Environmental Testing Co., Inc. arrived at the plant at 1:00 p.m. on Monday, August 1, 1983. The equipment was moved onto the exhaust stack of the Kiln Baghouse, and the preliminary data were collected before securing for the night at 5:30 p.m.

On Tuesday, August 2, work began at 8:00 a.m. The equipment was prepared for testing, and the first test on the Kiln Baghouse Stack for particulates, sulfur dioxide, and oxides of nitrogen began at 8:39 a.m. Testing continued without difficulty until the completion of the first test at 10:18 a.m. The second test began at 11:00 a.m. and continued until its completion at 12:41 p.m. The third test on the Kiln Baghouse Stack began at 1:22 p.m. and continued without difficulty until its completion at 3:00 p.m. The equipment was moved off the Kiln Baghouse Stack and onto the Clinker Cooler Stack before securing for the night at 6:30 p.m.

On Wednesday, August 3, work began at 8:00 a.m. The equipment was prepared for testing, but testing was delayed due to a broken probe tip. The first test for particulates on the Clinker Cooler Stack began at 9:05 a.m. and continued without difficulty until its completion at 10:13 a.m. The second test began at 11:09 a.m. and continued until its completion at 12:41 p.m. with a thirty-minute delay halfway through the test while the communications

cable was repaired. The third test began at 1:15 p.m. and continued, with only a brief delay due to plant operational problems, until its completion at 2:26 p.m.

The equipment was moved off the Clinker Cooler 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 Lehigh Portland Cement Company near Waco, Texas, were completed at 3:00 p.m. on Wednesday, August 3, 1983.

Billy J. Mullins, Jr.

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

APPENDICES

A. Location of Sampling Points

B. Source Emissions Calculations

C. Calibration Data

D. Field Testing Data

E. Analytical Data

F. Plant Operational Data

G. Visible Emissions Data

H. Chain of Custody

I. Resumes of Test Personnel

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APPENDIX A

Location of Sampling Points
Kiln Baghouse Stack

The sampling ports are located 20 feet 6 1/2 inches (2.05 stack diameters) downstream from the inlet to the stack and 30 feet (3.00 stack diameters) upstream from the outlet of the stack. The locations of the sampling points were calculated as follows:

Port and Wall Thickness = 6 1/4 inches
Inside Stack Diameter = 120 1/16 inches

Point Number	Percent of Diameter From Wall	Distance From Wall
1	1.1	1 5/16"
2	3.2	3 13/16"
3	5.5	6 5/8 "
4	7.9	9 1/2 "
5	10.5	12 5/8 "
6	13.2	15 7/8 "
7	16.1	19 5/16"
8	19.4	23 5/16"
9	23.0	27 5/8 "
10	27.2	32 11/16"
11	32.3	38 3/4 "
12	39.8	47 13/16"
13	60.2	72 1/4 "
14	67.7	81 5/16"
15	72.8	87 3/8 "
16	77.0	92 7/16"
17	80.6	96 3/4 "
18	83.9	100 3/4 "
19	86.8	104 3/16"
20	89.5	107 7/16"
21	92.1	110 9/16"
22	94.5	113 7/16"
23	96.8	116 1/4 "
24	98.9	118 3/4 "

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APPENDIX A

Location of Sampling Points
Clinker Cooler Stack

The sampling ports are located 31 feet 5 1/2 inches (5.30 stack diameters) downstream from the inlet to the stack and 12 feet 1/8 inch (2.02 stack diameters) upstream from the outlet of the stack. The locations of the sampling points were calculated as follows:

Port and Wall Thickness = 6 3/8 inches

Inside Stack Diameter = 71 1/4 inches

Point Number	Percent of Diameter From Wall	Distance From Wall
1	1.6	1 1/8 "
2	4.9	3 1/2 "
3	8.5	6 1/16"
4	12.5	8 7/8 "
5	16.9	12 1/16"
6	22.0	15 11/16"
7	28.3	20 3/16"
8	37.5	26 3/4 "
9	62.5	44 1/2 "
10	71.7	51 1/16"
11	78.0	55 9/16"
12	83.1	59 3/16"
13	87.5	62 3/8 "
14	91.5	65 3/16"
15	95.1	67 3/4 "
16	98.4	70 1/8 "

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APPENDIX B

Nomenclature and Equations

for

Calculation of Source Emissions

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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
m_t	mg	mg	Particulate - total

* 528°R, 29.92 "Hg (20°C, 760 mm Hg)

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Symbol	English Units	Metric Units	Description
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 at 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)

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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)

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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)

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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.

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

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

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

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)

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

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

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

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

16. Particulate - total, at stack conditions.

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

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

17. Particulate - probe, cyclone and filter.

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

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

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

18. Particulate - total.

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

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

* 528°R, 29.92 "Hg (20°C, 760 mm Hg)

METCO

SOURCE EMISSIONS SURVEY
LEHIGH PORTLAND CEMENT COMPANY
WACO, TEXAS
FILE NUMBER 83-69

SOURCE EMISSIONS CALCULATIONS

Kiln Baghouse Stack

Symbol	Description	Units	1	2	3
Run No.			1	2	3
Date			8/2/83	8/2/83	8/2/83
Begin			0839	1100	1322
End			1018	1241	1500
P_b	barometric pressure	"Hg Abs. (mm Hg)	29.62 (752)	29.60 (752)	29.58 (751)
P_m	orifice pressure drop	"H_2O (mm H_2O)	1.040 (26.4)	1.090 (27.7)	1.116 (28.3)
V_m	volume dry gas sampled @ meter conditions	$ft.^3$ (m^3)	55.351 (1.567)	57.397 (1.625)	58.062 (1.644)
T_m	avg. gas meter temp.	°F (°C)	102 (39)	113 (45)	108 (42)
$V_{m_{std}}$	volume dry gas sampled @ standard conditions*	dscf (dscm)	51.622 (1.462)	52.474 (1.486)	53.517 (1.515)
V_w	total H_2O collected, impingers & silica gel	ml	80.9	110.7	103.1
$V_{w_{gas}}$	volume water vapor collected @ standard conditions*	scf (scm)	3.818 (0.108)	5.225 (0.148)	4.866 (0.138)
%M	moisture in stack gas by volume	%	6.89	9.06	8.34

* 68°F, 29.92 "Hg (20°C, 760 mm Hg)

METCO

Source Emissions Calculations

Lehigh Portland Cement Company
Kiln Baghouse Stack
File Number 83-69

Symbol	Description	Units			
M_d	mol fraction of dry gas	----	0.9311	0.9094	0.9166
CO_2		%	6.6	7.9	6.9
O_2		%	15.7	15.1	15.6
N_2		%	77.7	77.0	77.5
%EA	excess air @ sampling point	%	321.0	284.6	315.9
MW_d	molecular weight of dry stack gas	lb/lb-mole (g/g-mole)	29.68 (29.68)	29.87 (29.87)	29.73 (29.73)
MW	molecular weight of stack gas	lb/lb-mole (g/g-mole)	28.88 (28.88)	28.79 (28.79)	28.75 (28.75)
ΔP_s	velocity head of stack gas	"H_2O (mm H_2O)	0.442 (11.2)	0.436 (11.1)	0.447 (11.4)
T_s	stack temperature	°F (°C)	359 (182)	366 (186)	363 (184)
P_s	stack pressure	"Hg Abs. (mm Hg)	29.60 (752)	29.57 (751)	29.56 (751)
V_s	stack velocity @ stack conditions	fpm (m/sec)	2,723 (13.83)	2,716 (13.80)	2,750 (13.97)
A_s	stack area	$in.^2$ (m^2)	11,322 (7.30)	11,322 (7.30)	11,322 (7.30)
Q_s	dry stack gas volume @ standard conditions*	DSCFM (dscm/hr)	127,609 (216,808)	123,136 (209,208)	126,080 (214,210)
Q_a	actual stack gas volume @ stack conditions	ACFM (m^3/hr)	214,115 (363,781)	213,523 (362,776)	216,242 (367,395)

* 68°F, 29.92 "Hg (20°C, 760 mm Hg)

METCO

Source Emissions Calculations

Lehigh Portland Cement Company
Kiln Baghouse Stack
File Number 83-69

Symbol	Description	Units			
T_t	net time of test	min.	96	96	96
D_n	sampling nozzle diam.	in. (m)	0.251 (0.006)	0.251 (0.006)	0.251 (0.006)
%I	percent isokinetic	%	96.8	101.9	101.5
m_f	particulate - probe, cyclone and filter	mg	128.1	128.8	126.7
m_t	particulate - total	mg	163.3	158.1	150.0
C_{an}	particulate - probe, cyclone and filter	gr/dscf* (g/dscm)	0.0382 (0.0875)	0.0378 (0.0866)	0.0365 (0.0835)
C_{ao}	particulate - total	gr/dscf* (g/dscm)	0.0487 (0.1116)	0.0464 (0.1063)	0.0432 (0.0988)
C_{at}	particulate - probe, cyclone and filter @ stack conditions	gr/cf (g/m^3)	0.0227 (0.0520)	0.0217 (0.0497)	0.0212 (0.0485)
C_{au}	particulate total @ stack conditions	gr/cf (g/m^3)	0.0289 (0.0663)	0.0267 (0.0611)	0.0251 (0.0574)
C_{aw}	particulate - probe, cyclone and filter	lbs/hr (kg/hr)	41.8 (19.0)	39.9 (18.1)	39.4 (17.9)
C_{ax}	particulate - total	lbs/hr (kg/hr)	53.3 (24.2)	49.0 (22.2)	46.6 (21.2)

* 68°F, 29.92 "Hg (20°C, 760 mm Hg)

SO_2 EMISSION DATA

ob Number 83-69

Location Waco, Texas

Job Name Lehigh Portland Cement Company

Unit Tested Kiln Baghouse Stack

un Number	1	2	3			
e	8/2/83	8/2/83	8/2/83			
ime	0839-1018	1100-1241	1322-1500			
N - normality of $BaCl_2$	0.0100	0.0100	0.0100			
L_I - ml in impinger #1	------	------	------			
L_I - ml in impinger #2	327	347	332			
ML_I - ml in impinger #3	325	317	343			
L_A - ml in aliquot #1	------	------	------			
ML_A - ml in aliquot #2	1.0	1.0	1.0			
L_A - ml in aliquot #3	10	10	10			
L_B - ml of $BaCl_2$ to titrate #1	------	------	------			
ML_B - ml of $BaCl_2$ to titrate #2	11.85	11.80	10.00			
L_B - ml of $BaCl_2$ to titrate #3	1.30	1.40	1.20			
ML_{BB} - ml of $BaCl_2$ to titrate blank	0.05	0.05	0.05			
T_m - average gas meter temp., °F	102	113	108			
V_m - volume of dry gas sampled @ meter conditions, $ft.^3$	55.351	57.397	58.062			
P_b - barometric pressure, "Hg Abs.	29.62	29.60	29.58			
Q_s - Stack gas volume dry @ standard conditions, *SCFM	127,609	123,136	126,080			
C_I - SO_2 in impinger #1, mgs	------	------	------			
C_I - SO_2 in impinger #2, mgs	1,234.8	1,304.7	1,057.1			
C_I - SO_2 in impinger #3, mgs	13.0	13.7	12.6			
C_T - total SO_2 in impingers, mgs	1,247.8	1,318.4	1,069.7			
ppm SO_2	321.3	334.1	265.8			
C_{SO_2} - emission rate of SO_2, lbs/day	9,808.7	9,839.8	8,015.8			
C_S - emission rate of S, lbs/day	4,904.3	4,919.9	4,007.9			

68°F, 29.92 "Hg (20°C, 760 mm Hg)

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

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

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

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

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

METCO

SULFUR TRIOXIDE EMISSION DATA

Job Number 83-69 Location Waco, Texas

Job Name Lehigh Portland Cement Company Unit Tested Kiln Baghouse Stack

Run Number	1	2	3	
Date	8/2/83	8/2/83	8/2/83	
Time	0839-1018	1100-1241	1322-1500	
$\underline{N}$ - normality of $BaCl_2$	0.0100	0.0100	0.0100	
ML_I - ml in impinger	202	255	218	
ML_A - ml in aliquot	10	10	10	
ML_B - ml of $BaCl_2$ to titrate	0.35	0.60	0.30	
ML_{BB}- ml of $BaCl_2$ to titrate blank	0.05	0.05	0.05	
T_m - average gas meter temp., °F	102	113	108	
V_m - volume of dry gas sampled @ meter conditions, $ft.^3$	55.351	57.397	58.062	
P_b - barometric pressure, "Hg Abs.	29.62	29.60	29.58	
Q_s - stack gas volume dry @ standard conditions, *SCFM	127,609	123,136	126,080	
C_I - SO_3 in impinger, mgs	2.4	5.6	2.2	
ppm SO_3	0.5	1.1	0.4	
C_{SO_3} - emission rate of SO_3, lbs/day	19.1	42.0	16.4	
C_S - emission rate of S, lbs/day	7.6	16.8	6.5	

*68°F, 29.92 "Hg (20°C, 760 mm Hg)

$$C_I = \frac{ML_I \times (ML_B - ML_{BB}) \times \underline{N} \times 40}{ML_A}$$

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

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

$$C_S = \frac{C_{SO_3}}{2.5}$$

METCO

NO_x EMISSION DATA

Job Number 83-69

Client Lehigh Portland Cement Company

Unit Tested Kiln Baghouse Stack

Date 8/2/83

Run Number 1

Flask Number	41	42	43	44	Average
Time	0932	0947	1002	1017	
Initial Barometric Pressure, "Hg Abs.	29.50	29.50	29.50	29.50	
Initial Manometer Reading, "Hg Abs.	-28.20	-28.20	-28.00	-28.00	
P_I - Initial Pressure of Flask, "Hg Abs.	1.30	1.30	1.50	1.50	
T_I - Initial Temperature of Flask, °F	94	99	101	104	
V_F - Volume of Flask, ml	2067	2048	2097	2047	
Final Barometric Pressure, "Hg Abs.	29.60	29.60	29.60	29.60	
Final Manometer Reading, "Hg Abs.	-1.50	-1.85	-1.60	-2.00	
P_F - Final Pressure of Flask, "Hg Abs.	28.10	27.75	28.00	27.60	
T_F - Final Temperature of Flask, °F	84	84	85	85	
μgNO_2 - micrograms of NO_2	974.6	1144.1	1218.2	1250.0	
V_s - Volume of sample at conditions*, ml	1777	1738	1781	1712	
ppm NO_2 - Concentration of NO_2, ppm	286.9	344.3	357.8	381.8	342.7
C_{NO_2} - Emission Rate of NO_2, lbs/dscf*	3.42×10^{-5}	4.11×10^{-5}	4.27×10^{-5}	4.56×10^{-5}	4.09×10^{-5}

* 68°F, 29.92 "Hg (20°C, 760 mm Hg)

$$V_s = \frac{528\ (V_F - 25)}{29.92} \left[\frac{P_F}{T_F + 460} - \frac{P_I}{T_I + 460} \right] = \text{ml}$$

$$\text{ppm } NO_2 = \frac{523 \times \mu g\ NO_2}{V_s} = \text{ppm}$$

$$C_{NO_2} = \frac{\mu g\ NO_2}{V_s} \times \frac{1\ lb/ft^3}{1.6 \times 10^4\ \mu g/ml} = 6.243 \times 10^{-5} \frac{\mu g\ NO_2}{V_s} = \text{lbs/dscf}$$

METCO

NO_x EMISSION DATA

Job Number 83-69

Client Lehigh Portland Cement Company

Unit Tested Kiln Baghouse Stack

Date 8/2/83

Run Number 2

Flask Number	45	46	47	48	Average
Time	1100	1115	1130	1145	
Initial Barometric Pressure, "Hg Abs.	29.50	29.48	29.48	29.48	
Initial Manometer Reading, "Hg Abs.	-28.20	-28.20	-28.00	-28.10	
P_I - Initial Pressure of Flask, "Hg Abs.	1.30	1.28	1.48	1.38	
T_I - Initial Temperature of Flask, °F	99	103	107	105	
V_F - Volume of Flask, ml	2046	2037	2055	2035	
Final Barometric Pressure, "Hg Abs.	29.60	29.60	29.60	29.60	
Final Manometer Reading, "Hg Abs.	+0.50	-0.40	-2.40	-1.60	
P_F - Final Pressure of Flask, "Hg Abs.	30.10	29.20	27.20	28.00	
T_F - Final Temperature of Flask, °F	85	86	86	85	
μgNO_2 - micrograms of NO_2	1364.4	1317.8	1317.8	1271.2	
V_s - Volume of sample at conditions*, ml	1887	1818	1691	1736	
ppm NO_2 - Concentration of NO_2, ppm	378.2	379.1	407.5	383.0	386.9
C_{NO_2} - Emission Rate of NO_2, lbs/dscf*	4.51×10^{-5}	4.53×10^{-5}	4.86×10^{-5}	4.57×10^{-5}	4.62×10^{-5}

* 68°F, 29.92 "Hg (20°C, 760 mm Hg)

$$V_s = \frac{528\ (V_F - 25)}{29.92} \left[\frac{P_F}{T_F + 460} - \frac{P_I}{T_I + 460} \right] = \text{ml}$$

$$\text{ppm } NO_2 = \frac{523 \times \mu g\ NO_2}{V_s} = \text{ppm}$$

$$C_{NO_2} = \frac{\mu g\ NO_2}{V_s} \times \frac{1\ \text{lb/ft}^3}{1.6 \times 10^4\ \mu g/\text{ml}} = 6.243 \times 10^{-5} \frac{\mu g\ NO_2}{V_s} = \text{lbs/dscf}$$

METCO

NO_x EMISSION DATA

Job Number 83-69

Client Lehigh Portland Cement Company

Unit Tested Kiln Baghouse Stack

Date 8/2/83

Run Number 3

Flask Number	49	50	51	52	Average
Time	1412	1427	1442	1457	
Initial Barometric Pressure, "Hg Abs.	29.45	29.45	29.45	29.45	
Initial Manometer Reading, "Hg Abs.	-28.20	-28.00	-28.20	-28.10	
P_I - Initial Pressure of Flask, "Hg Abs.	1.25	1.45	1.25	1.35	
T_I - Initial Temperature of Flask, °F	102	100	100	102	
V_F - Volume of Flask, ml	2034	2055	2036	2071	
Final Barometric Pressure, "Hg Abs.	29.60	29.60	29.60	29.60	
Final Manometer Reading, "Hg Abs.	-2.20	-1.80	-2.30	-1.00	
P_F - Final Pressure of Flask, "Hg Abs.	27.40	27.80	27.30	28.60	
T_F - Final Temperature of Flask, °F	85	84	85	85	
μgNO_2 - micrograms of NO_2	1207.7	1220.4	1110.2	1237.3	
V_s - Volume of sample at conditions*, ml	1704	1738	1698	1808	
ppm NO_2 - Concentration of NO_2, ppm	370.8	367.3	341.9	357.9	359.5
C_{NO_2} - Emission Rate of NO_2, lbs/dscf*	4.43×10^{-5}	4.38×10^{-5}	4.08×10^{-5}	4.27×10^{-5}	4.29×10^{-5}

* 68°F, 29.92 "Hg (20°C, 760 mm Hg)

$$V_s = \frac{528\ (V_F - 25)}{29.92} \left[\frac{P_F}{T_F + 460} - \frac{P_I}{T_I + 460} \right] = \text{ml}$$

$$\text{ppm } NO_2 = \frac{523 \times \mu g\ NO_2}{V_s} = \text{ppm}$$

$$C_{NO_2} = \frac{\mu g\ NO_2}{V_s} \times \frac{1\ lb/ft^3}{1.6 \times 10^4\ \mu g/ml} = 6.243 \times 10^{-5} \frac{\mu g\ NO_2}{V_s} = \text{lbs/dscf}$$

METCO

SOURCE EMISSIONS SURVEY
LEHIGH PORTLAND CEMENT COMPANY
WACO, TEXAS
FILE NUMBER 83-69

SOURCE EMISSIONS CALCULATIONS

Clinker Cooler Stack

Symbol	Description	Units	1	2	3
Run No.			1	2	3
Date			8/3/83	8/3/83	8/3/83
Begin			0905	1109	1315
End			1013	1241	1426
P_b	barometric pressure	"Hg Abs. (mm Hg)	29.60 (752)	29.60 (752)	29.60 (752)
P_m	orifice pressure drop	"H_2O (mm H_2O)	0.898 (22.8)	2.211 (56.2)	2.117 (53.8)
V_m	volume dry gas sampled @ meter conditions	$ft.^3$ (m^3)	35.261 (0.998)	54.498 (1.543)	53.511 (1.515)
T_m	avg. gas meter temp.	°F (°C)	92 (33)	95 (35)	95 (35)
$V_{m_{std}}$	volume dry gas sampled @ standard conditions*	dscf (dscm)	33.447 (0.947)	51.582 (1.461)	50.637 (1.434)
V_w	total H_2O collected, impingers & silica gel	ml	18.1	25.8	31.8
$V_{w_{gas}}$	volume water vapor collected @ standard conditions*	scf (scm)	0.854 (0.024)	1.218 (0.034)	1.501 (0.043)
%M	moisture in stack gas by volume	%	2.49	2.31	2.88

* 68°F, 29.92 "Hg (20°C, 760 mm Hg)

METCO

Source Emissions Calculations

Lehigh Portland Cement Company
Clinker Cooler Stack
File Number 83-69

Symbol	Description	Units			
M_d	mol fraction of dry gas	----	0.9751	0.9769	0.9712
CO_2		%	0.0	0.0	0.0
O_2		%	20.8	20.8	20.8
N_2		%	79.2	79.2	79.2
%EA	excess air @ sampling point	%	------	------	------
MW_d	molecular weight of dry stack gas	lb/lb-mole (g/g-mole)	28.83 (28.83)	28.83 (28.83)	28.83 (28.83)
MW	molecular weight of stack gas	lb/lb-mole (g/g-mole)	28.56 (28.56)	28.58 (28.58)	28.52 (28.52)
ΔP_s	velocity head of stack gas	"H_2O (mm H_2O)	0.285 (7.2)	0.302 (7.7)	0.277 (7.0)
T_s	stack temperature	°F (°C)	227 (108)	214 (101)	239 (115)
P_s	stack pressure	"Hg Abs. (mm Hg)	29.59 (752)	29.58 (751)	29.59 (752)
V_s	stack velocity @ stack conditions	fpm (m/sec)	2,020 (10.26)	2,057 (10.45)	2,005 (10.19)
A_s	stack area	$in.^2$ (m^2)	3,987 (2.57)	3,987 (2.57)	3,987 (2.57)
Q_s	dry stack gas volume @ standard conditions*	DSCFM (dscm/hr)	41,604 (70,685)	43,249 (73,480)	40,424 (68,680)
Q_a	actual stack gas volume @ stack conditions	ACFM (m^3/hr)	55,941 (95,044)	56,955 (96,767)	55,515 (94,320)

* 68°F, 29.92 "Hg (20°C, 760 mm Hg)

METCO

Source Emissions Calculations

Lehigh Portland Cement
Clinker Cooler Stack
File Number 83-69

Symbol	Description	Units			
T_t	net time of test	min.	64	64	64
D_n	sampling nozzle diam.	in. (m)	0.251 (0.006)	0.312 (0.008)	0.312 (0.008)
%I	percent isokinetic	%	101.6	97.5	102.4
m_f	particulate - probe, cyclone and filter	mg	47.0	59.6	35.9
m_t	particulate - total	mg	48.9	62.3	42.6
C_{an}	particulate - probe, cyclone and filter	gr/dscf* (g/dscm)	0.0216 (0.0496)	0.0178 (0.0407)	0.0109 (0.0250)
C_{ao}	particulate - total	gr/dscf* (g/dscm)	0.0225 (0.0516)	0.0186 (0.0426)	0.0130 (0.0297)
C_{at}	particulate - probe, cyclone and filter @ stack conditions	gr/cf (g/m^3)	0.0160 (0.0367)	0.0135 (0.0308)	0.0079 (0.0181)
C_{au}	particulate total @ stack conditions	gr/cf (g/m^3)	0.0167 (0.0382)	0.0141 (0.0322)	0.0094 (0.0215)
C_{aw}	particulate - probe, cyclone and filter	lbs/hr (kg/hr)	7.7 (3.5)	6.6 (3.0)	3.8 (1.7)
C_{ax}	particulate - total	lbs/hr (kg/hr)	8.0 (3.6)	6.9 (3.1)	4.5 (2.0)

* 68°F, 29.92 "Hg (20°C, 760 mm Hg)

METCO

APPENDIX C

Calibration Data

Equipment	Calibration Factor	Calibration Date
Pitot Tube #9	0.819	5/ 4/83
Probe Tip #II-3	0.251	7/14/83
Probe Tip #II-5	0.312	7/14/83
Dry Gas Meter #1	1.029	5/13/83
Stack Unit Orifice #1		6/27/83
Digital Temperature Indicator #1		7/18/83
Barometer #2		6/ 3/83

PITOT TUBE CALIBRATION

Date: 5-4-83

Pitot No. 9 (10')

Time: 10:38

P_b: 29.43 "Hg P_s: — "H_2O

T_s: 80° °F C_{pstd}: .99

Motor Setting	fps mark	CALIBRATOR STANDARD START	CALIBRATOR STANDARD END	$\sqrt{\text{STANDARD AVERAGE}}$	HIGH	$\sqrt{\text{HIGH}}$	CAL. FACTOR	LOW	$\sqrt{\text{LOW}}$	CAL. FACTOR
31	10	—	—	—	—	—	—	—	—	—
39	20	.110	.110	.332	.160	.400	.822	.165	.406	.810
48	30	.250	.245	.497	.365	.604	.815	.365	.604	.815
55	40	.415	.415	.644	.610	.781	.816	.615	.784	.813
63	50	.645	.645	.803	.950	.975	.815	.960	.980	.811
70	60	.880	.875	.937	1.25	1.118	.830	1.30	1.140	.814
76	70	1.05	1.10	1.037	1.55	1.245	.825	1.60	1.265	.812
84	80	1.40	1.40	1.183	2.1	1.449	.808	2.15	1.466	.798
100	90	1.65	1.70	1.294	2.45	1.565	.818	2.45	1.565	.818
Average							.819			.812

Summary of Results:

Normal high side calibration factor .819

variation -1.34, +1.34

Normal low side calibration factor .812

variation -1.72, +.74

Jim Biela

Signature of Calibrator

METCO

NOZZLE CALIBRATION

Nozzle Set No. II

Date: 7-14-83 Calibrator: Jim Biela

	1	2	3	4	5
Reading 1	0.183	0.131	0.251	0.247	0.311
Reading 2	0.182	0.130	0.250	0.246	0.313
Reading 3	0.183	0.129	0.251	0.246	0.313
Reading 4	0.184	0.130	0.251	0.245	0.312
Reading 5	0.184	0.129	0.252	0.246	0.311
Reading 6	0.183	0.129	0.250	0.245	0.312
Reading 7	0.183	0.130	0.251	0.247	0.312
Reading 8	0.182	0.130	0.250	0.245	0.311
Reading 9	0.183	0.131	0.251	0.246	0.313
Reading 10	0.183	0.130	0.251	0.246	0.312
Average	0.183	0.130	0.251	0.246	0.312

	6	7	8	9	10
Reading 1	0330	0.352	0.418	0.502	0.502
Reading 2	0329	0.353	0.421	0.500	0.503
Reading 3	0.328	0.351	0.420	0.499	0.501
Reading 4	0.328	0.352	0.420	0.500	0.501
Reading 5	0.328	0.352	0.421	0.502	0.502
Reading 6	0.327	0.353	0.418	0.502	0.500
Reading 7	0.327	0.352	0.418	0.500	0.501
Reading 8	0.328	0.352	0.421	0.501	0.501
Reading 9	0.330	0.351	0.420	0.499	0.503
Reading 10	0.329	0.351	0.420	0.500	0.501
Average	0.328	0.352	0.420	0.501	0.502

METCO

DRY GAS METER CALIBRATION

Meter Number: 1 Calibrator: Don C Alford

Date: 5/13/83

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

Run No.: 1 P_b: 29.32 "Hg

Control Module Vacuum 4.5 "Hg

	WET TEST METER				DRY GAS METER			
	Time	Meter Reading	Temp.	P_m	Meter Reading	Temp. In	Temp. Out	P_m
End	1218	15.001 cf	75 °F	-0.85 "H_2O	534.386 cf	80 °F	79 °F	0.50 "H_2O
Start	1142	0.000 cf	74 °F	0.85 "H_2O	520.002 cf	79 °F	78 °F	0.50 "H_2O
	36	15.001 cf	°F	"H_2O	14.384 cf	79 °F	°F	"H_2O

Wet Test Meter $V_{m_{std}}$ = $17.65 \times 15.001 \left(\frac{29.32 + \frac{-0.80}{13.6}}{74.5 + 460} \right) \times \underset{(C_f)}{0.998} = 14.466$ dscf

Dry Gas Meter $V_{m_{std}}$ = $17.65 \times 14.384 \left(\frac{29.32 + \frac{0.50}{13.6}}{79 + 460} \right) = 13.827$ dscf

$$C_{DG} = \frac{14.466}{13.827} = \boxed{1.046}$$

Avg. C_{DG} = 1.029

METCO

DRY GAS METER CALIBRATION

Meter Number: 1 Calibrator: Don C Aldridge

Date: 5/13/83

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

Run No.: 2 P_b: 29.32 "Hg

Control Module Vacuum 5.2 "Hg

	WET TEST METER				DRY GAS METER			
	Time	Meter Reading	Temp.	P_m	Meter Reading	Temp. In	Temp. Out	P_m
End	1325	18.000 cf	75 °F	-1.30 "H_2O	574.75 cf	82 °F	80 °F	1.00 "H_2O
Start	1254 27	0.000 cf	75 °F	-1.30 "H_2O	557.40 cf 17,352	92 °F 81	80 °F	1.00 "H_2O
		cf	°F	"H_2O	cf	°F	°F	"H_2O

Wet Test Meter $V_{m_{std}}$ = 17.65 x 18.000 $\left(\frac{29.32 + \frac{-1.30}{13.6}}{75 + 460}\right)$ x 0.998 (C_f) = dscf

Dry Gas Meter $V_{m_{std}}$ = 17.65 x 17.352 $\left(\frac{29.32 + \frac{1.00}{13.6}}{81 + 460}\right)$ 16.640 = dscf

$$C_{DG} = \frac{17.320}{16.640} = \boxed{1.041}$$

METCO

DRY GAS METER CALIBRATION

Meter Number: 1 Calibrator: Dan C Alexander

Date: 5/13/83

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

Run No.: 3 P_b: 29.30 "Hg

Control Module Vacuum 6.2 "Hg

	WET TEST METER				DRY GAS METER			
	Time	Meter Reading	Temp.	P_m	Meter Reading	Temp. In	Temp. Out	P_m
End	1354	19,000 cf	75 °F	"H_2O	593,372 cf	81 °F	79 °F	1.50 "H_2O
Start	1326	0.000 cf	25 °F	-1.90 "H_2O	575.002 cf	82 °F	80 °F	1.50 "H_2O
		19,000 cf	°F	"H_2O	18,370 cf	°F	°F	"H_2O

Wet Test Meter $V_{m_{std}}$ = 17.65 x 19.000 $\left(\frac{29.30 - 1.90}{75 + 460}\right)$ x 0.998 (C_f) = dscf

Dry Gas Meter $V_{m_{std}}$ = 17.65 x 18.370 $\left(\frac{29.30 + 1.50}{80 + 460}\right)$ = 17.659 dscf

$$C_{DG} = \frac{18.242}{17.659} = \boxed{1.033}$$

METCO

DRY GAS METER CALIBRATION

Meter Number: 1 Calibrator: Dan C Oleksuk

Date: 5/13/83

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

Run No.: 4 P_b: 29.29 "Hg

Control Module Vacuum 6.0 "Hg

	WET TEST METER				DRY GAS METER			
	Time	Meter Reading	Temp.	P_m	Meter Reading	Temp. In	Temp. Out	P_m
End		1423 22.750 cf	75 °F	-2.30 "H_2O	616.131 cf	82 °F	79 °F	"H_2O
Start	1355	0.000 cf	75 °F	-2.30 "H_2O	594.100 cf	80 °F	79 °F	2.00 "H_2O
		22.750 cf	°F	"H_2O	22.031 cf	80 °F	°F	"H_2O

$$\text{Wet Test Meter } V_{m_{std}} = 17.65 \times 22.750 \left(\frac{29.29 - 2.30 / 13.6}{75 + 460} \right) \times \underset{(C_f)}{0.998} = 21.813 \text{ dscf}$$

$$\text{Dry Gas Meter } V_{m_{std}} = 17.65 \times \left(\frac{29.29 + 2.00 / 13.6}{80 + 460} \right) = 21.197 \text{ dscf}$$

$$C_{DG} = \frac{21.813}{21.197} = \boxed{1.029}$$

METCO

DRY GAS METER CALIBRATION

Meter Number: 1 Calibrator: Don C Alexander

Date: 5/13/83

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

Run No.: 5 P_b: 29.30 "Hg

Control Module Vacuum 6.0 "Hg

	WET TEST METER				DRY GAS METER			
	Time	Meter Reading	Temp.	P_m	Meter Reading	Temp. In	Temp. Out	P_m
End	1456	24.253 cf	75 °F	-3.20 "H_2O	640.167 cf	82 °F	80 °F	"H_2O
Start	1435	0.000 cf	75 °F	-3.20 "H_2O	616.504 cf	83 °F	80 °F	3.00 "H_2O
		24.253 cf	°F	"H_2O	23.663 cf	°F	°F	"H_2O

Wet Test Meter $V_{m_{std}}$ = 17.65 x 24.253 $\left(\frac{29.30 + \frac{-3.20}{13.6}}{75 + 460}\right)$ x 0.998 (C_f) = 23.009 dscf

Dry Gas Meter $V_{m_{std}}$ = 17.65 x 23.663 $\left(\frac{29.30 + \frac{3.00}{13.6}}{81 + 460}\right)$ = 22.790 dscf

$$C_{DG} = \frac{23.209}{22.790} = \boxed{1.018}$$

METCO

DRY GAS METER CALIBRATION

Meter Number: 1 Calibrator: Don C Alexander

Date: 5/13/83

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

Run No.: 6 P_b: 29.29 "Hg

Control Module Vacuum 6.2 "Hg

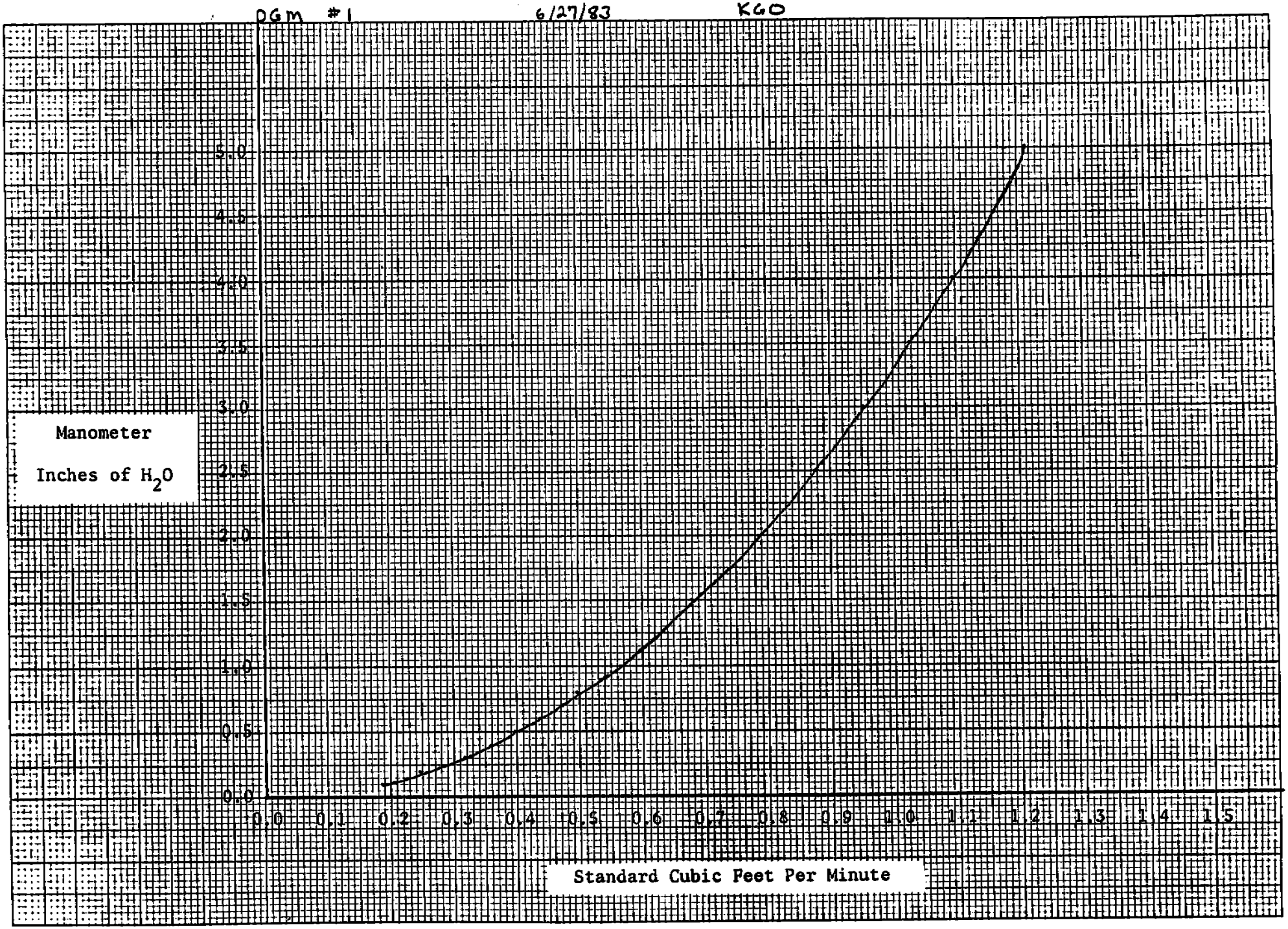
	WET TEST METER				DRY GAS METER				
	Time	Meter Reading	Temp.	P_m	Meter Reading	Temp. In	Temp. Out	P_m
End	1515	27.002 cf	75 °F	-4.10 "H_2O	667.036 cf	83 °F	80 °F	4.00 "H_2O
Start	1452	0.000 cf	75 °F	-4.10 "H_2O	640.503 cf	82 °F	80 °F	4.00 "H_2O
		27.002 cf	°F	"H_2O	26.533 cf	°F	°F	"H_2O

Wet Test Meter $V_{m_{std}}$ = $17.65 \times 27.002 \left(\frac{29.29 + \frac{-4.10}{13.6}}{75 + 460} \right) \times \underset{(C_f)}{0.998} = 25.772$ dscf

Dry Gas Meter $V_{m_{std}}$ = $17.65 \times 26.533 \left(\frac{29.29 + \frac{4.00}{13.6}}{81 + 460} \right) = 25.609$ dscf

$$C_{DG} = \frac{25.772}{25.609} = \boxed{1.006}$$

DGM #1 6/27/83 KGO



METCO

DIGITAL TEMPERATURE INDICATOR NO. 1

CALIBRATION DATA

Date: 7/18/83

Media	Time	Mercury Thermometer (°F)	DTI (°F)
Ice Bath	1432	33	33
Ambient Air	1420	79	78
Boiling Water	1450	211	212
Oven	1505	165	163
Oven	1525	260	259
Oven	1537	378	376
Oven	1543	446	446

Meter Adjusted? Yes _____ No ✓

Douglas R Scalf
Signature of Calibrator

METCO

BAROMETER CALIBRATION

Barometer No. 2

Date: 6/3/83

Time: 1037

Barometric Pressure @ Addison Field @ 719 ft.	=	29.840
	-	0.719
Absolute Pressure at Addison Field	=	29.121
	+	0.076
Absolute Pressure @ METCO @ 643 ft.	=	29.197
Barometer Reading	=	29.180
Variation	=	0.017

Barometer Adjusted? Yes ~ No ____

Larry M Wilburn
Signature of Calibrator

METCO

APPENDIX D

Field Testing Data

MILLINS ENVIRONMENTAL TESTING CO., INC.

Job No. 83-61 — East, 502 — FIELD DATA

Job Name Lehigh Portland Cement Co.

Run No. 1

Location Waco, TX Kiln Stack

Date 2 August 1983

Operator Williams, Biela, Mullins

Sample Box No. 4 Meter Box No. 1

Read and record at the start of each test point.

Purge to: 516.530

Purge time: 1021-1025

Ambient Temp. °F 86

Assumed Moisture % 7

Probe Length 10'

C Factor — 23.5 to reference

Initial Leak @ 16.0 "Hg = 0.003 cfm

Final Leak @ 8.0 "Hg = 0.000 cfm

Point	Clock Time	Dry Gas Meter, CF	Pitot in. H_2O (ΔP_s)	Orifice ΔH in. H_2O		Pump Vacuum In. Hg Gauge (P_m)	Stack Temp. °F (T_s)	Probe Temp. °F	Oven Temp. °F	Effluent Temp. °F	Dry Gas Temp. °F (T_m)		Remarks
				Desired	Actual						Inlet	Outlet	
B-24	839	460.638	0.44	1.05	1.05	4.5	344	249	255	~~100~~ 87	89	90	
23	841	461.795	0.44	1.05	1.05	4.5	350	249	258	80	89	90	
22	843	462.931	0.52	1.20	1.20	5.0	355	247	242	76	90	90	
21	845	464.095	0.55	1.30	1.30	5.0	357	248	243	74	91	91	
20	847	465.309	0.55	1.30	1.30	5.0	358	249	244	71	91	92	
19	849	466.526	0.53	1.25	1.25	5.0	359	251	245	71	92	92	
18	851	467.741	0.48	1.15	1.15	4.5	360	254	244	71	93	93	
17	853	468.020	0.47	1.10	1.10	4.5	360	252	245	71	94	95	
16	855	470.074	0.47	1.10	1.10	4.5	359	250	245	72	95	95	
15	857	471.241	0.45	1.05	1.05	4.5	358	251	244	72	96	96	
14	859	472.350	042	1.00	1.00	4.0	357	254	241	68	97	97	
13	901	473.464	0.35	0.84	0.84	3.5	356	258	244	68	97	98	ORSAT
12	903	474.505	0.35	0.84	0.84	3.5	356	250	244	69	98	99	
11	905	475.530	0.36	0.85	0.85	3.5	355	247	255	68	99	100	
10	907	476.554	0.39	0.92	0.92	4.0	356	252	248	69	100	101	
9	909	477.620	0.40	0.95	0.95	4.0	356	253	241	70	100	101	
8	911	478.695	0.46	1.10	1.10	4.5	356	249	245	69	101	102	
7	913	479.835	0.49	1.15	1.15	4.5	356	250	246	69	102	103	

Pitot Tube Calibration Factor C_p 0.819

Volume Collected V_m 55.351 ft^3

Water Collected V_w 80.9 ml

Time of Test T_t 96 min.

Stack Pressure P_s -0.25 "H_2O

Baro. Press. P_b 29.62 "Hg

Probe Tip Dia. D_n 0.251 in.

% CO_2 6.6 % CO 0.0

% O_2 15.7 % N_2 77.7

Area Stack A_s 11322 in^2

Pitot Tube No. 9 Barometer No. 2

Probe Tip No. II-3

V_m = Dry Gas Meter Calibration Factor 1.029 X 53.791 [Dry Gas Meter Reading ____ ft^3 - (T_t ____ min X Leak Rate ____ cfm)]

M_F = _____ M_T = _____

Impinger Box No. 4

Impinger 1	Final Weight	627.7
	Initial Weight	647.6
	Increase	-19.9
Impinger 2	Final Weight	767.2
	Initial Weight	701.6
	Increase	65.6
Impinger 3	Final Weight	695.5
	Initial Weight	676.6
	Increase	18.9
Impinger 4	Final Weight	482.2
	Initial Weight	481.2
	Increase	1.0
Impinger 5	Final Weight	782.6
	Initial Weight	767.0
	Increase	15.6
Impinger 6	Final Weight	
	Initial Weight	
	Increase	

Filter # ____ Final Weight ____ Initial Weight ____ Increase ____

Water Weight Gain

Impinger 1	-19.9
Impinger 2	65.6
Impinger 3	18.9
Impinger 4	1.0
Impinger 5	15.6
Impinger 6	
Total	81.2 ✓ = V_w

V_w = 81.2
g SO_2 = -0.3
V_w = 80.9 ✓

P_b	29.62 ✓	%CO_2	6.2, 7.0 - 6.6 Avg
V_m	55.351 ✓	%O_2	15.8 15.6 15.7
V_w	80.9 ✓	%CO	0.0 0.0 0.0
P_m	1.040 ✓	%N_2	78.0 77.4 77.7
Avg ΔP	0.942 ✓	A_s	11322 ✓
Avg $\sqrt{\Delta P}$	0.663 ✓	D_n	0.251 ✓
C_p	0.819 ✓	T_t	96 ✓
P_s	-0.25 ✓ "H_2O	29.60	"Hg ✓
T_m	102 ✓ °F	562	°R ✓
T_s	359 ✓ °F	819	°R ✓

Moisture Content: %M = 6.94 (89) ✓ M_d = 0.9309 (11) ✓ MW_d = 29.684 ✓ MW = 28.88 ✓

$$V_{m_{std}} = 17.65\ V_m \left(\frac{P_b + \frac{P_m}{13.6}}{T_m + 460} \right) = 17.65 \times 55.351 \left(\frac{29.62 + \frac{1.040}{13.6}}{102 + 460} \right) = 51.622 \text{ sft}^3 \checkmark$$

0.538 scfm

$$V_{w_{gas}} = 0.0472 \times V_w = 0.0472 \times \frac{80.9}{81.2} = 3.833\ (18) \checkmark \text{ sft}^3$$

$$\% \text{ Moisture} = \frac{V_{w_{gas}}}{V_{m_{std}} + V_{w_{gas}}} \times 100 = \frac{3.833\ (18)}{51.622 + 3.833\ (18)} \times 100 = 6.94\ (89) \checkmark \%$$

$$V_s = 5123.8 \times 0.819 \sqrt{\frac{819}{29.60 \times 28.88}} \times 0.663 = 2723 \checkmark \text{ fpm}$$

ACFM: 214,115 ✓

SCFM: 127,584 (609) ✓

$$\%I = \frac{1039 \times 51.622 \times 819}{0.9309\ (11) \times 29.60 \times 2723 \times 96 \times (0.251)^2} = 96.8 \checkmark \%$$

%EA: 321.0 ✓

Run No. 1

PARTICULATE FIELD DATA

Location KILN STACK

Date AUGUST 2, 1983

			ΔP_s	P_m		T_s					T_m		
Point	Clock Time	Dry Gas Meter, CF	Pitot in. H_2O	Orifice ΔH in. H_2O		Pump Vacuum In. Hg Gauge	Stack Temp. °F	Probe Temp. °F	Oven Temp. °F	Effluent Temp. °F	Dry Gas Temp. °F		Remarks
				Desired	Actual						Inlet	Outlet	
B-6	915	480.992	0.52	1.20	1.20	5.0	356	248	255	69	103	104	
5	917	482.179	0.51	1.20	1.20	5.0	356	247	256	69	104	105	
4	919	483.370	0.50	1.15	1.15	5.0	355	245	252	69	104	105	
3	921	484.569	0.51	1.20	1.20	5.0	355	243	245	70	105	106	
2	923	485.745	0.47	1.10	1.10	4.5	353	244	244	70	106	107	
1	926	486.860	0.30	0.70	0.70	3.0	338	241	244	70	105	107	Pump off 925
End	928	487.948	-	-	-	-	-	-	-	-	-	-	Pump on 926
A-24	930	487.948	0.33	0.78	0.78	3.5	346	252	255	72	103	107	
23	932	488.948	0.33	0.78	0.78	3.5	353	251	255	71	104	107	
22	934	489.944	0.36	0.85	0.85	4.0	354	259	255	70	104	107	
21	936	490.969	0.38	0.90	0.90	4.0	356	253	255	67	104	107	
20	938	492.004	0.40	0.95	0.95	4.0	358	256	258	66	104	106	
19	940	493.069	0.38	0.90	0.90	4.0	359	257	256	65	104	106	
18	942	494.130	0.38	0.90	0.90	4.0	359	256	257	65	104	106	
17	944	495.183	0.38	0.90	0.90	4.0	359	252	258	64	104	106	
16	946	496.240	0.38	0.90	0.90	4.0	359	251	249	64	104	106	
15	948	497.284	0.38	0.90	0.90	4.0	361	255	247	64	105	107	
14	950	498.331	0.36	0.85	0.85	4.0	361	257	246	66	105	107	
13	952	499.368	0.33	0.78	0.78	3.5	362	258	245	66	105	107	ORSAT
12	954	500.369	0.45	1.05	1.05	4.5	366	253	244	65	105	107	
11	956	501.466	0.45	1.05	1.05	4.5	367	254	245	65	105	107	
10	958	502.602	0.45	1.05	1.05	4.5	370	255	246	64	106	108	
9	1000	503.745	0.47	1.10	1.10	4.5	370	256	249	64	107	108	
8	1002	504.879	0.50	1.15	1.15	5.0	372	256	253	64	107	108	
7	1004	506.064	0.53	1.25	1.25	5.0	373	254	256	64	108	109	
6	1006	507.229	0.55	1.30	1.30	5.0	373	252	255	64	108	109	
5	1008	508.459	0.55	1.30	1.30	5.0	373	250	256	64	109	110	
4	1010	509.685	0.53	1.25	1.25	5.0	372	248	256	64	109	110	
3	1012	510.920	0.53	1.25	1.25	5.0	372	248	256	64	109	110	
2	1014	512.139	0.50	1.15	1.15	5.0	370	247	256	65	110	111	
1	1016	513.339	0.38	0.90	0.90	4.0	363	245	257	66	110	111	
End Run	1018	514.429	-	-	-	-	-	-	-	-	-	-	

MULLINS ENVIRONMENTAL TESTING CO., INC.

Job No. 83-69 PARTICULATE/SO2 FIELD DATA

Job Name LEHIGH PORTLAND CEMENT CO.

Run No. 2

Location KILN STACK

Date AUGUST 2, 1983

Operator WILLIAMS, BIGLA, MULLINS Jr.

Sample Box No. 5 Meter Box No. 1

Read and record at the start of each test point.

Purge to: 524.739

Purge time: 1244-1248

Ambient Temp. °F 96

Assumed Moisture % 7%

Probe Length 10'

C Factor 25.0 ~ to reference

Initial Leak @ 15.5 "Hg = 0.002 cfm

Final Leak @ 15.0 "Hg = 0.002 cfm

Point	Clock Time	Dry Gas Meter, CF	Pitot in. H_2O	Orifice ΔH in. H_2O		Pump Vacuum In. Hg Gauge	Stack Temp. °F	Probe Temp. °F	Oven Temp. °F	Effluent Temp. °F	Dry Gas Temp. °F		Remarks
				Desired	Actual						Inlet	Outlet	
			ΔP_s			P_m	T_s				T_m		
A-24	1100	516.855	0.35	0.88	0.88	4.0	350	245	247	72	101	105	
23	1102	517.905	0.37	0.94	0.94	4.2	355	251	245	71	102	105	
22	1104	518.992	0.35	0.88	0.88	4.0	358	246	247	69	102	105	
21	1106	520.048	0.38	0.95	0.95	4.2	359	251	249	69	103	105	
20	1108	521.134	0.37	0.94	0.94	4.2	361	252	250	68	103	105	
19	1110	522.231	0.35	0.88	0.88	4.0	361	258	255	68	104	106	
18	1112	523.269	0.37	0.94	0.94	4.2	362	257	256	68	105	107	
17	1114	524.411	0.35	0.88	0.88	4.0	363	258	258	68	106	108	
16	1116	525.425	0.35	0.88	0.88	4.0	364	255	254	68	107	108	
15	1118	526.491	0.34	0.86	0.86	4.0	364	252	256	69	107	109	
14	1120	527.480	0.35	0.88	0.88	4.0	365	252	256	69	108	110	
13	1122	528.510	0.34	0.86	0.86	4.0	366	245	255	69	109	110	ORSAT
12	1124	529.605	0.39	0.98	0.98	4.0	367	258	256	69	110	112	
11	1126	530.935	0.45	1.15	1.15	4.5	368	259	259	68	110	112	
10	1128	531.775	0.45	1.16	1.15	4.5	369	257	259	68	111	113	
9	1130	532.890	0.48	1.20	1.20	4.5	368	251	259	69	112	113	
8	1132	534.068	0.52	1.30	1.30	5.2	368	250	256	69	112	114	
7	1134	535.235	0.52	1.30	1.30	5.2	369	250	248	70	113	115	

Pitot Tube Calibration Factor C_p 0.819

Volume Collected V_m 57.397 ft^3

Water Collected V_w 110.7 ml

Time of Test T_t 96 min.

Stack Pressure P_s -0.34 "H_2O

Baro. Press. P_b 29.60 "Hg

Probe Tip Dia. D_n 0.251 in.

% CO_2 9.9 % CO 0.0

% O_2 15.1 % N_2 77.0

Area Stack A_s 11322 in^2

Pitot Tube No. 9 Barometer No. 2

Probe Tip No. II-3

V_m = Dry Gas Meter Calibration Factor 1.029 X 55.779 [Dry Gas Meter Reading ____ ft^3 - (T_t ____ min X Leak Rate ____ cfm)]

M_F = ____ M_T = ____

Impinger Box No. 5

Impinger 1	Final Weight	649.3
	Initial Weight	645.0
	Increase	4.3
Impinger 2	Final Weight	752.9
	Initial Weight	687.2
	Increase	65.7
Impinger 3	Final Weight	707.8
	Initial Weight	684.6
	Increase	23.2
Impinger 4	Final Weight	477.4
	Initial Weight	476.3
	Increase	1.1
Impinger 5	Final Weight	815.0
	Initial Weight	798.3
	Increase	16.7
Impinger 6	Final Weight	
	Initial Weight	
	Increase	

Filter # ____ Final Weight ____ Initial Weight ____ Increase ____

Water Weight Gain

V_w = 111.0
g SO_2 = -0.3
V_w = 110.7

Impinger 1	4.3
Impinger 2	65.7
Impinger 3	23.2
Impinger 4	1.1
Impinger 5	16.7
Impinger 6	
Total	111.0 ✓ = V_w Avg

P_b = 29.60 ✓
V_m = 57.397 ✓
V_w = 110.7 ✓
P_m = 1.090 ✓
Avg ΔP = 0.436 ✓
Avg $\sqrt{\Delta P}$ = 0.657 ✓
C_p = 0.819 ✓
P_s = -0.34 ✓ "H_2O 29.57 "Hg ✓
T_m = 113 ✓ °F 573 °R ✓
T_s = 366 ✓ °F 826 °R ✓

$\%CO_2$ = 8.0, 7.8 — 7.9
$\%O_2$ = 14.8, 15.4 — 15.
%CO = 0.0, 0.0 — 0.0
$\%N_2$ = 77.2, 76.8 — 77
A_s = 11322 ✓
D_n = 0.251 ✓
T_t = 96 ✓

Moisture Content: %M = 9.08 (6) ✓ M_d = 0.9098 (4) ✓ MW_d = 29.868 ✓ MW = 28.79 ✓

$$V_{m_{std}} = 17.65\ V_m \left(\frac{P_b + \frac{P_m}{13.6}}{T_m + 460}\right) = 17.65 \times 57.397 \left(\frac{29.60 + \frac{1.090}{13.6}}{113 + 460}\right) = 52.474 \text{ sft}^3 \checkmark$$

0.547 ✓ scfm

$$V_{w_{gas}} = 0.0472 \times V_w = 0.0472 \times \frac{111.0}{0.7} = 5.239 \text{ (25)} \checkmark \text{ sft}^3$$

$$\% \text{ Moisture} = \frac{V_{w_{gas}}}{V_{m_{std}} + V_{w_{gas}}} \times 100 = \frac{5.239}{52.474 + 5.239} \times 100 = 9.08 \text{ (6)} \checkmark \%$$

$$V_s = 5123.8 \times 0.819 \sqrt{\frac{826}{29.57 \times 28.79}} \times 0.657 = 2716 \checkmark \text{ fpm}$$

ACFM: 213,523 ✓
SCFM: 123,107 (36) ✓
%EA: 284.6 ✓

$$\%I = \frac{1039 \times 52.474 \times 826}{0.9098 \times 29.57 \times 2716 \times 96 \times (0.251)^2} = 101.9 \text{ (1.9)} \checkmark \%$$

Run No. 2

Location Kiln Stack

Date August 2, 1983

PARTICULATE FIELD DATA

			ΔP_s	P_m			T_s				T_m		
Point	Clock Time	Dry Gas Meter, CF	Pitot in. H_2O	Orifice ΔH in. H_2O		Pump Vacuum In. Hg Gauge	Stack Temp. °F	Probe Temp. °F	Oven Temp. °F	Effluent Temp. °F	Dry Gas Temp. °F		Remarks
				Desired	Actual						Inlet	Outlet	
A-6	1134	536.540	0.51	1.25	1.25	5.2	369	252	241	69	113	115	
5	1138	537.774	0.56	1.40	1.40	5.8	369	258	247	70	114	116	
4	1140	539.074	0.56	1.40	1.40	5.8	368	258	244	70	114	116	
3	1142	540.340	0.56	1.40	1.40	5.8	369	255	246	70	114	116	
2	1144	541.622	0.50	1.25	1.25	5.6	369	259	246	71	115	117	
1	1146	542.911	0.36	0.90	0.90	4.5	361	256	248	71	115	117	
End	1148	544.011	-	-	-	-	-	-	-	-	-	-	
B-24	1150	544.011	0.40	1.00	1.00	4.8	352	259	258	79	113	117	
23	1152	545.174	0.48	1.20	1.20	4.8	365	255	259	79	114	117	
22	1154	546.295	0.51	1.25	1.25	4.8	370	247	252	78	114	117	
21	1156	547.444	0.52	1.30	1.30	5.2	373	244	257	77	114	117	
20	1158	548.639	0.60	1.50	1.50	6.0	373	245	241	77	115	117	
19	1200	549.952	0.56	1.40	1.40	6.0	373	245	247	76	115	117	
18	1202	551.252	0.54	1.35	1.35	6.0	373	242	248	76	115	118	
17	1204	552.558	0.54	1.35	1.35	6.0	373	245	247	76	115	118	
16	1206	553.874	0.51	1.25	1.25	6.0	373	248	241	76	115	118	
15	1208	555.814	0.40	1.00	1.00	5.0	375	254	249	76	116	118	Power Loss/Po
14	1212	556.939	0.40	1.00	1.00	5.0	372	252	255	77	114	118	Power ON 12
13	1214	558.063	0.37	0.93	0.93	4.5	371	256	255	78	114	119	ORSAT
12	1216	559.174	0.32	0.80	0.80	4.0	368	252	253	78	115	119	
11	1218	560.239	0.38	0.95	0.95	4.5	368	251	253	78	114	119	Power Loss 121
10	1220	561.175	0.38	0.95	0.95	4.5	368	251	254	78	114	119	Power on 121
9	1223	562.268	0.38	0.95	0.95	4.5	368	249	255	79	114	119	
8	1225	563.359	0.38	0.95	0.95	4.5	368	251	254	79	114	119	
7	1227	564.441	0.46	1.15	1.15	5.0	367	253	255	79	114	119	
6	1229	565.599	0.46	1.15	1.15	6.0	368	254	253	79	113	118	
5	1231	566.760	0.50	1.25	1.25	5.5	367	252	254	80	113	118	
4	1233	567.974	0.51	1.25	1.25	5.5	367	253	255	80	113	118	
3	1235	569.205	0.48	1.20	1.20	5.5	367	249	248	80	113	117	
2	1237	570.544	0.45	1.10	1.10	5.2	364	246	245	80	113	117	
1	1239	571.619	0.25	0.63	0.63	3.0	350	245	245	80	113	117	
End Run	1241	572.634	-	-	-	-	-	-	-	-	-	-	

MULLINS ENVIRONMENTAL TESTING CO., INC.

Job No. 83-69 PARTICULATE >02 FIELD DATA

Job Name LEHIGH PORTLAND CEMENT CO.

Run No. 3

Location KILN STACK

Date AUGUST 2, 1983

Operator WILLIAMS, BIGLER, MULLINS SR.

Sample Box No. 6 Meter Box No. 1

Read and record at the start of each test point.

Purge to: 633.690

Purge time: 1503-1507

Ambient Temp. °F 98

Assumed Moisture % 7%

Probe Length 10'

C Factor 25.0 - to reference

Initial Leak @ 17.0 "Hg = 0.002 cfm

Final Leak @ 9.0 "Hg = 0.000 cfm

Point	Clock Time	Dry Gas Meter, CF	Pitot in. H_2O (ΔP_s)	Orifice ΔH in. H_2O		Pump Vacuum In. Hg Gauge (P_m)	Stack Temp. °F (T_s)	Probe Temp. °F	Oven Temp. °F	Effluent Temp. °F	Dry Gas Temp. °F (T_m)		Remarks
				Desired	Actual						Inlet	Outlet	
B 24	1322	575.064	0.51	1.25	1.25	6.0	352	252	247	77	100	105	
23	1324	576.329	0.51	1.25	1.25	6.0	358	255	244	70	101	105	
22	1326	577.549	0.57	1.40	1.40	6.0	367	255	245	69	102	105	
21	1328	578.829	0.59	1.50	1.50	6.2	368	256	241	69	102	106	
20	1330	580.149	0.57	1.40	1.40	6.0	368	252	243	69	103	106	
19	1332	581.489	0.50	1.25	1.25	6.0	369	253	246	70	104	107	
18	1334	582.790	0.54	1.35	1.35	6.0	368	255	242	70	105	108	
17	1336	584.056	0.45	1.10	1.10	5.0	368	258	257	70	106	109	
16	1338	585.238	0.50	1.25	1.25	5.2	369	254	249	70	107	110	
15	1340	586.420	0.47	1.15	1.15	5.0	369	256	252	70	107	110	
14	1342	587.629	0.50	1.25	1.25	5.2	368	257	250	70	107	110	
13	1344	588.858	0.37	0.92	0.92	4.8	368	255	252	70	107	110	
12	1346	589.965	0.37	0.92	0.92	4.8	367	252	253	69	107	110	
11	1348	591.052	0.37	0.92	0.92	4.8	366	252	246	70	108	111	
10	1350	592.122	0.38	0.96	0.96	4.8	366	249	256	70	108	112	
9	1352	593.229	0.45	1.10	1.10	5.0	365	245	246	71	108	111	
8	1354	594.426	0.45	1.10	1.10	5.0	365	246	248	71	109	112	
7	1356	595.574	0.48	1.20	1.20	5.0	365	252	246	72	109	111	

Pitot Tube Calibration Factor C_p 0.819

Volume Collected V_m 58.062 ft^3

Water Collected V_w 103.1 ml

Time of Test T_t 96 min.

Stack Pressure P_s -0.25 "H_2O

Baro. Press. P_b 29.58 "Hg

Probe Tip Dia. D_n 0.261 in.

% CO_2 6.9 % CO 0.0

% O_2 15.6 % N_2 77.5

Area Stack A_s 11322 in^2

Pitot Tube No. 9 Barometer No. 2

Probe Tip No. II-3

V_m = Dry Gas Meter Calibration Factor 1.029 X 56.426

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

M_F = _____ M_T = _____

Impinger Box No. 6

Impinger 1	Final Weight	640.5
	Initial Weight	639.0
	Increase	1.5
Impinger 2	Final Weight	760.7
	Initial Weight	696.6
	Increase	64.1
Impinger 3	Final Weight	704.6
	Initial Weight	681.1
	Increase	23.5
Impinger 4	Final Weight	476.1
	Initial Weight	475.7
	Increase	0.4
Impinger 5	Final Weight	815.3
	Initial Weight	801.4
	Increase	13.9
Impinger 6	Final Weight	
	Initial Weight	
	Increase	

Filter # ____ Final Weight ____ Initial Weight ____ Increase ____

Water Weight Gain

V_w = 103.4
g SO_2 = - 0.3
V_w = 103.1

Impinger 1	1.5
Impinger 2	64.1
Impinger 3	23.5
Impinger 4	0.4
Impinger 5	13.9
Impinger 6	
Total	103.4 ✓ = V_w

P_b	29.58 ✓	%CO_2	7.0, 6.8 - 6.8
V_m	58.062 ✓	%O_2	15.4, 15.8 - 15.8
V_w	1.116 103.1 ✓	%CO	0.0, 0.0 - 0.0
P_m	1.116 ✓	%N_2	77.6, 77.4 - 77.4
Avg ΔP	0.448 ✓	A_s	11322 ✓
Avg $\sqrt{\Delta P}$	0.666 ✓	D_n	0.251 ✓
C_p	0.819 ✓	T_t	96 ✓
P_s	-0.25 ✓ "H_2O	29.56	"Hg ✓
T_m	108 ✓ °F	568	°R ✓
T_s	363 ✓ °F	823	°R ✓

Moisture Content: %M = 8.34 ✓ M_d = 0.9164 ✓ MW_d = 29.728 ✓ MW = 28.75 ✓

$$V_{m_{std}} = 17.65\ V_m \left(\frac{P_b + \frac{P_m}{13.6}}{T_m + 460} \right) = 17.65 \times 58062 \left(\frac{29.58 + \frac{1.116}{13.6}}{108 + 460} \right) = 53.517 \text{ sft}^3 \checkmark$$

0.557 ✓ scfm

$$V_{w_{gas}} = 0.0472 \times V_w = 0.0472 \times 103.1 = 4.866 \text{ sft}^3 \checkmark$$

$$\% \text{ Moisture} = \frac{V_{w_{gas}}}{V_{m_{std}} + V_{w_{gas}}} \times 100 = \frac{4.866}{4.866 + 53.517} \times 100 = 8.34 \checkmark \%$$

$$V_s = 5123.8 \times 0.819 \sqrt{\frac{823}{29.56 \times 28.75}} \times 0.666 = 2750 \checkmark \text{ fpm}$$

ACFM: 216,242 ✓

$$\%I = \frac{1039 \times 53.517 \times 823}{0.9164 \times 29.56 \times 2750 \times 96 \times (0.251)^2} = 101.6 \checkmark \%$$

SCFM: 126,052 ✓

%EA: 315.9 ✓

Run No. 3

Location Kiln Stack

Date August 2, 1983

PARTICULATE FIELD DATA

			ΔP_s	P_m			T_s				T_m		
Point	Clock Time	Dry Gas Meter, CF	Pitot in. H_2O	Orifice ΔH in. H_2O		Pump Vacuum In. Hg Gauge	Stack Temp. °F	Probe Temp. °F	Oven Temp. °F	Effluent Temp. °F	Dry Gas Temp. °F		Remarks
				Desired	Actual						Inlet	Outlet	
B 6	1358	596.762	0.48	1.20	1.20	5.2	364	250	248	71	109	112	
5	1400	597.939	0.45	1.10	1.10	5.0	364	255	252	71	109	112	
4	1402	599.147	0.48	1.20	1.20	5.2	363	250	252	72	110	112	
3	1404	600.346	0.48	1.20	1.20	5.2	363	252	254	72	110	112	
2	1406	601.546	0.46	1.15	1.15	5.2	363	252	255	72	110	113	
1	1408	602.742	0.31	0.78	0.78	4.0	342	258	253	72	110	113	
End	1410	603.772	-	-	-	-	-	-	-	-	-	-	
A-24	1412	603.772	0.31	0.78	0.78	4.0	355	256	258	76	108	112	
23	1414	604.789	0.35	0.88	0.88	4.0	358	258	252	74	107	112	
22	1416	605.808	0.38	0.95	0.95	4.5	358	252	252	69	107	111	
21	1418	606.888	0.38	0.95	0.95	4.5	358	253	252	67	107	110	
20	1420	607.982	0.36	0.90	0.90	4.5	360	255	252	66	106	110	
19	1422	609.065	0.38	0.95	0.95	4.5	360	253	248	64	106	109	
18	1424	610.164	0.38	0.95	0.95	4.5	360	257	252	63	106	110	
17	1426	611.254	0.35	0.88	0.88	4.2	359	256	254	63	106	109	
16	1428	612.382	0.37	0.93	0.93	4.5	360	259	249	64	106	109	
15	1430	613.545	0.35	0.88	0.88	4.5	360	249	248	65	106	109	
14	1432	615.054	0.35	0.88	0.88	4.5	362	250	249	65	106	109	
13	1434	615.635	0.35	0.88	0.88	4.5	362	251	250	65	107	109	
12	1436	616.1665	0.40	1.00	1.00	4.8	365	254	254	63	107	110	
11	1438	617.774	0.45	1.15	1.15	5.0	365	257	255	66	107	110	
10	1440	618.930	0.49	1.25	1.25	5.5	366	255	254	66	107	110	
9	1442	620.130	0.49	1.25	1.25	5.5	367	256	251	67	108	110	
8	1444	621.429	0.55	1.40	1.40	6.0	366	257	255	67	108	110	
7	1446	622.602	0.55	1.40	1.40	6.0	368	256	254	65	109	111	
6	1448	623.885	0.54	1.35	1.35	6.0	368	252	255	68	109	111	
5	1450	625.256	0.50	1.25	1.25	6.0	366	255	255	66	109	111	
4	1452	626.542	0.54	1.35	1.35	6.0	365	249	255	64	109	112	
3	1454	627.739	0.54	1.35	1.35	6.0	364	251	252	64	109	111	
2	1456	629.029	0.50	1.25	1.25	6.0	365	252	258	63	109	112	
1	1458	630.260	0.35	0.88	0.88	4.8	359	250	256	64	109	111	
End All	1500	631.490	-	-	-	-	-	-	-	-	-	-	

MULLINS ENVIRONMENTAL TESTING CO., INC.

Job No. 83-69 PARTICULATE & SO_2 FIELD DATA

Job Name LEHIGH PORTLAND CEMENT

Run No. 1

Location CLINKER COOLER

Date AUGUST 3, 1983

Operator WILLIAMS, BIELA, MULLINS JR.

Sample Box No. 4 Meter Box No. 1

Read and record at the start of each test point.

Purge to: -

Purge time: -

Ambient Temp. °F 72

Assumed Moisture % 2.5%

Probe Length 10'

C Factor 31.0 - to reference

Initial Leak @ 16.0 "Hg = 0.000 cfm

Final Leak @ 6.0 "Hg = 0.000 cfm

Point	Clock Time	Dry Gas Meter, CF	Pitot in. H_2O	Orifice ΔH in. H_2O		Pump Vacuum In. Hg Gauge	Stack Temp. °F	Probe Temp. °F	Oven Temp. °F	Effluent Temp. °F	Dry Gas Temp. °F		Remarks
				Desired	Actual						Inlet	Outlet	
				ΔP_s		P_m	T_s				T_m		
A-16	905	633.988	0.23	0.72	0.72	2.5	220	256	242	62	82	84	
15	907	634.935	0.26	0.82	0.82	3.0	226	257	241	59	83	84	
14	909	635.941	0.28	0.88	0.88	3.0	229	253	244	58	83	85	
13	911	636.993	0.28	0.88	0.88	3.0	228	251	249	57	84	86	
12	913	638.050	0.28	0.88	0.88	3.0	227	245	251	57	85	86	
11	915	639.169	0.28	0.88	0.88	3.0	228	246	251	57	85	87	
10	917	640.140	0.28	0.88	0.88	3.0	226	247	251	57	85	87	
9	919	641.200	0.28	0.88	0.88	3.0	228	250	254	58	86	88	
8	921	642.269	0.30	0.95	0.95	3.0	225	249	256	58	87	89	
7	923	643.422	0.30	0.95	0.95	3.0	227	249	255	58	88	90	
6	925	644.487	0.30	0.95	0.95	3.0	225	250	254	58	89	91	
5	927	645.598	0.30	0.95	0.95	3.0	226	248	252	58	90	92	
4	929	646.675	0.32	1.00	1.00	3.5	229	246	252	59	91	94	
3	931	647.791	0.32	1.00	1.00	3.5	227	246	253	59	92	95	
2	933	648.917	0.30	0.95	0.95	3.5	227	249	252	59	93	96	Pump off 934
1	936	650.000	0.24	0.76	0.76	3.0	222	250	251	60	93	97	Pump on 935
End	938	651.069	-	-	-	-	-	-	-	-	-	-	
B-16	941	651.069	0.30	0.95	0.95	3.5	221	251	246	62	92	98	

Pitot Tube Calibration Factor C_p 0.819

Volume Collected V_m 35.261 ft^3

Water Collected V_w 18.1 ml

Time of Test T_t 64 min.

Stack Pressure P_s ~~0.07~~ -0.07 "H_2O

Baro. Press. P_b 29.60 "Hg

Probe Tip Dia. D_n 0.251 in.

% CO_2 0.0 % CO 0.0

% O_2 20.8 % N_2 79.2

Area Stack A_s 3987 in^2

Pitot Tube No. 9 Barometer No. 2

Probe Tip No. T-3

V_m = Dry Gas Meter Calibration Factor 1.029 X 34.267 [Dry Gas Meter Reading ____ ft^3 - (T_t ____ min X Leak Rate ____ cfm)]

M_F = ____ M_T = ____

Impinger Box No. 4

Impinger 1	Final Weight	592.3
	Initial Weight	586.3
	Increase	6.0
Impinger 2	Final Weight	622.5
	Initial Weight	619.3
	Increase	3.2
Impinger 3	Final Weight	474.8
	Initial Weight	473.8
	Increase	1.0
Impinger 4	Final Weight	814.2
	Initial Weight	806.3
	Increase	7.9
Impinger 5	Final Weight	
	Initial Weight	
	Increase	
Impinger 6	Final Weight	
	Initial Weight	
	Increase	
Filter #	Final Weight	
	Initial Weight	
	Increase	

Water Weight Gain

Impinger 1	6.0
Impinger 2	3.2
Impinger 3	1.0
Impinger 4	7.9
Impinger 5	
Impinger 6	
Total	18.1 ✓ = V_w

V_w =
g SO_2 = -
V_w =

P_b =	29.60 ✓	%CO_2 =	0.0 ✓
V_m =	35.261 ✓	%O_2 =	20.8 ✓
V_w =	18.1 ✓	%CO =	0.0 ✓
P_m =	0.898 ✓	%N_2 =	79.2 ✓
Avg ΔP =	0.285 ✓	A_s =	3987 ✓
Avg $\sqrt{\Delta P}$ =	0.534 ✓	D_n =	0.251 ✓
C_p =	0.819 ✓	T_t =	64 ✓
P_s =	-0.07 ✓ "H_2O	29.59	"Hg ✓
T_m =	92 ✓ °F	552	°R ✓
T_s =	227 ✓ °F	687	°R ✓

Moisture Content: %M = 2.49 ✓ M_d = 0.9751 ✓ MW_d = 28.832 ✓ MW = 28.56 ✓

$$m_{std} = 17.65\ V_m \left(\frac{P_b + \frac{P_m}{13.6}}{T_m + 460} \right) = 17.65 \times 35.261 \left(\frac{29.60 + \frac{0.898}{13.6}}{92 + 460} \right) = 33.447\ ✓\ sft^3$$

$$0.523\ ✓\ scfm$$

$$V_{w_{gas}} = 0.0472 \times V_w = 0.0472 \times 18.1 = 0.854\ ✓\ sft^3$$

$$\% \text{ Moisture} = \frac{V_{w_{gas}}}{V_{m_{std}} + V_{w_{gas}}} \times 100 = \frac{0.854}{33.447 + 0.854} \times 100 = 2.49\ ✓\ \%$$

$$V_s = 5123.8 \times 0.819 \sqrt{\frac{687}{29.59 \times 28.56}} \times 0.534 = 2020\ ✓\ fpm$$

ACFM: 55,941 ✓

SCFM: 41,604 ✓

$$\%I = \frac{1039 \times 33.447 \times 687}{0.9751 \times 29.59 \times 2020 \times 64 \times (0.251)^2} = 101.6\ ✓\ \%$$

%EA: — ✓

II-S 0.312
2.10 73 to Ref
3.795

Run No. 1

PARTICULATE FIELD DATA

Location CLINKER COOLER

Date AUGUST 3, 1983

			ΔP_s	P_m		T_s					T_m		
Point	Clock Time	Dry Gas Meter, CF	Pitot in. H_2O	Orifice ΔH in. H_2O		Pump Vacuum In. Hg Gauge	Stack Temp. °F	Probe Temp. °F	Oven Temp. °F	Effluent Temp. °F	Dry Gas Temp. °F		Remarks
				Desired	Actual						Inlet	Outlet	
15	943	652.146	0.32	1.00	1.00	3.5	225	248	242	61	93	98	
14	945	653.277	0.32	1.00	1.00	3.5	225	248	241	61	93	97	
13	947	654.399	0.31	0.98	0.98	3.5	228	246	243	62	93	97	
12	949	655.517	0.31	0.98	0.98	3.5	227	246	243	63	93	97	
11	951	656.638	0.29	0.92	0.92	3.5	227	245	242	64	93	97	
10	953	657.729	0.29	0.92	0.92	3.5	229	247	243	64	93	97	
9	955	658.819	0.28	0.88	0.88	3.5	228	247	246	64	93	97	
8	957	659.888	0.28	0.88	0.89	3.5	231	248	243	65	94	98	
7	959	660.976	0.28	0.88	0.88	3.5	229	247	242	65	94	98	
6	1001	662.029	0.28	0.88	0.88	3.5	231	250	244	65	95	99	
5	1003	663.096	0.28	0.88	0.88	3.5	232	251	248	65	95	99	
4	1005	664.159	0.28	0.88	0.88	3.5	232	251	246	65	95	99	
3	1007	665.212	0.28	0.88	0.88	3.5	232	252	249	66	96	100	
2	1009	666.278	0.28	0.88	0.88	3.5	231	252	251	66	97	101	
1	1011	667.345	0.20	0.63	0.63	2.5	231	251	248	66	97	102	
END RUN	1013	668.255	-	-	-	-	-	-	-	-	-	-	

MULLINS ENVIRONMENTAL TESTING CO., INC.

Job No. 83-69 PARTICULATE & O2 FIELD DATA

Job Name LEHIGH PORTLAND CEMENT Co

Run No. 2

Location CLINKER COOLER

Date AUGUST 3, 1983

Operator WILLIAMS, BIELA, MULLINS JR

Sample Box No. 5 Meter Box No. 1

Read and record at the start of each test point.

Purge to: —

Purge time: —

Ambient Temp. °F 88

Assumed Moisture % 2.5%

Probe Length 10'

C Factor 72.0 — to reference

Initial Leak @ 16.5 "Hg = 0.002 cfm

Final Leak @ 130 "Hg = 0.002 cfm

Point	Clock Time	Dry Gas Meter, CF	Pitot in. H_2O (ΔP_s)	Orifice ΔH in. H_2O Desired	Orifice ΔH in. H_2O Actual	Pump Vacuum In. Hg Gauge (P_m)	Stack Temp. °F (T_s)	Probe Temp. °F	Oven Temp. °F	Effluent Temp. °F	Dry Gas Temp. °F Inlet (T_m)	Dry Gas Temp. °F Outlet	Remarks
B-16	1109	669.005	0.31	2.25	2.25	8.5	220	251	250	74	89	91	
15	1111	670.645	0.33	2.40	2.40	9.5	224	251	248	72	89	91	
14	1113	672.364	0.35	2.55	2.55	10.0	226	256	253	72	90	91	
13	1115	674.116	0.33	2.40	2.40	10.0	223	257	251	71	91	92	
12	1117	675.868	0.32	2.30	2.30	9.5	223	256	250	67	92	92	
11	1119	677.584	0.31	2.25	2.25	9.2	225	252	253	66	93	93	
10	1121	679.302	0.30	2.20	2.20	9.0	223	251	252	67	94	93	
9	1123	680.947	0.28	2.05	2.05	8.5	224	250	253	67	94	94	
8	1125	682.610	0.30	2.20	2.20	9.0	222	251	254	68	95	95	
7	1127	684.269	0.30	2.20	2.20	9.0	224	250	247	68	96	96	
6	1129	685.897	0.31	2.25	2.25	9.0	222	251	248	68	97	96	
5	1131	687.565	0.30	2.20	2.20	9.0	221	252	249	69	97	97	
4	1133	689.244	0.30	2.20	2.20	9.0	220	251	252	69	98	97	
3	1135	690.905	0.29	2.15	2.15	9.0	218	250	251	70	98	98	
2	1137	692.558	0.25	1.80	1.80	8.0	218	250	253	70	99	99	
1	1139	694.155	0.21	1.55	1.55	7.0	211	251	254	70	99	99	
END	1141	695.602	—	—	—	—	—	—	—	—	—	—	
A-16	1209	695.602	0.24	1.75	1.75	6.0	197	258	253	74	90	94	

Pitot Tube Calibration Factor C_p 0.819

Volume Collected V_m 54.498 ft^3

Water Collected V_w 25.8 ml

Time of Test T_t 64 min.

Stack Pressure P_s -0.22 "H_2O

Baro. Press. P_b 29.60 "Hg

Probe Tip Dia. D_n 0.312 / ~~0.251~~ in.

% CO_2 0.0 % CO 0.0

% O_2 20.8 % N_2 79.2

Area Stack A_s 3987 in^2

Pitot Tube No. 9 Barometer No. 2

Probe Tip No. ~~I-3~~ II-5

V_m = Dry Gas Meter Calibration Factor 1.029 X 52.962

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

M_F = ____ M_T = ____

Impinger Box No. 5

Impinger 1	Final Weight	600.0
	Initial Weight	595.6
	Increase	4.4
Impinger 2	Final Weight	651.4
	Initial Weight	644.6
	Increase	6.8
Impinger 3	Final Weight	480.0
	Initial Weight	477.9
	Increase	2.1
Impinger 4	Final Weight	826.9
	Initial Weight	814.4
	Increase	12.5
Impinger 5	Final Weight	
	Initial Weight	
	Increase	
Impinger 6	Final Weight	
	Initial Weight	
	Increase	

Filter # ____ Final Weight ____ Initial Weight ____ Increase ____

Water Weight Gain

V_w =

g SO_2 = -____

V_w =

Impinger 1	4.4
Impinger 2	6.8
Impinger 3	2.1
Impinger 4	12.5
Impinger 5	
Impinger 6	
Total	25.8 = V_w

P_b =	29.60	$\%CO_2$ =	0.0
V_m =	54.498	$\%O_2$ =	20.8
V_w =	25.8	%CO =	0.0
P_m =	2.211	$\%N_2$ =	79.2
Avg ΔP =	0.302	A_s =	3987
Avg $\sqrt{\Delta P}$ =	0.549	D_n =	0.312
C_p =	0.819	T_t =	64
P_s =	-0.22 "H_2O	29.58	"Hg
T_m =	95 °F	555	°R
T_s =	214 °F	674	°R

Moisture Content: %M = 2.31 M_d = 0.9769 MW_d = 28.832 MW = 28.58

$$V_{m_{std}} = 17.65\ V_m \left(\frac{P_b + \frac{P_m}{13.6}}{T_m + 460} \right) = 17.65 \times 54.498 \left(\frac{29.60 + \frac{2.211}{13.6}}{95 + 460} \right) = 51.582 \text{ sft}^3$$

0.806 scfm

$$V_{w_{gas}} = 0.0472 \times V_w = 0.0472 \times 25.8 = 1.218 \text{ sft}^3$$

$$\% \text{ Moisture} = \frac{V_{w_{gas}}}{V_{m_{std}} + V_{w_{gas}}} \times 100 = \frac{1.218}{51.582 + 1.218} \times 100 = 2.31\ \%$$

$$V_s = 5123.8 \times 0.819 \sqrt{\frac{674}{29.58 \times 28.58}} \times 0.549 = 2057 \text{ fpm}$$

ACFM: 56,955

SCFM: 43,249

$$\%I = \frac{1039 \times 51.582 \times 674}{0.9769 \times 29.58 \times 2057 \times 64 \times (0.312)^2} = 97.5\ \%$$

%EA: —

0.826

2.50

Run No. 2

PARTICULATE FIELD DATA

Location CLINKER COOLER

Date AUGUST 3, 1983

			ΔP_s	P_m		T_s					T_m		
Point	Clock Time	Dry Gas Meter, CF	Pitot in. H_2O	Orifice ΔH in. H_2O		Pump Vacuum In. Hg Gauge	Stack Temp. °F	Probe Temp. °F	Oven Temp. °F	Effluent Temp. °F	Dry Gas Temp. °F		Remarks
				Desired	Actual						Inlet	Outlet	
15	1211	696.789	0.27	2.00	2.00	7.0	205	254	257	67	90	94	
14	1213	698.369	0.30	2.20	2.20	8.5	208	258	256	66	90	93	
13	1215	699.989	0.28	2.10	2.10	8.5	206	256	254	64	91	93	
12	1217	701.600	0.31	2.25	2.25	9.0	205	257	255	63	92	94	
11	1219	703.220	0.29	2.15	2.15	9.0	205	258	254	64	92	94	
10	1221	704.871	0.30	2.20	2.20	9.0	204	258	250	65	93	94	
9	1223	706.529	0.30	2.20	2.20	9.0	207	259	248	65	94	95	
8	1225	708.184	0.30	2.20	2.20	9.0	211	258	254	66	95	95	
7	1227	709.848	0.32	2.35	2.35	9.5	208	256	255	66	95	96	
6	1229	711.552	0.33	2.40	2.40	10.0	210	251	254	66	96	96	
5	1231	713.267	0.35	2.55	2.55	10.5	208	250	254	66	96	97	
4	1233	715.055	0.34	2.50	2.50	10.5	209	249	253	66	96	97	
3	1235	716.848	0.35	2.55	2.55	10.5	207	249	250	66	97	97	
2	1237	718.619	0.34	2.50	2.50	10.5	204	250	251	67	97	97	
1	1239	720.392	0.26	1.90	1.90	8.0	202	247	250	67	97	98	
End Run	1241	721.967	-	-	-	-	-	-	-	-	-	-	

MULLINS ENVIRONMENTAL TESTING CO., INC.

Job No. 80-69 PARTICULATE / SO2 FIELD DATA

Job Name LEHIGH PORTLAND CEMENT CO.

Run No. 3

Location #1 CLINKER COOLER

Date AUGUST 3, 1983

Operator WILLIAMS, BIELA MULLINS JR.

Sample Box No. 6 Meter Box No. 1

Read and record at the start of each test point.

Purge to: —

Purge time: —

Ambient Temp. °F 75

Assumed Moisture % 2.5%

Probe Length 10

C Factor 76.0 78.0 — to reference

Initial Leak @ 16.0 "Hg = 0.002 cfm

Final Leak @ 12.0 "Hg = 0.000 cfm

Point	Clock Time	Dry Gas Meter, CF	Pitot in. H_2O (ΔP_s)	Orifice ΔH in. H_2O Desired	Orifice ΔH in. H_2O Actual	Pump Vacuum In. Hg Gauge (P_m)	Stack Temp. °F (T_s)	Probe Temp. °F	Oven Temp. °F	Effluent Temp. °F	Dry Gas Temp. °F Inlet (T_m)	Dry Gas Temp. °F Outlet (T_m)	Remarks
A-16	1315	722.658	0.21	1.60	1.60	5.0	200	255	251	60	87	91	
15	1317	724.050	0.25	1.90	1.90	6.0	213	254	252	54	87	91	
14	1319	725.558	0.28	2.15	2.15	7.0	214	252	253	53	88	91	
13	1321	727.229	0.27	2.05	2.05	6.5	218	258	248	52	89	91	CLINKER KILN UPSET 1323
12	~~1323~~ 1328	728.815	0.27	2.05	2.05	6.0	218	244	254	59	88	92	
11	~~1325~~ 1330	730.310	0.28	2.15	2.15	6.8	230	246	256	53	89	92	PUMP ON 1328
10	~~1327~~ 1332	731.926	0.21	1.60	1.60	5.2	233	244	258	52	89	93	
9	1334	733.620	0.20	1.50	1.50	5.0	235	245	259	53	90	93	
8	1336	734.828	0.23	1.75	1.75	5.5	236	246	259	53	90	93	
7	1338	736.268	0.31	2.35	2.35	7.0	240	248	258	53	91	94	
6	1340	737.892	0.32	2.45	2.45	8.0	241	249	258	54	92	94	
5	1342	739.628	0.32	2.45	2.45	8.0	242	246	257	54	93	95	
4	1344	741.368	0.18	1.40	1.40	5.0	237	248	252	55	93	95	
3	1346	742.855	0.20	1.50	1.50	5.0	237	251	248	56	94	96	
2	1348	744.238	0.36	2.70	2.70	8.5	244	253	246	56	94	96	
1	1350	746.001	0.27	2.05	2.05	7.0	237	255	245	57	95	96	
END.	1352	747.698	-	-	-	-	-	-	-	-	-	-	
B-16	1354	747.698	0.32	2.45	2.45	7.5	244	258	248	61	94	97	

Pitot Tube Calibration Factor C_p 0.819

Volume Collected V_m 53.511 ft^3

Water Collected V_w _____ ml

Time of Test T_t 64 min.

Stack Pressure P_s −0.16 "H_2O

Baro. Press. P_b 29.60 "Hg

Probe Tip Dia. D_n 0.312 in.

% CO_2 0.0 % CO 0.0

% O_2 20.8 % N_2 79.2

Area Stack A_s 3987 in^2

Pitot Tube No. 9 Barometer No. 2

Probe Tip No. II-5

V_m = Dry Gas Meter Calibration Factor 1.029 X 52.003 [Dry Gas Meter Reading _____ ft^3 − (T_t _____ min X Leak Rate _____ cfm)]

M_F = _____ M_T = _____

Impinger Box No. 6

Impinger 1	Final Weight	640.3
	Initial Weight	628.9
	Increase	11.4
Impinger 2	Final Weight	648.3
	Initial Weight	641.1
	Increase	7.2
Impinger 3	Final Weight	478.3
	Initial Weight	476.3
	Increase	2.0
Impinger 4	Final Weight	824.5
	Initial Weight	813.3
	Increase	11.2
Impinger 5	Final Weight	
	Initial Weight	
	Increase	
Impinger 6	Final Weight	
	Initial Weight	
	Increase	

Filter # ____ Final Weight ____ Initial Weight ____ Increase ____

Water Weight Gain

Impinger 1	11.4
Impinger 2	7.2
Impinger 3	2.0
Impinger 4	11.2
Impinger 5	
Impinger 6	
Total	31.8 ✓ = V_w

V_w =

g SO_2 = -____

V_w =

P_b = 29.60 ✓ "Hg

V_m = 53.511 ✓ ft³

V_w = 31.8 ✓ ml

P_m = 2.117 ✓ "Hg

Avg ΔP = 0.277 ✓ "

Avg $\sqrt{\Delta P}$ = 0.525 ✓

C_p = 0.819 ✓

P_s = -0.16 ✓ "H_2O 29.59 "Hg ✓

T_m = 95 ✓ °F 555 °R ✓

T_s = 239 ✓ °F 699 °R ✓

%CO_2 = 0.0 ✓

%O_2 = 20.8 ✓

%CO = 0.0 ✓

%N_2 = 79.2 ✓

A_s = 3987 ✓ ft²

D_n = 0.312 ✓ "

T_t = 64 ✓ °F

Moisture Content: %M = 2.88 ✓ M_d = 0.9712 ✓ MW_d = 28.832 ✓ MW = 28.52 ✓

$$V_{m_{std}} = 17.65\, V_m \left(\frac{P_b + \frac{P_m}{13.6}}{T_m + 460} \right) = 17.65 \times 53.511 \left(\frac{29.60 + \frac{2.117}{13.6}}{95 + 460} \right) = 50.637 \text{ sft}^3 \checkmark$$

$$0.791 \text{ scfm} \checkmark$$

$$V_{w_{gas}} = 0.0472 \times V_w = 0.0472 \times 31.8 = 1.501 \text{ sft}^3 \checkmark$$

$$\% \text{ Moisture} = \frac{V_{w_{gas}}}{V_{m_{std}} + V_{w_{gas}}} \times 100 = \frac{1.501}{50.637 + 1.501} \times 100 = 2.88\ \% \checkmark$$

$$V_s = 5123.8 \times 0.819 \sqrt{\frac{699}{29.59 \times 28.52}} \times 0.525 = 2005 \text{ fpm} \checkmark$$

ACFM: 55,515 ✓

$$\%I = \frac{1039 \times 50.637 \times 699}{0.9712 \times 29.59 \times 2005 \times 64 \times (0.312)^2} = 102.4\ \% \checkmark$$

SCFM: 40,424 ✓

%EA: — ✓

Run No. 5

Location Clinker Cooler

Date August 3, 1983

PARTICULATE FIELD DATA

Point	Clock Time	Dry Gas Meter, CF	ΔP_s Pitot in. H_2O	P_m Orifice ΔH in. H_2O Desired	P_m Orifice ΔH in. H_2O Actual	Pump Vacuum In. Hg Gauge	T_s Stack Temp. °F	T_s Probe Temp. °F	T_s Oven Temp. °F	T_s Effluent Temp. °F	T_m Dry Gas Temp. °F Inlet	T_m Dry Gas Temp. °F Outlet	Remarks
B-15	1356	749.389	0.33	2.50	2.50	8.0	247	250	244	59	95	97	
14	1358	751.143	0.32	2.45	2.45	8.0	250	253	242	59	95	97	
13	1400	752.995	0.30	2.30	2.30	8.0	248	255	242	60	96	97	
12	1402	754.619	0.29	2.25	2.25	7.5	250	256	248	60	96	97	
11	1404	756.316	0.29	2.25	2.25	7.5	250	256	254	60	96	97	
10	1406	758.000	0.30	2.30	2.30	7.5	252	258	256	60	97	98	
9	1408	759.690	0.30	2.30	2.30	7.5	251	258	259	60	98	98	
8	1410	761.380	0.30	2.30	2.30	7.5	249	256	258	61	98	98	
7	1412	763.074	0.30	2.30	2.30	7.5	251	253	257	61	99	99	
6	1414	764.768	0.31	2.35	2.35	7.5	249	252	253	62	99	99	
5	1416	766.479	0.30	2.30	2.30	7.5	250	254	250	62	100	100	
4	1418	768.188	0.31	2.35	2.35	7.5	248	255	251	62	100	100	
3	1420	769.897	0.27	2.05	2.05	7.0	248	249	249	63	100	100	
2	1422	771.563	0.23	1.75	1.75	6.0	239	252	251	62	101	101	
1	1424	773.099	0.25	1.90	1.90	6.0	241	251	251	62	101	101	
End Aq.	1426	774.661	–	–	–	–	–	–	–	–	–	–	

Job No. 83-69

PRELIMINARY VELOCITY TRAVERSE DATA AND SAMPLING LOCATION DATA

Job Name LEHIGH PORTLAND Cement

Location KILN STACK

Date 1 Aug 1983 Time _____

Port & Inside Diameter Port A 127 3/8 in. Port B 125 1/4 in.

Port & Wall Thickness A 6 1/4 B 6 1/4 in. 12 11/16 & 120 1/16

Inside Stack Diameter A 121 1/4 B 119 in. 120 1/16

Sampling ports are 95 ft. above ground

Stack Temperature Start _____ °F

End _____ °F

2.05 Diameters
Sampling ports are 246 1/2 downstream of ~~disturbance~~

3.00 Diameters
Sampling ports are 360 upstream of disturbance

Point No.	Percent Diameter	Distance from Inside Wall in.	Distance from Ref. Point in.	$\Delta P/\sqrt{\Delta P}$ Port A	$\Delta P/\sqrt{\Delta P}$ Port B	$\Delta P/\sqrt{\Delta P}$ Port A	$\Delta P/\sqrt{\Delta P}$ Port B
1	1.1	1.321	1 5/16	026 /327	034 /334	-4° /	+6° /
2	3.2	3.842	3 13/16	044 / 337	0.48 /341	+5° /	+2° /
3	5.5	6 603	6. 5/8	0.48 / 338	0.51 /342	+7° /	+3° /
4	7.9	9,485	9 1/2	0.49/339	049 /342	-3° /	+2° /
5	10.5	12,607	12 5/8	0.47/339	049 /343	+4° /	+3° /
6	13.2	15.848	15 7/8	049 /338	0.51 /343	-1° /	+1° /
7	16.1	19.330	19 5/16	047 / 337	0.50 /343	+2° /	+1° /
8	19.4	23 292	23 5/16	048 / 337	047 /343	+1° /	+5° /
9	23.0	27.614	27 5/8	0.48 /337	045 /342	0° //	+3° /
10	27.2	32.657	32 11/16	0.47 / 337	0.42 /342	+1° /	+9° /
11	32.3	38,780	38 3/4	045 / 336	040 /341	0° /	10° /
12	39.8	47.785	47 13/16	043 / 335	037 /340	+5° /	-13° /
13	60.2	72.278	72 1/4	033/335	0.39 /336	0° /	-16° /
14	67.7	81.282	81 5/16	033/335	044 /336	+3° /	-15° /
15	72.8	87.405	87 3/8	032/335	0.42 / 336	-2° /	-16° /
16	77.0	92.448	92 7/16	033/334	0.44 /336	0° /	-10° /
17	80.6	96.770	96 3/4	0.36 /334	0.47 /336	-2° /	-10° /
18	83.9	100.732	100 3/4	035 /334	048 /336	0° /	-5° /
19	86.8	104.214	104 3/16	039 /332	048 /335	-2° /	-4° /
20	89.5	107.456	107 7/16	038 /331	045 /336	0° /	-2° /
21	92.1	110.578	110 9/16	037/330	0.47 /335	-6° /	-1° /
22	94.5	113 459	113 7/16	036 /329	044 /332	-9° /	-2° /
23	96.8	116. 220	116 1/4	037 /329	037 /328	-10° /	0° /
24	98.9	118. 742	118 3/4	033 /328	039 /328	-2° /	+18 /
			Average $\Delta P/\sqrt{\Delta P}$	0.401 /	0.445 /	Average =	4.7° /

10.49 906

Pitot Tube No. 9

P_s = _____ " H_2O _____ " Hg

C_p = 0.819

P_b = 29.56 " Hg

CO_2 = 7.2
O_2 = 15.6
CO = 00
N_2 = 77.2

ΔP - 042 3
$\sqrt{\Delta P}$ 0634 0648
T_s 335
335°F

J b No. 83-69

PRELIMINARY VELOCITY TRAVERSE DATA
AND
SAMPLING LOCATION DATA

Job Name LEHIGH PORTLAND

I cation CLINKER COOLER

Sampling ports are 44 ft. above ground

Stack Temperature Start ____ °F

End ____ °F

D te 8/22/83 Time ____

Port & Inside Diameter A 77 7/8 / B 78 3/8 in.

5.30 Dia.
Sampling ports are 87 1/2 downstream of disturbance

F rt & Wall Thickness 6 3/8 in.

Inside Stack Diameter 70 3/4 / 71 3/4 in. 71.25

2.0Z dia.
Sampling ports are 144 1/8 upstream of disturbance

Point No.	Percent Diameter	Distance from Inside Wall in.	Distance from Ref. Point in.	ΔP/√ΔP Port A	ΔP/√ΔP Port B	ΔP/√ΔP Port A	ΔP/√ΔP Port B
1	1.6	1.140	1 1/8 ✓	027/230	033/230	+8° /	+8° /
2	4.9	3.491	3 1/2 ✓	0.49/232	041/232	+9° /	+8° /
3	8.5	6.056	6 1/16 ✓	050/233	042/232	+10° /	+7° /
4	12.5	8.906	8 7/8 ✓	046/237	043/232	+12° /	+8° /
5	16.9	12.041	12 1/16	047/237	044/232	+8° /	+8° /
6	22.0	15.675	15 11/16	047/236	042/232	+10° /	+6° /
7	28.3	20.164	20 3/16	046/236	042/232	+8° /	+6° /
8	37.5	26.719	26 3/4	045/236	043/232	-6° /	+4° /
9	62.5	44.531	44 1/2	045/235	044/232	-5° /	-3° /
10	71.7	51.086	51 1/8 1/16	044/235	044/232	-5° /	+5° /
11	78.0	55.575	55 9/16	043/234	044/231	+12 /	+6° /
12	83.1	59.209	59 3/16	043/233	045/231	-8° /	-3° /
13	87.5	62.344	62 3/8	044/233	048/233	-5° /	-5° /
14	91.5	65.194	65 3/16	044/232	048/233	+5° /	+8° /
15	95.1	67.759	67 3/4	039/231	047/232	+8° /	+8° /
16	98.4	70.110	70 1/8	028/228	048/232	+8° /	+8° /
17				/	/	/	/
18				/	/	/	/
19				/	/	/	/
20				/	/	/	/
21				/	/	/	/
22				/	/	/	/
23				/	/	/	/
24				/	/	/	/
				/	/	/	/

Pi t Tube No. 9 ✓

P_s = -0.32 " H_2O 29.52 " Hg

C_p = 0.819

P_b = 29.54 " Hg

Average ΔP/√ΔP

ΔP = 0.432 ✓

√ΔP = 0.657 ✓

T_s = 233 = 693 ✓

Avg = ~~7.8~~ 7.0°

METCO

APPENDIX E

Analytical Data

Mullins Environmental Testing Co., Inc.

Particulate Analysis Summary

Job Number 83-69 Date Analysis Completed 8/10/83

Job Name Lehigh Portland Cement Unit Tested Kiln Stack

Location Waco, TX

Run No.	1 ✓	2 ✓	3 ✓		
Particulate on Filter (mg)	49.4	68.2	67.2		
Particulate in Front Wash (mg)*	78.7	60.6	59.5		
MF (mg)	128.1	128.8	126.7		
Particulate in Impinger #1 (mg)**	35.2	29.3	23.3		
MT (mg)	163.3	158.1	150.0		

J R Mullins

Analyst

* Less Acetone Residue

** Less Ammonium Sulfate

Mullins Environmental Testing Co., Inc.

Particulate Analysis EPA Method 5

Stack Filters

Job Number 83-69 Location Waco, TX

Job Name Lehigh Portland Cement Unit Tested Kiln Stack

Desiccator Time In	1100 8/4/83	1403 8/8/83			
Desiccator Time Out	1350 8/8/83				

Run No. 1	Filter No. B-11				
Filter & Particulate + Tare Weight (g)	2.5235	2.5223			
Tare Weight (g)	1.8215	1.8208	✓		
Filter & Particulate (g)	0.7020	0.7015			

Filter & Particulate Average (g) 0.7018

Initial Filter Weight (g) 0.6524

Total Particulate (mg) 49.4 ✓

Run No. 2	Filter No. B-10				
Filter & Particulate + Tare Weight (g)	2.5329	2.5319			
Tare Weight (g)	1.8214	1.8207	✓		
Filter & Particulate (g)	0.7115	0.7112			

Filter & Particulate Average (g) 0.7114

Initial Filter Weight (g) 0.6432

Total Particulate (mg) 68.2 ✓

Run No. 3	Filter No. A-98				
Filter & Particulate + Tare Weight (g)	2.5572	2.5562			
Tare Weight (g)	1.8213	1.8206	✓		
Filter & Particulate (g)	0.7359	0.7356			

Filter & Particulate Average (g) 0.7358

Initial Filter Weight (g) 0.6686

Total Particulate (mg) 67.2 ✓

J R Morfis

Analyst

Mullins Environmental Testing Co., Inc.

Particulate Analysis EPA Method 5

Front Wash

Job Number 83-69 Location Waco, TX

Job Name Lehigh Portland Cement Unit Tested Kiln Stack

Desiccator Time In	1400 8/5/83	1424 8/8/83	0823 8/10/83		
Desiccator Time Out	1413 8/8/83	0815 8/10/83			

Run No. 1	Volume (ml) 503				
Final Weight (g)	141.8841	141.8840			
Initial Weight (g)	141.8014	141.8014	✓		
Particulate Weight (g)	0.0827	0.0826			

Particulate Average (mg) 82.7
Less Acetone Blank (mg) 4.0
Total Particulate (mg) 78.7 ✓

Run No. 2	Volume (ml) 471				
Final Weight (g)	142.3493	142.3488			
Initial Weight (g)	142.2848	142.2848	✓		
Particulate Weight (g)	0.0645	0.0640			

Particulate Average (mg) 64.3
Less Acetone Blank (mg) 3.7
Total Particulate (mg) 60.6 ✓

Run No. 3	Volume (ml) 520				
Final Weight (g)	142.7521	142.7519			
Initial Weight (g)	142.6884	142.6884	✓		
Particulate Weight (g)	0.0637	0.0635			

Particulate Average (mg) 63.6
Less Acetone Blank (mg) 4.1
Total Particulate (mg) 59.5 ✓

Acetone Blank	Volume (ml) 330				
Final Weight (g)	142.4901	142.4900			
Initial Weight (g)	142.4841	142.4841	✓		
Difference (g)	0.0060	0.0059			

Average (mg) 6.0
* mg/l 18.2 ✓

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

J R Mullins
Analyst

Mullins Environmental Testing Co., Inc.

Particulate Analysis EPA Method 5

Back Half Analysis

Location Waco, Tx

Unit Tested Kiln Stack

Job Number 83-69

Job Name Lehigh Portland Cement

Desiccator Time In	1400 8/5/83	1424 8/11/83	0829 8/10/83		
Desiccator Time Out	1413 8/8/83	0823 8/10/83	1430 8/11/83		

Run No. 1	Volume (ml) 202				
Final Weight (g)	143.8281	143.8288	143.8209	✓	
Initial Weight (g)	143.7817	143.7817	143.7817		
Particulate Weight (g)	0.0384	0.0391	0.0392		

Particulate Average (mg) 39.2

Less Ammonium Sulfate (mg) 4.0

Total Particulate (mg) 35.2 ✓

Run No. 2	Volume (ml) 255				
Final Weight (g)	143.5984	143.5983	✓		
Initial Weight (g)	143.5599	143.5599			
Particulate Weight (g)	0.0385	0.0384			

Particulate Average (mg) 38.5

Less Ammonium Sulfate (mg) 9.2

Total Particulate (mg) 29.3 ✓

Run No. 3	Volume (ml) 318				
Final Weight (g)	154.2281	154.2274	154.2276	✓	
Initial Weight (g)	154.2006	154.2006	154.2006		
Particulate Weight (g)	0.0275	0.0268	0.0270		

Particulate Average (mg) 26.9

Less Ammonium Sulfate (mg) 3.6

Total Particulate (mg) 23.3

J R Monfino

Analyst

METCO

SULFUR TRIOXIDE EMISSION DATA

Job Number 83-69 Location Waco, TX

Job Name Lehigh Portland Cement Unit Tested Kiln Stack

Run Number	1	2	3	
Date	8/2/83	8/2/83	8/2/83	
Time	0839-1018	1100-1241	1322-1500	
$\underline{N}$ - normality of $BaCl_2$	0.0100	0.0100	0.0100	
ML_I - ml in impinger	202	255	218	
ML_A - ml in aliquot	10	10	10	
ML_B - ml of $BaCl_2$ to titrate	0.35	0.60	0.30	
ML_{BB}- ml of $BaCl_2$ to titrate blank	0.05	0.05	0.05	
T_m - average gas meter temp., °F	102	113	108	
V_m - volume of dry gas sampled @ meter conditions, $ft.^3$	55.351	57.397	58.062	
P_b - barometric pressure, "Hg Abs.	29.62	29.60	29.58	
Q_s - stack gas volume dry @ standard conditions, *SCFM	127,609	123,136	126,080	
C_I - SO_3 in impinger, mgs	2.4	5.6	2.2	
ppm SO_3	0.5	1.1	0.4	
C_{SO_3} - emission rate of SO_3, lbs/day	19.1	42.0	16.4	
C_S - emission rate of S, lbs/day	7.6	16.8	6.5	

*68°F, 29.92 "Hg (20°C, 760 mm Hg)

$$C_I = \frac{ML_I \times (ML_B - ML_{BB}) \times \underline{N} \times 40}{ML_A}$$

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

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

$$C_S = \frac{C_{SO_3}}{2.5}$$

Mullins Environmental Testing Co., Inc.

Particulate Analysis EPA Method 5

Back Half Analysis

Job Number 83-69 Location Waco, TX

Job Name Lehigh Portland Cement Unit Tested Kiln Stack

Desiccator Time In	1400 8/5/83	1424 8/8/83	0829 8/10/83		
Desiccator Time Out	1413 8/8/83	0823 8/10/83	1430 8/11/83		

Run No. 1	Volume (ml) 202				
Final Weight (g)	143.8201	143.8208	143.8209		
Initial Weight (g)	143.7817	143.7817	143.7817	✓	
Particulate Weight (g)	0.0384	0.0391	0.0392		

Particulate Average (mg) 39.2

Less Ammonium Sulfate (mg) 4.0

Total Particulate (mg) 35.2 ✓

Run No. 2	Volume (ml) 255				
Final Weight (g)	143.5984	143.5983			
Initial Weight (g)	143.5599	143.5599	✓		
Particulate Weight (g)	0.0385	0.0384			

Particulate Average (mg) 38.5

Less Ammonium Sulfate (mg) 9.2

Total Particulate (mg) 29.3 ✓

Run No. 3	Volume (ml) 218				
Final Weight (g)	154.2281	154.2274	154.2276		
Initial Weight (g)	154.2006	154.2006	154.2006	✓	
Particulate Weight (g)	0.0275	0.0268	0.0270		

Particulate Average (mg) 26.9

Less Ammonium Sulfate (mg) 3.6

Total Particulate (mg) 23.3 ✓

JR Montes

Analyst

METCO

NO_x EMISSION DATA

Job Number 83-69

Client Lehigh Portland Cement Co.

Unit Tested Kilns Stack

Date 2 August 1983

Run Number 1

Flask Number	41	42	43	44	Average
Time	0932	0947	1002	1017	
Initial Barometric Pressure, "Hg Abs.	29.50	29.50	29.50	29.50	
Initial Manometer Reading, "Hg Abs.	-28.20	-28.20	-28.00	-28.00	
P_I - Initial Pressure of Flask, "Hg Abs.	1.30	1.30	1.50	1.50	
T_I - Initial Temperature of Flask, °F	94	99	101	104	
V_F - Volume of Flask, ml	2067	2048	2097	2047	
Final Barometric Pressure, "Hg Abs.	29.60	29.60	29.60	29.60	
Final Manometer Reading, "Hg Abs.	-1.50	-1.85	-1.60	-2.00	
P_F - Final Pressure of Flask, "Hg Abs.	28.10	27.75	28.00	27.60	
T_F - Final Temperature of Flask, °F	84	84	85	85	
μgNO_2 - micrograms of NO_2	974.6	1144.1	1218.2	1250.0	
V_s - Volume of sample at conditions*, ml	1777	1738	1781	1712	✓
ppm NO_2 - Concentration of NO_2, ppm	286.9	344.3	357.8	381.8	342.7
C_{NO_2} - Emission Rate of NO_2, lbs/dscf*	3.42×10^{-5}	4.11×10^{-5}	4.27×10^{-5}	4.56×10^{-5}	4.09×10^{-5}
	✓	✓	✓	✓	✓

* 68°F, 29.92 "Hg (20°C, 760 mm Hg)

$$V_s = \frac{528\ (V_F - 25)}{29.92} \left[\frac{P_F}{T_F + 460} - \frac{P_I}{T_I + 460} \right] = \text{ml}$$

$$\text{ppm } NO_2 = \frac{523 \times \mu g\ NO_2}{V_s} = \text{ppm}$$

$$C_{NO_2} = \frac{\mu g\ NO_2}{V_s} \times \frac{1\ \text{lb/ft}^3}{1.6 \times 10^4\ \mu g/\text{ml}} = 6.243 \times 10^{-5} \frac{\mu g\ NO_2}{V_s} = \text{lbs/dscf}$$

METCO

NO_x EMISSION DATA

Job Number 83-69

Client Lehigh Portland Cement Co. Date 2 August 1983

Unit Tested Kilns Stack Run Number 2

Flask Number	45	46	47	48	Average
Time	1100	1115	1130	1145	
Initial Barometric Pressure, "Hg Abs.	29.50	29.48	29.48	29.48	
Initial Manometer Reading, "Hg Abs.	-28.20	-28.20	-28.00	-28.10	
P_I - Initial Pressure of Flask, "Hg Abs.	1.30	1.28	1.48	1.38	
T_I - Initial Temperature of Flask, °F	99	103	107	105	
V_F - Volume of Flask, ml	2046	2037	2055	2035	
Final Barometric Pressure, "Hg Abs.	29.60	29.60	29.60	29.60	
Final Manometer Reading, "Hg Abs.	+0.50	-0.40	-2.40	-1.60	
P_F - Final Pressure of Flask, "Hg Abs.	30.10	29.20	27.20	28.00	
T_F - Final Temperature of Flask, °F	85	86	86	85	
μgNO_2 - micrograms of NO_2	1364.4	1317.8	1317.8	1271.2	
V_s - Volume of sample at conditions*, ml	1887	1818	1691	1736	✓
ppm NO_2 - Concentration of NO_2, ppm	378.2	379.1	407.5	383.0	386.9
C_{NO_2} - Emission Rate of NO_2, lbs/dscf*	4.51×10^{-5} ✓	4.53×10^{-5} ✓	4.86×10^{-5} ✓	4.57×10^{-5} ✓	4.62×10^{-5} ✓

* 68°F, 29.92 "Hg (20°C, 760 mm Hg)

$$V_s = \frac{528\ (V_F - 25)}{29.92} \left[\frac{P_F}{T_F + 460} - \frac{P_I}{T_I + 460} \right] = \text{ml}$$

$$\text{ppm } NO_2 = \frac{523 \times \mu g\ NO_2}{V_s} = \text{ppm}$$

$$C_{NO_2} = \frac{\mu g\ NO_2}{V_s} \times \frac{1\ \text{lb/ft}^3}{1.6 \times 10^4\ \mu g/\text{ml}} = 6.243 \times 10^{-5} \frac{\mu g\ NO_2}{V_s} = \text{lbs/dscf}$$

METCO

NO_x EMISSION DATA

Job Number 83-69
Client Lehigh Portland Cement Co.
Unit Tested Kilns Stack

Date 2 August 1983
Run Number 3

Flask Number	49	50	51	52	Average
Time	1412	1427	1442	1457	
Initial Barometric Pressure, "Hg Abs.	29.45	29.45	29.45	29.45	
Initial Manometer Reading, "Hg Abs.	-28.20	-28.00	-28.20	-28.10	
P_I - Initial Pressure of Flask, "Hg Abs.	1.25	1.45	1.25	1.35	
T_I - Initial Temperature of Flask, °F	102	100	100	102	
V_F - Volume of Flask, ml	2034	2055	2036	2071	
Final Barometric Pressure, "Hg Abs.	29.60	29.60	29.60	29.60	
Final Manometer Reading, "Hg Abs.	-2.20	-1.80	-2.30	-1.00	
P_F - Final Pressure of Flask, "Hg Abs.	27.40	27.80	27.30	28.60	
T_F - Final Temperature of Flask, °F	85	84	85	85	
μgNO_2 - micrograms of NO_2	1207.7	1220.4	1110.2	1237.3	
V_s - Volume of sample at conditions*, ml	1704	1738	1698	1808	✓
ppm NO_2 - Concentration of NO_2, ppm	370.8	367.3	341.9	357.9	359.5
C_{NO_2} - Emission Rate of NO_2, lbs/dscf*	4.43×10^{-5}	4.38×10^{-5}	4.08×10^{-5}	4.27×10^{-5}	4.29×10^{-5}

* 68°F, 29.92 "Hg (20°C, 760 mm Hg)

$$V_s = \frac{528\ (V_F - 25)}{29.92} \left[\frac{P_F}{T_F + 460} - \frac{P_I}{T_I + 460} \right] = \text{ml}$$

$$\text{ppm } NO_2 = \frac{523 \times \mu g\ NO_2}{V_s} = \text{ppm}$$

$$C_{NO_2} = \frac{\mu g\ NO_2}{V_s} \times \frac{1\ \text{lb/ft}^3}{1.6 \times 10^4\ \mu g/\text{ml}} = 6.243 \times 10^{-5} \frac{\mu g\ NO_2}{V_s} = \text{lbs/dscf}$$

SO_2 EMISSION DATA

Job Number 83-69 Location Waco, TX

Job Name Lehigh Portland Unit Tested Kiln Stack

Run Number	1	2	3			
Date	8/2/83	8/2/83	8/2/83			
Time	0839-1018	1100-1241	1322-1500			
N - normality of $BaCl_2$	0.0100	0.0100	0.0100			
ML_I - ml in impinger #1	—	—	—			
ML_I - ml in impinger #2	327	347	332			
ML_I - ml in impinger #3	325	317	343			
ML_A - ml in aliquot #1	—	—	—			
ML_A - ml in aliquot #2	1.0	1.0	1.0			
ML_A - ml in aliquot #3	10	10	10			
ML_B - ml of $BaCl_2$ to titrate #1	—	—	—			
ML_B - ml of $BaCl_2$ to titrate #2	11.85	11.80	10.00			
ML_B - ml of $BaCl_2$ to titrate #3	1.30	1.40	1.20			
ML_{BB} - ml of $BaCl_2$ to titrate blank	0.05	0.05	0.05			
T_m - average gas meter temp., °F	102	113	108			
V_m - volume of dry gas sampled @ meter conditions, $ft.^3$	55.351	57.397	58.062			
P_b - barometric pressure, "Hg Abs.	29.62	29.60	29.58			
Q_s - Stack gas volume dry @ standard conditions, *SCFM	127,609	123,136	126,080			
C_I - SO_2 in impinger #1, mgs	—	—	—			
C_I - SO_2 in impinger #2, mgs	1234.8	1304.7	1057.1			
C_I - SO_2 in impinger #3, mgs	13.0	13.7	12.6			
C_T - total SO_2 in impingers, mgs	1247.8	1318.4	1069.7			
ppm SO_2	321.3	334.1	265.8			
C_{SO_2} - emission rate of SO_2, lbs/day	9808.7	9839.8	8015.8			
C_s - emission rate of S, lbs/day	4904.3	4919.9	4007.9			

*68°F, 29.92 "Hg (20°C, 760 mm Hg)

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

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

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

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

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

Mullins Environmental Testing Co., Inc.

Particulate Analysis Summary

Job Number 83-67 Date Analysis Completed 8/10/83

Job Name Lehigh Portland Cement Unit Tested Clinker Cooler

Location Waco, Tx

	✓	✓	✓		
Run No.	1	2	3		
Particulate on Filter (mg)	20.8	37.3	12.8		
Particulate in Front Wash (mg)*	26.2	22.3	23.1		
MF (mg)	47.0	59.6	35.9		
Particulate in Impinger #1 (mg)**	1.9	2.7	6.7		
MT (mg)	48.9	62.3	42.6		

JR Monfils
Analyst

* Less Acetone Residue

** Less Ammonium Sulfate

Mullins Environmental Testing Co., Inc.

Particulate Analysis EPA Method 5

Stack Filters

Job Number 83-69 Location Waco, TX

Job Name Lehigh Portland Cement Unit Tested Clinker Cooler

Desiccator Time In	1100 8/4/83	1410 8/8/83			
Desiccator Time Out	1404 8/8/83	0748 8/9/83			

Run No. 1	Filter No. B-83				
Filter & Particulate + Tare Weight (g)	2.4902	2.4890			
Tare Weight (g)	1.8220	1.8211	✓		
Filter & Particulate (g)	0.6682	0.6679			

Filter & Particulate Average (g) 0.6681

Initial Filter Weight (g) 0.6473

Total Particulate (mg) 20.8 ✓

Run No. 2	Filter No. B-84				
Filter & Particulate + Tare Weight (g)	2.5152	2.5139			
Tare Weight (g)	1.8219	1.8210	✓		
Filter & Particulate (g)	0.6933	0.6929			

Filter & Particulate Average (g) 0.6931

Initial Filter Weight (g) 0.6558

Total Particulate (mg) 37.3 ✓

Run No. 3	Filter No. B-85				
Filter & Particulate + Tare Weight (g)	2.4879	2.4867			
Tare Weight (g)	1.8218	1.8207	✓		
Filter & Particulate (g)	0.6661	0.6660			

Filter & Particulate Average (g) 0.6661

Initial Filter Weight (g) 0.6533

Total Particulate (mg) 12.8 ✓

J R Mullins

Analyst

Mullins Environmental Testing Co., Inc.

Particulate Analysis EPA Method 5

Front Wash

Job Number 83-69 Location Waco, TX

Job Name Lehigh Portland Cement Unit Tested Clinker Cooler Stack

Desiccator Time In	1400 8/5/83	0818 8/9/83	0823 8/10/83		
Desiccator Time Out	0810 8/9/83	0607 8/10/83			

Run No. 1	Volume (ml) 576				
Final Weight (g)	140.1512	140.1523	140.1527		
Initial Weight (g)	140.1217	140.1217	140.1217	✓	
Particulate Weight (g)	0.0295	0.0306	0.0310		

Particulate Average (mg) 30.8
Less Acetone Blank (mg) 4.6
Total Particulate (mg) 26.2 ✓

Run No. 2	Volume (ml) 450				
Final Weight (g)	140.9613	140.9612			
Initial Weight (g)	140.9354	140.9354	✓		
Particulate Weight (g)	0.0259	0.0258			

Particulate Average (mg) 25.9
Less Acetone Blank (mg) 3.6
Total Particulate (mg) 22.3 ✓

Run No. 3	Volume (ml) 610				
Final Weight (g)	141.9910	141.9914			
Initial Weight (g)	141.9633	141.9633	✓		
Particulate Weight (g)	0.0277	0.0281			

Particulate Average (mg) 27.9
Less Acetone Blank (mg) 4.8
Total Particulate (mg) 23.1 ✓

Acetone Blank	Volume (ml) 448				
Final Weight (g)	141.5323	141.5328			
Initial Weight (g)	141.5288	141.5288	✓		
Difference (g)	0.0035	0.0040			

Average (mg) 3.8 ✓
* mg/l 8.5

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

J R Mullins
Analyst

Mullins Environmental Testing Co., Inc.

Particulate Analysis EPA Method 5

Back Half Analysis

Job Number 83-69 Location Waco, TX

Job Name Lehigh Portland Cement Unit Tested Clinker Cooler Stack

Desiccator Time In	1400 8/5/83	0818 8/9/83	0823 8/10/83		
Desiccator Time Out	0810 8/9/83	0807 8/10/83	1427 8/10/83		

Run No. 1	Volume (ml) 408				
Final Weight (g)	141.8236	141.8241			
Initial Weight (g)	141.8220	141.8220	✓		
Particulate Weight (g)	0.0016	0.0021			

Particulate Average (mg) 1.9

Less Ammonium Sulfate (mg)

Total Particulate (mg) 1.9 ✓

Run No. 2	Volume (ml) 475				
Final Weight (g)	142.8232	142.8245	142.8250		
Initial Weight (g)	142.8221	142.8221	142.8221	✓	
Particulate Weight (g)	0.0011	0.0024	0.0029		

Particulate Average (mg) 2.7

Less Ammonium Sulfate (mg)

Total Particulate (mg) 2.7 ✓

Run No. 3	Volume (ml) 424				
Final Weight (g)	142.7565	142.7571	142.7576		
Initial Weight (g)	142.7507	142.7507	142.7507	✓	
Particulate Weight (g)	0.0058	0.0064	0.0069		

Particulate Average (mg) 6.7

Less Ammonium Sulfate (mg)

Total Particulate (mg) 6.7 ✓

J R Mullins

Analyst

NO_x Analysis

Job Number 83-69

Client Lehigh Portland Cement

Unit Kiln Stack

Date 8/5/83

Sample Number	Run Number	Flask Number	Volume (ml)	Aliquot (ml)	Absorbance	$\mu g NO_2^-$
1	1	41	50	15	0.460	974.6
2	1	42			0.540	1144.1
3	1	43			0.575	1218.2
4	1	44			0.590	1250.0
5	2	45	100		0.322	1364.4
6	2	46			0.311	1317.8
7	2	47			0.311	1317.8
8	2	48			0.300	1271.2
9	3	49			0.285	1207.7
10	3	50			0.288	1220.4
11	3	51			0.262	1110.2
12	3	52			0.292	1237.3

Standards

	Abs.
100	0.160
200	0.309

4.3108

	Abs.
300	0.460
400	0.640

K_c = 635.60835

APPENDIX F

Plant Operational Data

LEHIGH

LEHIGH PORTLAND CEMENT COMPANY

P.O. BOX 8176
HIGHWAY 84 WEST
WACO, TEXAS 76710
817: 772-1110

August 8, 1983

Mr. Bill Mullins
Mullins Testing
METCO
Addison, Texas

Dear Sir:

Below, please find test results on stack testing that was performed on August 2 and 3, 1983.

Kiln & Raw Material Parameters During Kiln Stack Tests on 8-2-83

Test #	1	2	3
Feed Screw Revs.	1361	1364	1445
Coal Usage	10.78 tons	10.78 tons	10.6 Tons
Clinker Production	53.5 tons	56 tons	59.4 Tons
Dryer Feed Rate	84 TPH	86 TPH	77 TPH
#1 ID Fan Inlet Temp.	415	430	430
#2 ID Fan Inlet Temp.	450	455	450
% O_2 #1 Kiln	2.1%	1.8%	2.1%
% O_2 #2 Kiln	2.5%	2.1%	2.4%
Time	8:39-10:18	11:00-12:41	13:22 -15:00

While conducting the three kiln stack sampling tests both kilns and the three dryers were operating under normal plant practices. There were no kiln upsets or delays.

Kiln Parameters During Clinker Cooler (Gravel Bed) Stack Tests 8/3/83

Test #	1	2	3
Feed Screw Revs.	880	793	897
Coal Usage	7.34 Tons	7.25 Tons	7.26
Clinker Production	36.2 Tons	36 Tons	36.8 Tons
Dryer Feed Rate	---	---	---
#1 ID Fan Inlet Temp.	498	502	500
#2 ID Fan Inlet Temp.	502	505	495
% O_2 #1 Kiln	2%	2.4%	3.2%
% O_2 #2 Kiln	3%	2.5%	2.8%
Time	9:05-10:13	11:09-Not rec.	13:15 - 14:26

During the first two clinker cooler (gravel bed) stack sampling tests there were no unusual kiln upsets or delays. Both kilns were operating under normal conditions. While conducting the third test, after 4 points had been taken, the back wash fans on the gravel bed dust collector shorted out and kicked off. The sampling probe was pulled from the stack at 13:23 and an upset condition was called. After evaluating the problem the decision was made to conduct the remainder of test 3 without the back wash fans. At 13:28 the probe was placed back in the stack and all operating parameters re-set.

There was no change in the gravel bed Delta P or clinker cooler settings. The only noticeable change was an increase in the stack temperatures. The test was completed at 14:26.

RCBuckner/ckn

cc: Frank DeVoaght - TACB
R. L. Norwood
C. W. Moore, Jr.

Robert C. Buckner
Process Engineer

Robert C. Buckner

METCO

APPENDIX G

Visible Emissions Data

SOURCE NAME Lehigh Portland Cement Co. OBSERVER Billy J. Mullins, JR.

ADDRESS: Waco, Texas DATE: 2 August 1983

Point of Emission: Kiln Baghouse Stack

OBSERVATION POINT: By Crusher House

STACK: DISTANCE FROM: 200' HEIGHT: 130'

WIND – SPEED: 5mph DIRECTION: West

SKY CONDITION: Hazy, Scattered Clouds

COLOR OF EMISSION: Light Brown

RELATIVE HUMIDITY: 30%

Background: sky

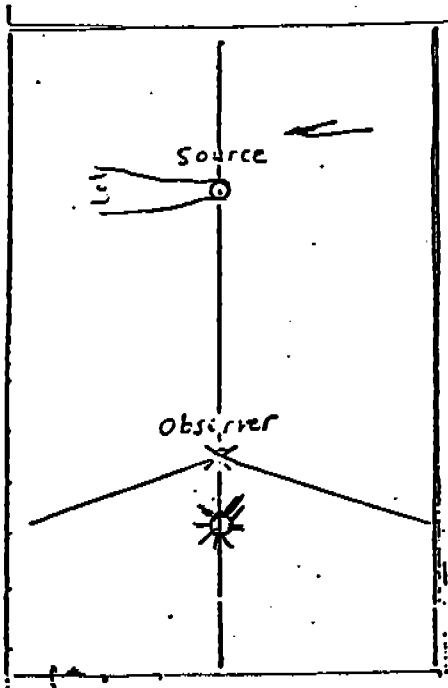
AMBIENT AIR TEMPERATURE: 95

CERTIFICATION DATE: May 26, 1983

SUMMARY OF AVERAGE OPACITY

Set Number	Time Start--End	Opacity Sum	Opacity Average
1	1205-1211	155	6.5
2	1240-1246	230	9.6
3	1337-1343	175	7.3
			7.8

Observer X
Sun Wind Plume & Stack



Remarks:

Evaluator's Signature: Billy J. Mullins, Jr.

	0	15	30	45		0	15	30	45
0	5	5	5	5	30				
1	5	5	5	5	31				
2	5	5	5	5	32				
3	5	5	10	10	33				
4	10	10	10	10	34				
5	10	5	5	5	35				
6					36				
7	10	10	10	10	37				
8	10	10	15	10	38				
9	10	10	10	10	39				
10	10	10	10	10	40				
11	5	10	10	5	41				
12	5	10	10	10	42				
13					43				
14	10	10	10	10	44				
15	10	10	10	10	45				
16	5	5	5	10	46				
17	5	10	5	5	47				
18	5	10	5	5	48				
19	5	5	5	5	49				
20					50				
21					51				
22					52				
23					53				
24					54				
25					55				
26					56				
27					57				
28					58				
29					59				

I received a copy of these opaci readings

Title: Date:

SOURCE NAME Lehigh Portland Cement Co. OBSERVER Billy J. Mullins, JR.

ADDRESS: Waco, Texas DATE: 3 August 1983

Point of Emission: Clinker Cooler Stack

OBSERVATION POINT Kiln Floor

STACK: DISTANCE FROM: 100' HEIGHT: 20'

WIND - SPEED: 10 mph DIRECTION: West

SKY CONDITION: Overcast

COLOR OF EMISSION: Light Brown-Grey

RELATIVE HUMIDITY: 30%

Background: Overcast sky

AMBIENT AIR TEMPERATURE: 85

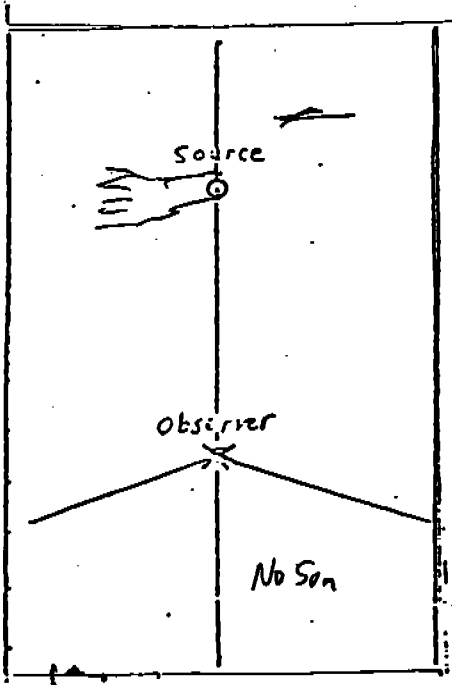
CERTIFICATION DATE: May 26, 1983

SUMMARY OF AVERAGE OPACITY

Set Number	Time Start--End	Opacity Sum	Opacity Average
1	1228-1234	120	5.0

Observer X

Sun Wind Plume & Stack



Remarks:

	0	15	30	45		0	15	30	45
0	5	5	5	5	30				
1	5	5	5	5	31				
2	5	5	5	5	32				
3	5	5	5	5	33				
4	5	5	5	5	34				
5	5	5	5	5	35				
6					36				
7					37				
8					38				
9					39				
10					40				
11					41				
12					42				
13					43				
14					44				
15					45				
16					46				
17					47				
18					48				
19					49				
20					50				
21					51				
22					52				
23					53				
24					54				
25					55				
26					56				
27					57				
28					58				
29					59				

I received a copy of these opaci readings

Evaluator's Signature: Billy J. Mullins, Jr.

Date:

Title:

METCO

APPENDIX H

Chain of Custody

MULLINS ENVIRONMENTAL TESTING CO., INC.

Chain of Custody

Job Number 83.69

Job Name LEHIGH PORTLAND CEMENT

Location KILN STACK WACO TX

Unit Tested KILN STACK

Date(s) Sampled August 2, 1983

Number of Tests 111

Date Results Required August 8, 1983

SOURCE SAMPLES

	Number of Containers	Particulate	SO_2	SO_3	H_2S	Cl_2	H_2SO_4	Metals	Other
Filter Container	111	✓							
Front Wash	111	✓							
Back Wash									
Impinger No. 1	111	✓		✓					
Impinger No. 2	111		✓						
Impinger No. 3	111		✓						
Impinger No. 4									
Acetone Blank	1	✓							
NO_x	IXI IXI II								NO_x

Special Instructions

Sample No. 1 Recovered by: L. Williams Date: 8/2/83 Time: 11:50 Location: VAN

Sample No. 2 Recovered by: Billy J. Mullins, Jr. Date: 8/2/83 Time: 1325 Location: Van

Sample No. 3 Recovered by: L. Williams Date: 8/2/83 Time: 1530 Location: VAN

NO_x Billy J. Mullins, Jr. 8/3/83 1000 Van

Samples Received by: Jim Biela for Transport Date: 8-3-83 Time: 1515

Samples Received at Lab by: Tamyra A. Jones Date: 8/4/83 Time: 0800

Samples Analyzed by: JR Morfus Date: 8/10/83 Time: 1500

MULLINS ENVIRONMENTAL TESTING CO., INC.

Chain of Custody

Job Number 83-69

Job Name Lehigh Portland Cement Co.

Location Waco, Texas

Unit Tested Clinker Cooler Stack

Date(s) Sampled 3 August 1983

Number of Tests 111

Date Results Required 8 August 1983

SOURCE SAMPLES

	Number of Containers	Particulate	SO_2	SO_3	H_2S	Cl_2	H_2SO_4	Metals	Other
Filter Container	111	✓							
Front Wash	111	✓							
Back Wash	111	✓							
Impinger No. 1									
Impinger No. 2									
Impinger No. 3									
Impinger No. 4									
Acetone Blank	1	✓							
NO_x									

Special Instructions

Sample No. 1 Recovered by: Billy J. Mullins, Jr. Date: 8/3/83 Time: 1100 Location: Van

Sample No. 2 Recovered by: Billy J. Mullins, Jr. Date: 8/3/83 Time: 1325 Location: Van

Sample No. 3 Recovered by: Billy J. Mullins, Jr. Date: 8/3/83 Time: 1505 Location: Van

Samples Received by: Jim Biela for Transport Date: 8-3-83 Time: 1515

Samples Received at Lab by: Tamyra A. Jones Date: 8/4/83 Time: 0800

Samples Analyzed by: JR Monfries Date: 8/10/83 Time: 1500

APPENDIX I

Resumes of Test Personnel

MULLINS ENVIRONMENTAL TESTING CO., INC.
P.O. Box 598
Addison, Tx 75001
(214) 931-7127

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 (Multi-Engine-Land, Instrument)
Diplomat in the American Academy of Environmental Engineers

Professional Memberships

Air Pollution Control Association - Past Chairman, Southwest Section; Chairman - Consultants Committee
Source Evaluation Society - President
Texas Society of Professional Engineers
National Society of Professional Engineers
American Management Association

METCO

MULLINS

Technical Experience

Directed and performed stack sampling on over 1000 sources of which over 100 were sampled simultaneously using more than one sampling train at several points in the flue gas stream. 1972-present.

Directed and performed over 100 short-term ambient air studies using mobile sampling vans and various ambient air sampling equipment. 1972-present.

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.

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MULLINS

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.

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.

Conducted a two-day short course entitled "Performing and Observing Source Sampling" in Lincoln, Nebraska, in March 1980 for the State of Nebraska, Air Quality Control Division.

MULLINS ENVIRONMENTAL TESTING CO., INC.
P.O. Box 598
Addison, Tx 75001
(214) 931-7127

METCO

LARRY WILLIAMS, Environmental Field Technician

Education	B.S. 1974, Southwest Texas State University, San Marcos, Texas, in Biology (Microbiology) with a minor in Chemistry. Completed graduate hours for Masters in Microbiology.
Technical Experience	Participated in the sampling of over 50 sources, including several which were sampled simultaneously using more than one sampling train. Thoroughly trained in all EPA testing procedures. 1982-present.
Research Projects	An Aerobiology Study of the Airborne Molds of the South and Southwest United States. Isolation and Quantification of the Major Energy Enzyme complexes of the Airborne Flagellated Protozoan Bodo sp.
Teaching Experience	Seven years as Laboratory Instructor of Microbiology, Pathogenic Microbiology, Immunology, Virology, and Pathogenic Mycology.

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(214) 931-7127

METCO

TIMOTHY P. BIELA, Environmental Field Technician

Education	B.S. 1982, Southeastern Oklahoma State University, Durant, Oklahoma, in Conservation with a minor in Biology.
Technical Experience	Participated in the sampling of over 25 sources, including several which were sampled simultaneously using more than one sampling train. Thoroughly trained in all EPA testing procedures. 1983-present.