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Field Services Division

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Comprehensive Emissions Test Report

Port Inland Plant
NOx, CO
Relative Accuracy Testing

Testing Date(s): August 28, 2013
Report Date: October 7, 2013
Revision Date: No revision to date

Subject Facility:
Graymont Western Lime Inc.
Port Inland Plant
181 County 432
Gulliver, MI 49480

Regulatory Permit No.:
Air Permit 26-04A
Western Lime Gulliver

Subject Emission Sources:
Lime Kiln Kiln 1

Test Locations:
Baghouse Exhaust SV-2

Report Prepared For:

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Pace Project No. 12-13-0703

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Executive Summary

Graymont Western Lime Inc. contracted Pace Analytical Services, Inc. to perform relative accuracy test audits (RATA) on the continuous emissions monitoring system for the Lime Kiln Stack at the Graymont Western Lime Inc. facility in Gulliver, Michigan. Testing was performed on August 28, 2013. Summary results are highlighted in the following table:

Test Results Summary

Parameter	RM Average	CEMS Average	RA	Status
Oxides of nitrogen,				
LB/HR	55.0	47.7	14.0%	Pass[1]
PPMv	145.6	122.0	17.2%	Pass[1]
Carbon monoxide,				
LB/HR	83.4	82.6	6.1%	Pass[1]
PPMv	362.6	347.6	9.4%	Pass[1]

[1]Relative Accuracy performance criterion is ≤20% of reference method.

Introduction

Pace Analytical Services, Inc. personnel conducted oxides of nitrogen (NO_x) and carbon monoxide (CO) continuous emissions monitoring system (CEMS) relative accuracy test audits (RATA). Testing was conducted on the Lime Kiln Stack at the Graymont Western Lime Inc. facility in Gulliver, Michigan. Mike Walter and Andrew Stock performed on-site testing activities. Terry Borgerding provided administrative project management. Amy Neste with Graymont Western Lime Inc. coordinated plant activities for testing. Nathaniel Hude with Michigan Department of Environmental Quality-Air Quality Division was on-site to witness the test event. Pace Analytical Services, Inc. prepared a comprehensive test protocol that was submitted to the Michigan Department of Environmental Quality and approved prior to testing. On-site activities consisted of the following measurements:

- Oxygen/carbon dioxide, nine 21-minute monitoring periods.
- Oxides of nitrogen, nine 21-minute monitoring periods
- Carbon monoxide, nine 21-minute monitoring periods.
- Moisture measurements in conjunction with each set of three constituent test runs.
- Volumetric airflow, measurements in conjunction with each constituent test run.

The project objectives were to quantify oxides of nitrogen and carbon monoxide emissions and compare them to the CEMS results to verify relative accuracy (RA) of the system. These measurements were performed at greater than 50% normal operating condition. Quality protocols comply with regulatory compliance testing requirements.

Subsequent sections summarize the test results and provide descriptions of the process and test methods. Supporting information and raw data are in the appendices.

Results Summary

Results of NO_x CEMS relative accuracy determinations are summarized in Table 1. Results of CO CEMS relative accuracy determinations are summarized in Table 2. The NO_x CEMS RA averaged 14.0% for LB/HR and 17.2% for PPMv based on the reference method average. The CO CEMS RA averaged 6.1% for LB/HR and 9.4% for PPMv based on the reference method average. EPA Performance Specification 6 requires that CEMS relative accuracy be ≤ 20% of the reference method average.

The data in this report are indicative of emission characteristics of the measured sources for process conditions at the time of the test. Representations to other sources and test conditions are beyond the scope of this report.

Summary Tables

Graymont Western Lime Inc.

Graymont Western Lime Gulliver
Gulliver, MI
Pace Project No. 12-13-0703

Table 1

NOx RATA Summary
Lime Kiln Stack
Test 1

Run No.	Date	Run Start	Run End	Ref. Method	CEMS	Difference
Airflow					**DSCFM**	
Run 1	8/28/2013	0910	0931	54,072	54,465	393
Run 2	8/28/2013	0932	0953	52,500	54,330	1,829
Run 3	8/28/2013	0954	1015	54,142	55,334	1,191
Run 4	8/28/2013	1045	1106	52,781	54,819	2,038
Run 5	8/28/2013	1107	1128	52,803	54,589	1,786
Run 6	8/28/2013	1129	1150	52,094	54,255	2,161
Run 7	8/28/2013	1215	1246	52,082	54,037	1,955
Run 8	8/28/2013	1247	1308	52,066	54,077	2,011
Run 9	8/28/2013	1309	1320	52,102	54,937	2,835
Average				52,738	54,538	1,800
Std. Dev.	678.048	Conf. Interva	521.193	**Relative Accuracy**		**4.4%**
						Based on Reference Method
Constituent Monitor, Oxides of Nitrogen					**PPMv**	
Run 1	8/28/2013	0910	0931	138.0	116.7	-21.3
Run 2	8/28/2013	0932	0953	138.6	113.6	-25.0
Run 3	8/28/2013	0954	1015	136.5	114.4	-22.0
Run 4	8/28/2013	1045	1106	145.2	121.8	-23.3
Run 5	8/28/2013	1107	1128	143.1	121.9	-21.2
Run 6	8/28/2013	1129	1150	151.1	127.9	-23.2
Run 7	8/28/2013	1215	1246	145.3	121.7	-23.6
Run 8	8/28/2013	1247	1308	149.8	125.2	-24.6
Run 9	8/28/2013	1309	1320	162.4	135.1	-27.3
Average				145.6	122.0	-23.5
Std. Dev.	1.95	Conf. Interva	1.50	**Relative Accuracy**		**17.2%**
						Based on Reference Method
System Reporting Value, Oxides of Nitrogen					**LB/HR**	
Run 1	8/28/2013	0910	0931	53.5	45.6	-7.9
Run 2	8/28/2013	0932	0953	52.1	44.2	-7.9
Run 3	8/28/2013	0954	1015	52.9	45.4	-7.6
Run 4	8/28/2013	1045	1106	54.9	47.9	-7.0
Run 5	8/28/2013	1107	1128	54.1	47.7	-6.5
Run 6	8/28/2013	1129	1150	56.4	49.7	-6.7
Run 7	8/28/2013	1215	1246	54.2	47.1	-7.1
Run 8	8/28/2013	1247	1308	55.9	48.5	-7.4
Run 9	8/28/2013	1309	1320	60.6	53.2	-7.4
Average				55.0	47.7	-7.3
Std. Dev.	0.51	Conf. Interva	0.39	**Relative Accuracy**		**14.0%**

Based On Reference Method

Graymont Western Lime Inc.

Graymont Western Lime Gulliver
Gulliver, MI
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Table 2

CO RATA Summary
Lime Kiln Stack
Test 1

Run No.	Date	Run Start	Run End	Ref. Method	CEMS	Difference
Airflow					**DSCFM**	
Run 1	8/28/2013	0910	0931	54,072	54,465	393
Run 2	8/28/2013	0932	0953	52,500	54,330	1,829
Run 3	8/28/2013	0954	1015	54,142	55,334	1,191
Run 4	8/28/2013	1045	1106	52,781	54,819	2,038
Run 5	8/28/2013	1107	1128	52,803	54,589	1,786
Run 6	8/28/2013	1129	1150	52,094	54,255	2,161
Run 7	8/28/2013	1215	1246	52,082	54,037	1,955
Run 8	8/28/2013	1247	1308	52,066	54,077	2,011
Run 9	8/28/2013	1309	1320	52,102	54,937	2,835
Average				52,738	54,538	1,800
Std. Dev.	678.048	Conf. Interva	521.193		**Relative Accuracy**	**4.4%**
						Based on Reference Method
Constituent Monitor, Carbon Monoxide					**PPMv**	
Run 1	8/28/2013	0910	0931	227.6	223.6	-4.0
Run 2	8/28/2013	0932	0953	329.3	310.6	-18.6
Run 3	8/28/2013	0954	1015	467.1	441.0	-26.0
Run 4	8/28/2013	1045	1106	338.9	332.4	-6.5
Run 5	8/28/2013	1107	1128	465.6	409.2	-56.5
Run 6	8/28/2013	1129	1150	356.8	368.8	12.0
Run 7	8/28/2013	1215	1246	481.5	433.1	-48.3
Run 8	8/28/2013	1247	1308	393.5	395.2	1.7
Run 9	8/28/2013	1309	1320	203.1	214.8	11.6
Average				362.6	347.6	-15.0
Std. Dev.	24.69	Conf. Interva	18.98		**Relative Accuracy**	**9.4%**
						Based On Reference Method
System Reporting Value, Carbon Monoxide					**LB/HR**	
Run 1	8/28/2013	0910	0931	53.7	53.2	-0.5
Run 2	8/28/2013	0932	0953	75.4	73.7	-1.7
Run 3	8/28/2013	0954	1015	110.3	106.4	-3.9
Run 4	8/28/2013	1045	1106	78.0	79.4	1.4
Run 5	8/28/2013	1107	1128	107.2	97.3	-9.9
Run 6	8/28/2013	1129	1150	81.1	87.2	6.1
Run 7	8/28/2013	1215	1246	109.4	101.8	-7.6
Run 8	8/28/2013	1247	1308	89.4	93.0	3.6
Run 9	8/28/2013	1309	1320	46.2	51.4	5.2
Average				83.4	82.6	-0.8
Std. Dev.	5.57	Conf. Interva	4.28		**Relative Accuracy**	**6.1%**

Based On Reference Method

Detail Tables

Graymont Western Lime Inc.

Graymont Western Lime Gulliver
Gulliver, MI
Pace Project No. 12-13-0703

Table 3

Major Gases and Moisture Results
Lime Kiln Stack
Test 1

Parameter	**Run 1**	**Run 2**	**Run 3**
Date of Run	8/28/13	8/28/13	8/28/13
Time of Run	0910-1010	1017-1117	1216-1316
Average Flue Gas Temperature, °F	391.7	393.3	398.0
Sample Volume, Meter Conditions, Ft^3	39.73	40.12	40.32
Sample Volume, Dry Standard, Ft^3	39.51	39.58	39.67
Moisture Collected, ml	72.7	73.6	78.0
Moisture Content, %v/v	7.97	8.05	8.47
Moisture Content if Saturated, %v/v	NA (>BP)	NA (>BP)	NA (>BP)
Relative Humidity, % rH	NA (>BP)	NA (>BP)	NA (>BP)
Molecular Weight of Flue Gas, lb/lb-mole			
Dry			
Wet	31.21	31.18	31.12

Graymont Western Lime Inc.

Graymont Western Lime Gulliver
Gulliver, MI
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Table 4

Airflow Measurement Results
Lime Kiln Stack
Test 1

Parameter	**Run 1**	**Run 2**	**Run 3**	**Run 4**	**Run 5**	**Run 6**	**Run 7**	**Run 8**	**Run 9**
Date of Run	8/28/13	8/28/13	8/28/13	8/28/13	8/28/13	8/28/13	8/28/13	8/28/13	8/28/13
Time of Measurement	0910	0932	0954	1045	1107	1129	1215	1247	1309
Barometric Pressure, Inches Hg	29.32	29.32	29.32	29.32	29.32	29.32	29.32	29.32	29.32
Static Pressure, Inches WC	-0.53	-0.57	-0.52	-0.53	-0.40	-0.38	-0.41	-0.39	-0.38
Absolute Gas Pressure (In. Hg)	29.28	29.28	29.28	29.28	29.29	29.29	29.29	29.29	29.29
Average Gas Temperature, °F	393	390	393	393	394	393	396	397	401
Moisture Determination Procedure		Method 4							
Average Moisture Content, %v/v	8.0	8.0	8.0	8.0	8.0	8.0	8.5	8.5	8.5
Gas Molecular Weight (Instrumental), lb/lb-mole									
Dry	32.3	32.4	32.4	32.3	32.3	32.3	32.3	32.3	32.3
Wet	31.2	31.2	31.2	31.2	31.2	31.2	31.1	31.1	31.1
Flue Gas Average Velocity, FPS	44.08	42.65	44.13	43.06	43.12	42.49	42.83	42.86	43.09
Duct Cross-sectional Area, Sq. Ft.	36.67	36.67	36.67	36.67	36.67	36.67	36.67	36.67	36.67
Volumetric Flow Rate (Rounded to 100 CFM)									
ACFM	96,992	93,851	97,115	94,758	94,876	93,489	94,234	94,310	94,814
SCFM	58,755	57,047	58,831	57,402	57,425	56,654	56,901	56,884	56,923
DSCFM	54,072	52,500	54,142	52,781	52,803	52,094	52,082	52,066	52,102

Airflow values are not rounded to appropriate significant figures for reconstruction to other values.

Process Description

Target Operating Conditions: Single Condition at 90+% Capacity

Graymont Western Lime Inc. operates a rotary lime kiln near Gulliver, Michigan. The operations at this facility are subject to the requirements of air quality operating permit MI-ROP-N7362-2010a, issued July 1, 2010. The plant has a maximum lime production rate of 870 tons per day (TPD) and 292,000 tons of lime production per year.

A rotary kiln is a long, cylindrical, refractory-lined furnace that is slightly inclined. The limestone and hot gases pass counter-currently through the kiln. The lime plant consists of a single 235-foot long rotary kiln with a pre-heater and lime cooler. The kiln is fired with coal or a mixture of coal and petroleum coke. Coal and/or petroleum coke is burned near the discharge end of the kiln to provide the necessary heat for the process. The kiln rotates continuously to prevent the drum from sagging, to improve the product contact with the hot gases, and to move the product through the kiln. To maximize fuel efficiency, a product cooler and limestone pre-heater are used to recover heat from the product and the hot gasses. The lime product is discharged from the kiln and then conveyed to various storage silos, where it is screened to size and then shipped to the end user. Lime is used in the metallurgical, pulp and paper, construction, and waste treatment industries.

Emissions from the process consist primarily of particulate matter (PM), carbon monoxide (CO), nitrogen oxides (NO_x), and sulfur dioxide (SO_2) from fuel combustion. Emission controls for the kiln consist of a fabric filter baghouse for PM control, a fuel sulfur content limit and combustion optimization to reduce CO and NO_x emissions. The majority of the SO_2 is collected within the process, owing to reactions with calcium oxide in the kiln.

Emission Monitor Locations

Air is forced through the kiln and passes through the preheater prior to entering the baghouse for treatment. Sealed ductwork carries the air from the kiln to the baghouse and from the baghouse to the stack. Therefore, all exhaust gases from the kiln are directed to and discharged through the kiln stack (SV-2 in the permit), located after the baghouse. Western Lime installed emission monitors on the kiln stack to monitor the performance of the kiln exhaust gases. The placement of these monitors was designed based on the applicable performance specifications and the manufacturer's recommendations. Each monitor's location was selected to ensure representative sampling, easy access for maintenance and calibration, and to reduce the potential for disturbances between monitoring equipment.

EPA Method 1 specifies test location acceptability criteria and defines the minimum number of traverse points for representative sampling. Linear measurements from upstream and downstream flow disturbances and the duct equivalent diameter are compared and the distances related to number of diameters. A flow disturbance can be defined as anything that changes or upsets the direction of flow within the duct including bends, dampers, fans, shape or size transitions and open flames. Method 1 stipulates that test ports should be located at least eight diameters downstream and two diameters upstream of any flow disturbance. The minimum acceptable criteria are two diameters downstream and 0.5 diameters upstream of flow disturbances. The test location must also be free of cyclonic or multidirectional flow. Once the distances have been determined, the values are used to select the minimum number of traverse points for representative sampling. Shorter distances require a greater number of traverse points. The test site configuration is shown in Figure 1 and has the following characteristics:

Test Location:	EU-Kiln #1 Exhaust Stack
Duct Cross-sectional Dimension:	82"
Distance From Upstream Disturbance:	300"
Number of Duct Diameters:	3.7
Distance To Downstream Disturbance:	768"
Number of Duct Diameters:	9.4
Cyclonic or Multidirectional Flow:	no, verified
Number of Traverse Points:	16

EPA Method 2 defines procedures used to measure linear velocity and volumetric flow rate of a confined gas stream. Using traverse points determined by EPA Method 1, multiple differential pressure measurements (pitot impact opening versus static pressure) are made using a pitot tube and differential pressure gauge. The individual measurements are averaged and combined with the gas density to calculate the average gas velocity. The velocity and duct cross-sectional area are used to calculate the volumetric flow rate. The volumetric flow rate is expressed as actual cubic feet per minute (ACFM), standard cubic feet per minute (SCFM), and dry standard cubic feet per minute (DSCFM). The technician maintains comprehensive test records on handwritten field data sheets. Details of the equipment used to measure gas velocity include:

Pitot Tube:	S-Type
Differential Pressure Gauge:	Oil Manometer
Temperature Device:	Type K Thermocouple
Barometer Type:	Electronic Digital Barometer
Gas Density Determination:	EPA Method 3
Gas Moisture Determination:	EPA Method 4

EPA Method 3A defines procedures to measure carbon dioxide (CO_2) and oxygen (O_2) concentrations from stationary sources. A stainless steel sampling probe and a sampling line draw a sample of the gas stream from the duct to a thermo-electric gas conditioner to remove moisture. The sample gas stream is delivered to an infrared gas analyzer to quantify CO_2 concentrations. A paramagnetic gas analyzer quantified O_2 concentrations. Zero grade cylinder nitrogen provides zero gas and span gases include varying concentrations of EPA Protocol 1 CO_2/O_2 standards. A computerized data acquisition system logs CO_2/O_2 concentrations for one-minute averages. The logged results are integrated to test periods and tabulated with spreadsheet software. The operator also maintains comprehensive test records on handwritten field data sheets. Equipment used for CO_2/O_2 testing includes:

Probe Material:	Stainless Steel
Moisture Removal:	Thermo-electric
Transfer Line:	Teflon™
Analytical Technique:	Non-dispersive Infrared Detector & Paramagnetic Detector
Calibration Gas:	EPA Protocol 1

EPA Method 4 defines procedures to measure the moisture content of emissions gas streams from stationary sources. A stainless steel sampling probe draws a sample of the gas stream from the duct to a series of impingers to condense the water vapor. The first two impingers initially contain deionized water and a third impinger is empty. A desiccant packed drying column follows the impingers to quantitatively collect the remaining moisture. An ice bath maintains the impinger train temperature (outlet) at 68°F or less. Collected water condensate is measured and discarded. Method 4 equations convert the condensed liquid volume to a gas volume. The water vapor volume compared with the dry standard gas volume collected through the isokinetic train determines the moisture content of the emissions gas stream and is reported in percent by volume.

Probe Material:	Stainless Steel
Impinger Train Material:	Aluminum
Desiccant:	Drierite
Condensate Measure:	Graduated Cylinder
Desiccant Measure:	Electronic balance

EPA Method 7E defines procedures to measure nitrogen oxides (NO_x) emissions from stationary sources. A stainless steel sampling probe and a heat-traced Teflon™ sampling line draw a sample of the gas stream from the duct to a thermo-electric gas conditioner to remove moisture. The sample gas stream is delivered to a chemiluminescence NO-NO_2-NO_x analyzer to quantify NO_x emissions. Zero grade cylinder air provides zero gas and span gases include varying concentrations of EPA Protocol 1 NO_x standards. A computerized data acquisition system logs NO_x concentrations for one-minute averages. The logged results are integrated to test periods and tabulated with spreadsheet software. The operator also maintains comprehensive test records on handwritten field data sheets. Equipment used for NO_x testing includes:

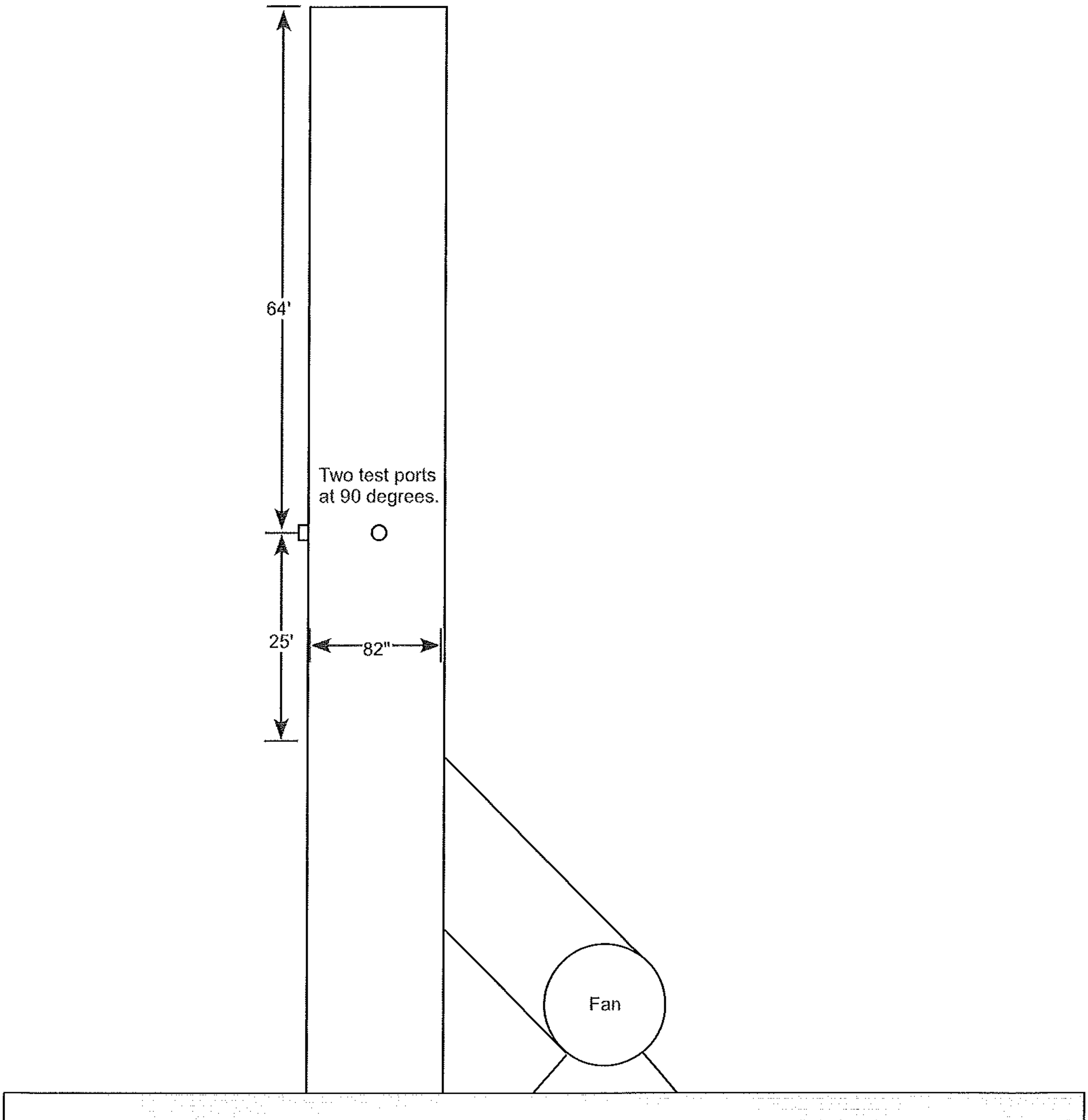
Probe Material:	Stainless Steel
Moisture Removal:	Thermo-electric
Transfer Line:	Teflon™
Analytical Technique:	Chemiluminescence
Calibration Gas:	EPA Protocol 1

EPA Method 10 defines procedures to measure carbon monoxide (CO) emissions from stationary sources. A stainless steel sampling probe and a heat-traced Teflon™ sampling line draw a sample of the gas stream from the duct to a thermo-electric gas conditioner to remove moisture. The sample gas stream is delivered to a gas filter correlation non-dispersive infrared analyzer to quantify CO concentrations. Zero grade cylinder air provides zero gas and span gases include varying concentrations of EPA Protocol 1 CO standards. A computerized data acquisition system logs CO concentrations for one-minute averages. The logged results are integrated to test periods and tabulated with spreadsheet software. The operator also maintains comprehensive test records on handwritten field data sheets. Equipment used for CO testing includes:

Probe Material:	Stainless Steel
Moisture Removal:	Thermo-electric
Transfer Line:	Teflon™
Analytical Technique:	Non-dispersive Infrared
Calibration Gas:	EPA Protocol 1

Pace Analytical
Field Services Division

Figure 1
Graymont Western Lime Inc.
Gulliver, Michigan
Kiln #1 Exhaust
JTD \ 07/09



Report Signatures

Field Testing and Reporting Performed by: Pace Analytical Services, Inc.
Field Services Division
1700 Elm Street, Suite 200
Minneapolis, MN 55414

Field Testing Affirmation

All field testing was performed in accordance with stated test methods subject to modifications and deviations listed herein. Raw field data presented in this report accurately reflects results and information as recorded at the time of tests or otherwise noted.

Date 10/1/13

Mike Walter, QSTI
Field Analyst

Report Affirmation

To the best of my knowledge, this report accurately represents the compiled field and laboratory information with no material omissions, alterations or misrepresentations.

Responsible Charge Affirmation

I have reviewed the information herein and it is approved for distribution.

Date 10/1/13

Terence J. Borgerding, QSTI
Operations Manager Air

Appendix A

Field Data Sheets and Documentation