

Comprehensive Emissions Test Report

Port Inland Plant
PM & PM-10 Compliance Testing
Airflow, NO_x, CO Relative Accuracy Testing

Testing Date(s): August 6 and 7, 2024

Report Date: September 25, 2024

Revision Date: No revision to date



Subject Facility:

Graymont Western Lime
Port Inland Plant
181 W County Road 432
Gulliver, MI 49480

Regulatory Permit No.:

ROP: MI-ROP-N7362-2020
SRN: N7362
EGLE Contact: Andrew Riley

Subject Emission Sources:

Lime Kiln Kiln 1

Test Locations:

Baghouse Stack SV-2

Report Prepared For:

Keith Miller
Graymont
800 Hill Avenue
Superior, WI 54880

Telephone No.: (218) 269-2750

E-mail Address: kmiller@graymont.com

Report Preparation Supervised By:

Thomas Rehling
Pace® Analytical Services
1700 Elm Street SE
Minneapolis, MN 55414
Telephone No.: (612) 759-5189
E-mail Address: thomas.rehling@pacelabs.com

Pace® Project No. 24-08393

Table of Contents

Report Cover	1
Table of Contents	2
Regulatory Summary	3
Introduction	4
Results Summary	6
Summary Tables	7
Table 1	Particulate Results Summary (M5) 8
Table 2	Particulate Results Summary (M201A/202) 9
Table 3	CEMS Relative Accuracy Results, Airflow 10
Table 4	CEMS Relative Accuracy Results, CO & NO _x 11
Detail Tables	12
Table 5	Particulate Results (M5) 13
Table 6	Particulate Results (M201A/202) 14
Table 7-9	Major Gases and Moisture Results 15
Table 10	Airflow Measurement Results (RATA) 18
Process Description	19
Test Procedures	20
Figure 1	Test Location Schematic 33
Report Signatures	34
Appendix A	Field Data Sheets and Documentation A-1
Appendix B	Quantitation and Laboratory Reports B-1
Appendix C	Calculation Equations and Report Nomenclature C-1
Appendix D	Quality Assurance Information D-1
Appendix E	Source/Process/Plant Information E-1
Appendix F	Test Protocol and Pretest Correspondence F-1

Regulatory Summary

Subject Facility: Graymont Western Lime
 Port Inland Plant
 Plant Address: 181 W County Road 432
 Gulliver, MI 49480

 Air Permit No.: MI-ROP-N7362-2020
 SRN: N7362
 EGLE Contact: Andrew Riley

Emission Unit IDs	Emission Unit Name	Regulated Constituent	Regulatory Citations	Regulatory Limit	Average Test Result
Kiln 1	Lime Kiln	Particulate Matter ¹	40 CFR 63.7090(a)	≤0.10 LB/Ton Stone Feed (TSF)	0.0167 LB/TSF
		PM-10 ²	R 336.1205 40 CFR 52.21(j)	≤7.5 LB/HR	4.26 LB/HR
				≤0.10 LB/TSF	0.0674 LB/TSF

¹Filterable non-condensable particulate matter (EPA Method 5).

²Filterable PM-10 (EPA Method 201A) + condensable (EPA Method 202) particulate matter.

RATA Test Results Summary

	Ref. Method Average	CEMS Average	RA or Difference	Status
Airflow, SCFM	53,981	50,913	7.37%	Pass ¹
CO, LB/HR	36.3	29.3	7.31%	Pass ²
NO _x , LB/HR	72.6	63.1	8.37%	Pass ³

¹Relative accuracy performance criteria is ≤20% based on the reference method.

²Relative accuracy performance criteria is ≤10% relative to the applicable standard of 113.2 LB/HR.

³Relative accuracy performance criteria is ≤10% relative to the applicable standard of 132.6 LB/HR.

Introduction

Pace® Analytical Services personnel conducted particulate and PM-10 emission compliance testing and relative accuracy test audits (RATA) on the continuous emission rate monitoring systems (CERMS) on the Lime Kiln (Kiln 1) Baghouse Stack (SV-2) at the Graymont Western Lime facility located in Gulliver, Michigan. Zack Eckstrom, Lucas Ruhland, and Marcus Demers performed on-site testing activities on August 6 and 7, 2024. Tom Rehling provided administrative project management. Chuck Clark and Keith Miller with Graymont Western Lime coordinated plant activities during testing. Pace® Analytical Services prepared a comprehensive test protocol that was submitted to the Michigan Department of Environment, Great Lakes, and Energy (EGLE) and approved prior to testing. Andrew Riley with EGLE was onsite to witness testing. On-site activities consisted of the following measurements:

Compliance Testing

- Particulate (EPA Method 5), four independent 96-minute samplings.
- PM-10 (EPA Method 201A/202), three independent samplings.
- Gas composition (O_2), data recorded on the M5 FDS from the calibrated analyzer during Runs 1 and 2.
- Gas composition (CO_2), the average concentration from the integrated bag samples collected during Runs 3 and 4 was used for Runs 1 and 2.
- Gas composition (O_2/CO_2), integrated bags collected concurrent with M201A/202 Runs 3 and 4.
- Volumetric airflow, measurements collected in conjunction with isokinetic testing.

Relative Accuracy Test Audits

- Carbon monoxide (CO), nitrogen oxides (NO_x), ten independent 21-minute monitoring periods.
- Gas composition (O_2/CO_2), ten independent 21-minute monitoring periods.
- Moisture, three independent one-hour samplings periods.
- Volumetric airflow, measurements with each constituent test run.

The project objectives were to quantify particulate and PM-10 emission constituents and compare them to applicable air emissions regulations stipulated by EGLE, the facility permit, and 40 CFR Part 63 Subpart AAAAA and to quantify CO and NO_x mass rates and compare them to CERMS results to verify relative accuracy (RA) of the system. Process conditions during testing were recorded by Graymont Western Lime personnel and are included in Appendix E. 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 particulate (EPA Method 5) determinations are summarized in Table 1. The filterable non-condensable particulate emission rate averaged 1.06 LB/HR and 0.0167 LB/TSF. The filterable non-condensable particulate emission limit for this source is 0.10 LB/TSF. The particulate dry catch (EPA Method 5) was used to report filterable non-condensable particulate matter. The umbilical was loose during the Run 2 post-test leak check. An additional run (Run 4) was performed and Runs 1, 3, and 4 were used to calculate results. The field data for Run 2 is included in Appendix A and the laboratory results are included in Appendix B.

Results of PM-10 determinations are summarized in Table 2. The PM-10 emission rate averaged 4.26 LB/HR and 0.0674 LB/TSF. The PM-10 emission limits for this source are 7.5 LB/HR and 0.10 LB/TSF. PM-10 was collected from an EPA Method 201A/202 train. The <10 μ m filterable catch (EPA Method 201A) was combined with the organic and inorganic wet catch (EPA Method 202) to report PM-10.

Results of CERMS RA determinations are summarized in Tables 3 and 4. The airflow RA was 7.37% comparing SCFM based on the reference method average. The CO RA was 7.31% comparing LB/HR relative to the applicable standard of 113.2 LB/HR. The NO_x RA was 8.37% comparing LB/HR relative to the applicable standard of 132.6 LB/HR. Results of moisture and airflow measurements used to calculate CO and NO_x mass rates (LB/HR) are summarized in Tables 9 and 10. EPA Performance Specification 6 requires that CERMS RA be $\leq 20\%$ of the reference method average or $\leq 10\%$ of the applicable standard.

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

Port Inland Plant

Gulliver, MI

Pace Project No. 24-08393

Table 1

Particulate Results Summary (M5)
Lime Kiln (Kiln 1) Baghouse Stack (SV-2)
Test 1

Parameter	Run 1	Run 3	Run 4	Average
Date of Run	8/6/24	8/7/24	8/7/24	
Time of Run	1110-1315	0745-0936	1055-1240	
Stone Feed Rate, TPH	62.70	64.68	64.09	63.82
Volumetric Flow Rate (Rounded to 100 CFM)				
ACFM	84,900	83,600	81,000	83,200
DSCFM	49,600	48,200	47,000	48,300
Gas Temperature, °F	367	376	371	372
Gas Moisture Content, %v/v	6.9	7.2	7.1	7.1
Gas Composition, %v/v, dry				
Carbon Dioxide, CO ₂	25.3	24.4	26.1	25.3
Oxygen, O ₂	8.2	7.7	6.9	7.6
Nitrogen, N ₂ (by difference)	66.6	67.9	67.1	67.2
Particulate Mass Rate, LB/HR				
Filterable Particulate	1.84	0.657	0.693	1.06
Particulate Concentration, GR/DSCF				
Filterable Particulate	0.00432	0.00159	0.00172	0.00254
Regulatory Units, LB/Ton Stone Feed				
Filterable Particulate	0.0293	0.0102	0.0108	0.0167

Graymont Western Lime

Port Inland Plant

Gulliver, MI

Pace Project No. 24-08393

Table 2

Particulate Results Summary (M201A/202)

Lime Kiln (Kiln 1) Baghouse Stack (SV-2)

Test 1

Parameter	Run 1	Run 2	Run 3	Average
Date of Run	8/6/24	8/6/24	8/7/24	
Time of Run	1110-1325	1442-1632	0745-0936	
Stone Feed Rate, TPH	62.70	62.00	64.68	63.13
Volumetric Flow Rate (Rounded to 100 CFM)				
ACFM	81,300	77,300	87,200	81,900
DSCFM	47,400	45,300	50,100	47,600
Gas Temperature, °F	368	370	377	372
Gas Moisture Content, %v/v	7.0	6.3	7.4	6.9
Gas Composition, %v/v, dry				
Carbon Dioxide, CO ₂	25.3	25.3	24.4	25.0
Oxygen, O ₂	8.2	8.8	7.7	8.2
Nitrogen, N ₂ (by difference)	66.6	66.0	67.9	66.8
Particulate Concentration, GR/DSCF				
< 10 µm Particulate Matter	0.0106	0.00901	0.0116	0.0104
Particulate Mass Rate, LB/HR				
< 10 µm Particulate Matter	4.30	3.49	4.99	4.26
Regulatory Units, LB/Ton Stone Feed				
< 10 µm Particulate Matter	0.0686	0.0564	0.0771	0.0674

Graymont Western Lime

Port Inland Plant

Gulliver, MI

Pace Project No. 24-08393

Table 3

CEMS Relative Accuracy Results
Lime Kiln (Kiln 1) Baghouse Stack (SV-2)

Test 1

Volumetric Flow Rate

Airflow, SCFM

<u>Run</u>	<u>Date</u>	<u>Start</u>	<u>End</u>	<u>Duration</u>	<u>RM Result</u>	<u>CEM Result</u>	<u>Difference</u>
1	8/7/24	12:50	13:11	0:21	53,460	51,328	-2,132
3	8/7/24	13:34	13:55	0:21	55,643	51,159	-4,484
4	8/7/24	14:20	14:41	0:21	53,008	51,234	-1,774
5	8/7/24	14:42	15:03	0:21	54,629	51,096	-3,533
6	8/7/24	15:04	15:25	0:21	54,617	50,581	-4,036
7	8/7/24	15:45	16:06	0:21	53,925	50,655	-3,270
8	8/7/24	16:07	16:28	0:21	54,406	50,381	-4,025
9	8/7/24	16:29	16:50	0:21	51,996	51,041	-955
10	8/7/24	17:08	17:29	0:21	54,148	50,743	-3,405
Run Average					53,981	50,913	-3,068
Standard Deviation							1,185
Confidence Coefficient							911
Relative Accuracy					(% of RM Avg)		7.37
RA Requirement					≤ 20% of RM Average		
RA Status					Pass		

Graymont Western Lime

Port Inland Plant
Gulliver, MI
Pace Project No. 24-08393

Table 4

CEMS Relative Accuracy Results
Lime Kiln (Kiln 1) Baghouse Stack (SV-2)
Test 1

Carbon Monoxide

LB/HR

Run	Date	Start	End	Duration	RM Result	CEM Result	Difference
1	8/7/24	12:50	13:11	0:21	36.3	29.8	-6.52
2	8/7/24	13:12	13:33	0:21	43.6	33.8	-9.75
3	8/7/24	13:34	13:55	0:21	34.3	26.0	-8.29
4	8/7/24	14:20	14:41	0:21	34.1	28.2	-5.88
5	8/7/24	14:42	15:03	0:21	32.0	26.7	-5.27
6	8/7/24	15:04	15:25	0:21	36.9	28.3	-8.51
7	8/7/24	15:45	16:06	0:21	35.6	28.5	-7.12
8	8/7/24	16:07	16:28	0:21	36.7	29.6	-7.18
9	8/7/24	16:29	16:50	0:21	37.1	32.4	-4.70
Run Average					36.3	29.3	-7.02
Standard Deviation							1.63
Confidence Coefficient							1.26
Relative Accuracy					(% of Em. Limit) [113.2]		7.31
RA Requirement					≤ 10% of Emission Limit		
RA Status					Pass		

Nitrogen Oxides as NO2

LB/HR

Run	Date	Start	End	Duration	RM Result	CEM Result	Difference
1	8/7/24	12:50	13:11	0:21	71.2	62.5	-8.72
2	8/7/24	13:12	13:33	0:21	75.6	63.3	-12.3
4	8/7/24	14:20	14:41	0:21	71.3	63.1	-8.28
5	8/7/24	14:42	15:03	0:21	75.5	65.0	-10.6
6	8/7/24	15:04	15:25	0:21	73.3	62.1	-11.2
7	8/7/24	15:45	16:06	0:21	72.7	62.6	-10.1
8	8/7/24	16:07	16:28	0:21	72.3	61.2	-11.1
9	8/7/24	16:29	16:50	0:21	70.6	63.2	-7.38
10	8/7/24	17:08	17:29	0:21	70.6	64.6	-5.99
Run Average					72.6	63.1	-9.52
Standard Deviation							2.06
Confidence Coefficient							1.58
Relative Accuracy					(% of Em. Limit) [132.6]		8.37
RA Requirement					≤ 10% of Emission Limit		
RA Status					Pass		

Detail Tables

Graymont Western Lime

Port Inland Plant

Gulliver, MI

Pace Project No. 24-08393

Table 5

Particulate Results (M5)

Lime Kiln (Kiln 1) Baghouse Stack (SV-2)

Test 1

Parameter	Run 1	Run 3	Run 4
Date of Run	8/6/24	8/7/24	8/7/24
Time of Run	1110-1315	0745-0936	1055-1240
Sample Duration, Minutes	96	96	96
Average Flue Gas Temperature, °F	367.4	376.4	370.8
Moisture Content of Flue Gas, %v/v	6.9	7.2	7.1
Particulate Collected, mg			
Dry Catch	19.29	7.22	7.51
Inorganic Wet Catch	NR	NR	NR
Organic Wet Catch	NR	NR	NR
Volumetric Flow Rate (Rounded to 100 CFM)			
ACFM	84,900	83,600	81,000
SCFM	53,200	51,900	50,600
DSCFM	49,600	48,200	47,000
Sample Volume, Meter Conditions, Ft ³	72.14	72.89	70.69
Sample Volume, Dry Standard, Ft ³	68.87	70.05	67.36
Particulate Concentration, GR/DSCF			
Filterable Particulate	0.00432	0.00159	0.00172
Particulate Emission Rate, LB/HR			
Filterable Particulate	1.84	0.657	0.693

NR=Not required or not requested.

Graymont Western Lime

Port Inland Plant

Gulliver, MI

Pace Project No. 24-08393

Table 6

Particulate Results (M201A/202)

Lime Kiln (Kiln 1) Baghouse Stack (SV-2)

Test 1

Parameter	Run 1	Run 2	Run 3
Date of Run	8/6/24	8/6/24	8/7/24
Time of Run	1110-1325	1442-1632	0745-0936
Sample Duration, Minutes	91.5	85.6	100.6
Average Flue Gas Temperature, °F	367.7	370.3	376.5
Moisture Content of Flue Gas, %v/v	7.0	6.3	7.4
Volumetric Flow Rate (Rounded to 100 CFM)			
ACFM	81,300	77,300	87,200
SCFM	51,000	48,300	54,100
DSCFM	47,400	45,300	50,100
Particulate Collected, mg Blank Corrected			
PM ₁₀ Cyclone - >10 µm Filterable	NTP	NTP	NTP
PM _{2.5} Cyclone - 2.5 - 10 µm Filterable	1.35	0.74	1.35
Filter Catch - <2.5 µm Filterable	1.12	0.52	0.87
CPM _{ORG} - Organic Condensable	0	1.49	3.59
CPM _{INORG} - Inorganic Condensable	20.36	15.73	22.44
Actual PM10 Cut Diameter, µm	10.4	10.4	10.2
Actual PM2.5 Cut Diameter, µm	2.42	2.40	2.35
Particulate Concentration, GR/DSCF			
< 10 µm Filterable PM	0.00114	0.000617	0.000913
Organic Condensable PM	0	0.000724	0.00147
Inorganic Condensable PM	0.00944	0.00767	0.00922
Particulate Emission Rate, LB/HR			
< 10 µm Filterable PM	0.465	0.239	0.392
Organic Condensable PM	0	0.281	0.633
Inorganic Condensable PM	3.84	2.97	3.96

NTP = Non-Target Parameter, intentionally excluded from the test protocol.

Graymont Western Lime

Port Inland Plant
Gulliver, MI
Pace Project No. 24-08393

Table 7

Major Gases and Moisture Results (M5)
Lime Kiln (Kiln 1) Baghouse Stack (SV-2)
Test 1

Parameter	Run 1	Run 3	Run 4
Date of Run	8/6/24	8/7/24	8/7/24
Time of Run	1110-1315	0745-0936	1055-1240
Major Gas Constituents - Instrumental, % v/v			
Dry Basis (as measured)			
Carbon Dioxide	25.25	24.40	26.10
Oxygen	8.20	7.67	6.85
Nitrogen (by difference)	66.55	67.93	67.05
Wet Basis (calculated)			
Carbon Dioxide	23.50	22.65	24.24
Oxygen	7.63	7.12	6.36
Nitrogen	61.94	63.05	62.26
Portable Oxygen Monitor Result			
Time Weighted Average, %O ₂	8.2	9.0	7.2
Moisture Collected, ml	109.0	115.3	110.1
Moisture Content, %v/v	6.93	7.19	7.14
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	32.37	32.21	32.45
Wet	31.37	31.19	31.42

Graymont Western Lime

Port Inland Plant

Gulliver, MI

Pace Project No. 24-08393

Table 8

Major Gases and Moisture Results (M201A/202)

Lime Kiln (Kiln 1) Baghouse Stack (SV-2)

Test 1

Parameter	Run 1	Run 2	Run 3
Date of Run	8/6/24	8/6/24	8/7/24
Time of Run	1110-1325	1442-1632	0745-0936
Major Gas Constituents - Instrumental, % v/v			
Dry Basis (as measured)			
Carbon Dioxide	25.25	25.25	24.40
Oxygen	8.20	8.76	7.67
Nitrogen (by difference)	66.55	65.99	67.93
Wet Basis (calculated)			
Carbon Dioxide	23.48	23.65	22.59
Oxygen	7.63	8.21	7.10
Nitrogen	61.89	61.81	62.90
Portable Oxygen Monitor Result			
Time Weighted Average, %O ₂	7.2	7.3	7.8
Moisture Collected, ml	53.2	45.5	63.8
Moisture Content, %v/v	7.00	6.33	7.40
Moisture Content if Saturated, %v/v	NA (T>BP)	NA (T>BP)	NA (T>BP)
Relative Humidity, % rH	NA (T>BP)	NA (T>BP)	NA (T>BP)
Molecular Weight of Flue Gas, lb/lb-mole			
Dry	32.37	32.39	32.21
Wet	31.36	31.48	31.16

NA (T>BP) = Not applicable, gas temperature is greater than boiling point of water (supersaturation is possible).

Graymont Western Lime

Port Inland Plant
Gulliver, MI
Pace Project No. 24-08393

Table 9

Major Gases and Moisture Results (RATA) Lime Kiln (Kiln 1) Baghouse Stack (SV-2) Test 1

Parameter	Run 1	Run 2	Run 3
Date of Run	8/7/24	8/7/24	8/7/24
Time of Run	1250-1350	1420-1520	1545-1645
Sample Duration, Minutes	60	60	60
Average Flue Gas Temperature, °F	370	377	374
Major Gas Constituents - Instrumental, % v/v			
Dry Basis (as measured)			
Carbon Dioxide	26.31	26.25	26.31
Oxygen	6.76	6.76	6.72
Nitrogen (by difference)	66.93	67.00	66.97
Wet Basis (calculated)			
Carbon Dioxide	24.65	24.31	24.43
Oxygen	6.33	6.26	6.24
Nitrogen	62.69	62.04	62.19
Portable O ₂ Monitor Average, %O ₂	7.42	7.23	7.23
Sample Volume, Meter Conditions, Ft ³	31.49	31.81	30.99
Sample Volume, Dry Standard, Ft ³	30.29	30.45	29.62
Moisture Collected, ml	43.5	51.7	48.4
Moisture Content of Gas Stream, %v/v	6.33	7.40	7.14
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	32.48	32.47	32.48
Wet	31.56	31.40	31.44

Graymont Western Lime

Port Inland Plant

Gulliver, MI

Pace Project No. 24-08393

Table 10

Airflow Measurement Results (RATA)
Lime Kiln (Kiln 1) Baghouse Stack (SV-2)
Test 1

Parameter	Run 1	Run 2	Run 3	Run 4	Run 5	Run 6	Run 7	Run 8	Run 9	Run 10
Date of Run	8/7/24	8/7/24	8/7/24	8/7/24	8/7/24	8/7/24	8/7/24	8/7/24	8/7/24	8/7/24
Time of Measurement	1140	1300	1320	1430	1450	1505	1605	1615	1640	1725
Barometric Pressure, Inches Hg	29.45	29.45	29.45	29.45	29.45	29.45	29.45	29.45	29.45	29.45
Static Pressure, Inches WC	-0.39	-0.39	-0.41	-0.37	-0.44	-0.43	-0.33	-0.34	-0.37	-0.43
Absolute Gas Pressure (In. Hg)	29.42	29.42	29.41	29.42	29.41	29.41	29.42	29.42	29.42	29.41
Average Gas Temperature, °F	358	360	360	376	379	379	375	375	370	370
Corresponding M-4 Run Number	1	1	1	2	2	2	3	3	3	3
Average Moisture Content, %v/v	6.3	6.3	6.3	7.4	7.4	7.4	7.1	7.1	7.1	7.1
Gas Molecular Weight (Instrumental), lb/lb-mole										
Dry	32.48	32.48	32.48	32.48	32.46	32.47	32.48	32.48	32.48	32.47
Wet	31.57	31.56	31.56	31.41	31.39	31.40	31.45	31.45	31.45	31.43
Flue Gas Average Velocity, FPS	38.27	40.20	39.93	38.78	40.11	40.10	39.40	39.75	37.77	39.33
Duct Cross-sectional Area, Sq. Ft	36.67	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	84,200	88,500	87,900	85,300	88,300	88,200	86,700	87,500	83,100	86,600
SCFM	53,500	56,000	55,600	53,000	54,600	54,600	53,900	54,400	52,000	54,100
DSCFM	50,100	52,500	52,100	49,100	50,600	50,600	50,100	50,500	48,300	50,300

Process Description

Graymont Western Lime 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-N7362-2020, issued November 19, 2020. 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 (SO₂) 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 SO₂ is collected within the process, owing to reactions with calcium oxide in the kiln.

Test related process and operational details were collected by Graymont Western Lime personnel and included in Appendix E.

Test Procedures

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 and measurement details are documented on EPA Method 1 Field Data Sheet.

Pace® FSD conducts the method as written with no routine deviations.

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 EPA Method 2 Field Data Sheet. Details of the equipment used to measure gas velocity include:

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

Method Defined Quality Control:

- Pitot tubes are verified on an annual basis.
- Temperature device operation is confirmed for single point temperature and polarity for each test. Temperature devices undergo a full multipoint verification on an annual basis.
- Electronic barometers are verified for accuracy and calibrated on a semi-annual basis. Aneroid barometers are not used.

- Electronic Digital Manometers (EDMs) are verified for accuracy and calibrated on a semi-annual basis. EDMs are operationally confirmed and leak checked for each run.
- Sampling system leak-checks are performed before and after each run and prior to any component change during a run.

Pace® FSD conducts the method with the following routine deviation:

Duct temperatures are measured at a single point using a handheld temperature probe rather than at each traverse point.

EPA Method 3A defines procedures to measure carbon dioxide (CO₂) and oxygen (O₂) 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 conditioned gas stream is delivered to an infrared gas analyzer to quantify CO₂ concentrations and paramagnetic gas analyzer to quantify O₂ concentrations. Zero grade cylinder air or a zero gas generator provides zero gas. Span gases include varying concentrations of EPA Protocol 1 CO₂/O₂ mixed standards specific to the target calibration range. A computerized data acquisition system logs CO₂/O₂ concentrations for one-minute averages. The logged results are integrated to test periods and tabulated with standardized and validated spreadsheets in Microsoft Excel. The operator also maintains comprehensive test records in the electronic Project Results Instrumental Workbook. Equipment used for CO₂/O₂ testing includes:

Probe Material:	Stainless Steel
Moisture Removal:	Thermo-electric
Transfer Line:	Teflon™
Analytical Technique:	Non-dispersive Infrared Detector (CO ₂) Paramagnetic Detector (O ₂)
Calibration Gas:	EPA Protocol 1

Method Defined Quality Control:

- Sampling system leak-checks are performed before each test and following any component change. Absence of leaks is confirmed through the bias check after each run.
- Calibration gas standards of the highest quality, Protocol 1 or traceable to NIST, are used in calibrations.
- Analyzer calibration error is determined before initial run and after any failed bias or drift test.
- Analyzer bias is verified once per test.
- System bias check is performed before and after each test.
- Calibration drift test is performed after each test run.
- System response time is determined during initial sampling system bias test.
- Stratification test is performed prior to first run.

- Purge time of $\geq 2x$ the response time observed before starting data collection and recording stratification traverse point values.

Pace® FSD conducts the method as written with no routine deviations.

Modified EPA Method 3/3A defines procedures to quantify carbon dioxide (CO₂) and oxygen (O₂) concentrations from stationary combustion sources. An integrated gas sample is collected simultaneously with other emissions testing. Sample gases are extracted from an emission stream at a constant rate over the course of a test period equal to other test constituents. A Tedlar™, aluminized Mylar™, or other inert material bag contains the collected gas sample prior to sample analyses. Instrumental gas analyzers compliant to EPA Method 3A quantify the CO₂ and O₂ concentrations. Three point instrument calibrations (zero, mid, and high span) are performed to certify the instruments for gas analyses. The technician maintains comprehensive test records on EPA Method 3 and Gas Analysis Field Data Sheets. Equipment used for measuring gas composition includes:

Filter Material:	Glass-fiber Filter or equivalent
Moisture removal:	Condenser and/or sorbent
Bag Material:	Tedlar™ or Aluminized Mylar™ or equivalent
Gas Analyzer:	Non-dispersive Infrared Detector (CO ₂) Paramagnetic Detector (O ₂)
Calibration Gases:	EPA Protocol 1

Method Defined Quality Control:

- Sampling bag leak check.

Pace® FSD conducts the method as written with the following routine sampling deviation:

In the field, the gas sample is analyzed within two hours of collection using a portable O₂ detector. At a later time, potentially outside of the eight hour hold period, the gas sample is re-analyzed using an EPA Method 3A instrumental gas analyzer to quantify CO₂ and O₂ concentrations.

The preliminary analysis result from the portable O₂ detector is used to validate the Method 3A results. The results are acceptable when the O₂ result from the field and the O₂ result from the lab differ by $\leq 0.3\%$.

EPA Method 4 defines procedures to measure the moisture content of emission 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 or aluminum condenser to condense the water vapor. The first two impingers initially contain deionized water and a third is dry. A condenser is initially dry. A desiccant packed drying column follows the impingers or condenser to quantitatively collect the remaining moisture. An ice bath

maintains the impinger train or condenser 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 measured through a dry gas meter determines the moisture content of the emissions gas stream and is reported in percent by volume. The operator maintains comprehensive test records on EPA Method 4 Field Data Sheet, Constant Rate Moisture Sampling.

Probe Material:	Stainless Steel
Filter Media:	Glass or Quartz Fiber or Glass Wool
Impinger Train Material:	Borosilicate Glass or aluminum
Desiccant:	Drierite
Condensate Measure:	Graduated Cylinder or Electronic Scale
Desiccant Measure:	Electronic Scale

Method Defined Quality Control:

- Dry gas meters are verified by wet test meter comparison for a three-point "as found" determination and a full five-point calibration every 500 CF, or 90 days (first occurring). The Pace® standard "as left" calibration factor is within $\pm 1\%$ (the method standard is $\pm 2\%$).
- Sample rate orifices are calibrated every 500 CF, or 90 days (first occurring).
- Temperature device operation is confirmed for single point temperature and polarity for each test. Temperature devices undergo a full multipoint verification on an annual basis.
- Electronic barometers are verified for accuracy and calibrated on a semi-annual basis. Aneroid barometers are not used.
- Sampling system leak-checks are performed before and after each run and prior to any component change during a run.
- Field scales are verified for accuracy over the entire range of use on an annual basis and verified before each use using stainless steel reference weights traceable to national standards maintained by NIST.

Pace® FSD conducts the method with the following sampling deviations:

The gas sample is extracted from the source from a single point in the centroid of the stack using an unheated probe with an in-stack filter. Water vapor is condensed using aluminum condensers followed by a drierite dry column. The metering system verification cited above is a method QC alternative but considered more rigorous.

EPA Method 4 - Isokinetic defines procedures to measure the moisture content of emission gas streams from stationary sources. The moisture content of the gas stream is determined in conjunction with an isokinetic sampling train. Collected water condensate is measured from the back half of the isokinetic train. 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. Test records are included on the associated isokinetic method data sheet. Equipment used for measuring moisture content includes:

Probe Material:	Borosilicate glass or Stainless Steel
Filter Media:	Glass or Quartz fiber
Impinger Train Material:	Borosilicate Glass
Desiccant:	Drierite
Condensate Measure:	Graduated Cylinder or Electronic Scale
Desiccant Measure:	Electronic Scale

Method Defined Quality Control:

- Dry gas meters are verified by wet test meter comparison for a three-point "as found" determination and a full five-point calibration every 500 CF, or 90 days (first occurring). The Pace® standard "as left" calibration factor is within $\pm 1\%$ (the method standard is $\pm 2\%$).
- Gas meter volumes are verified at each traverse point by calculating the expected gas volume for each interval and comparing the gas volume metered during the interval.
- Sample rate orifices are calibrated every 500 CF, or 90 days (first occurring).
- Temperature device operation is confirmed for single point temperature and polarity for each test. Temperature devices undergo a full multipoint verification on an annual basis.
- Electronic barometers are verified for accuracy and calibrated on a semi-annual basis. Aneroid barometers are not used.
- Sampling system leak-checks are performed before and after each run and prior to any component change during a run.
- Field scales are verified for accuracy over the entire range of use on an annual basis and verified before each use using stainless steel reference weights traceable to national standards maintained by NIST.

The metering system verification cited above is a method QC alternative but considered more rigorous. Pace® FSD conducts the method as written with no routine sampling deviations.

EPA Method 5 defines procedures to measure particulate emissions from stationary sources. Using traverse points determined from EPA Method 1 and incorporating procedures from EPA Methods 2, 3, and 4, a sample gas stream is isokinetically drawn from the emission stream. The particulate dry fraction collects in the sampling probe and on a quartz or glass-fiber filter. The probe and filter components of the sampling train are heated to 248°F ($\pm 25^\circ\text{F}$) to prevent moisture condensation and preserve sample integrity. The filtered sample gas stream passes through a series of impingers to condense water vapor and collect gaseous constituents. The first two impingers

initially contain deionized water, and the 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. The impinger contents can be discarded or saved for additional analyses. Sample recovery and train clean up are performed after each run using procedures to ensure sample integrity and quantitative recovery. The train operator maintains comprehensive test records on EPA Method 5 Field Data Sheet, Isokinetic Particulate Sampling. Details of particulate testing are outlined below:

Nozzle/Probe Material:	Stainless Steel and Borosilicate Glass
Filter Holder Material:	Borosilicate Glass with glass or Teflon support
Filter Media:	Quartz or Glass-fiber, >99.95% efficient at 0.3µm
Impinger Train Material:	Borosilicate Glass
Impinger Reagents:	Deionized Water
Recovery Reagents:	Acetone Deionized water
Control Train:	Gas meter, orifice, differential pressure gauges, pump, valves, temperature monitors and controllers
Analytical Techniques:	Gravimetric

Method Defined Quality Control:

- Dry gas meters are verified by wet test meter comparison for a three-point "as found" determination and a full five-point calibration every 500 CF, or 90 days (first occurring). The Pace® standard "as left" calibration factor is within $\pm 1\%$ (the method standard is $\pm 2\%$).
- Sample rate orifices are calibrated every 500 CF, or 90 days (first occurring).
- Gas meter volumes are verified at each traverse point by calculating the expected gas volume for each interval and comparing the gas volume metered during the interval.
- Pitot tubes are verified on an annual basis.
- Temperature device operation is confirmed for single point temperature and polarity for each test. Temperature devices undergo a full multipoint verification on an annual basis.
- Electronic barometers are verified for accuracy and calibrated on a semi-annual basis. Aneroid barometers are not used.
- Electronic Digital Manometers (EDMs) are verified for accuracy and calibrated on a semi-annual basis. EDMs are operationally confirmed and leak checked for each run.
- Sampling system leak-checks are performed before and after each run and prior to any component change during a run.
- Sampling is performed at an isokinetic rate between 90 and 110%.

- A field blank is collected to verify site conditions to be non-contaminating.
- Sampling and recovery reagents are reagent grade or better.
- Analytical balances are calibrated and certified on an annual basis by an external service provider and verified before each use using stainless steel reference weights traceable to national standards maintained by NIST.
- Field scales are verified for accuracy over the entire range of use on an annual basis and verified before each use using stainless steel reference weights traceable to national standards maintained by NIST.

The metering system verification cited above is a method QC alternative but considered more rigorous. Pace® FSD conducts the method as written with no routine sampling deviations.

EPA Method 7E defines procedures to measure nitrogen oxide (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-NO₂-NO_x analyzer to quantify NO_x emissions. Zero grade cylinder air or a zero gas generator provides zero gas. Span gases include varying concentrations of EPA NO_x standards specific to the target calibration range. A computerized data acquisition system logs NO_x concentrations for one-minute averages. The logged results are integrated to test periods and tabulated with standardized and validated spreadsheets in Microsoft Excel. The operator also maintains comprehensive test records in the electronic Project Results Instrumental Workbook. 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

Method Defined Quality Control:

- Sampling system leak-checks are performed before each test and following any component change. Absence of leaks is confirmed through the bias check after each run.
- Calibration gas standards of the highest quality, Protocol 1 or traceable to NIST, are used in calibrations.
- Analyzer calibration error is determined before initial run and after any failed bias or drift test.
- Analyzer bias is verified once per test.
- System bias check is performed before and after each test.
- Calibration drift test is performed after each test run.

- System response time is determined during initial sampling system bias test.
- Stratification test is performed prior to first run.
- Purge time of $\geq 2x$ the response time observed before starting data collection and recording stratification traverse point values.
- NO₂ to NO converter efficiency verified $\geq 90\%$ before or after each test.

Pace® FSD conducts the method as written with no routine deviations.

In-Stack Method: 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 or a zero gas generator provides zero gas. Span gases include varying concentrations of EPA Protocol 1 CO standards specific to the target calibration range. A computerized data acquisition system logs CO concentrations for one-minute averages. The logged results are integrated to test periods and tabulated with standardized and validated spreadsheets in Microsoft Excel. The operator also maintains comprehensive test records in the electronic Project Results Instrumental Workbook. Equipment used to conduct Method 10 stack method testing includes:

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

Method Defined Quality Control:

- Sampling system leak-checks are performed before each test and following any component change. Absence of leaks is confirmed through the bias check after each run.
- Calibration gas standards of the highest quality, Protocol 1 or traceable to NIST, are used in calibrations.
- Analyzer calibration error is determined before initial run and after any failed bias or drift test.
- System bias check is performed before and after each test.
- Analyzer bias is verified once per test.
- Calibration drift test is performed after each test run.
- System response time is determined during initial sampling system bias test.
- Stratification test is performed prior to first run.
- Purge time of $\geq 2x$ the response time observed before starting data collection and recording stratification traverse point values.

Pace® FSD conducts the method as written with no routine deviations.

EPA Method 201A defines procedures to measure particulate matter equal to or less than 10 microns (PM-10) and 2.5 microns (PM-2.5) from stationary sources. Using traverse points determined from EPA Method 1 and incorporating procedures from EPA Methods 2, 3, 4, and 5, a sample gas stream is drawn from the emission stream at a constant rate through an in-stack sizing devices: a PM-10 cyclone followed by a PM-2.5 cyclone. The cyclones separator classifies particulate matter at 10-micron (μm) and 2.5-micron (μm) aerodynamic cut diameters (nominal). Cyclones collect particulate matter at the cut size and larger. The omission of either cyclone excludes the measurement of that particle cut size from the method. The cyclones are followed by an in-stack glass fiber filter to collect remaining filterable particulate (less than the cut diameter). The sample gas moves through a heated sampling probe to the back half of the sampling train. This method is used in conjunction with Method 202 when the gas stream temperature exceeds 85°F to collect condensable particulate which is included as PM-2.5. See separate summary for Method 202. The back half of the train consists of glass impingers and a desiccant packed drying column to quantitatively collect water vapor. An ice bath maintains the impinger train temperature (outlet) at 68°F or less. Sample recovery and train clean-up are performed after each run using procedures to ensure sample integrity and quantitative recovery. Sample fractions are processed from the cyclone heads into separate sample containers using a brush and acetone. Gravimetric analysis is applied to determine the particulate mass for each size fraction. The train operator maintains comprehensive test records on EPA Method 201A Field Data Sheet. Details of PM-10 and PM-2.5 particulate testing include:

Nozzle/Probe Material:	Stainless Steel
PM-2.5 Separator:	Stainless Steel Cyclone
PM-10 Separator:	Stainless Steel Cyclone
Filter Holder Material:	Stainless Steel
Filter Media:	Glass-fiber, >99.95% efficient at 0.3 μm
Impinger Train Material:	Borosilicate Glass
Recovery Reagents:	Acetone Deionized Water
Control Train:	EPA Method 17
Analytical Technique:	Gravimetric

Method Defined Quality Control:

- Dry gas meters are verified by wet test meter comparison for a three-point "as found" determination and a full five-point calibration every 500 CF, or 90 days (first occurring). The Pace® standard "as left" calibration factor is within $\pm 1\%$ (the method standard is $\pm 2\%$).
- Sample rate orifices are calibrated every 500 CF, or 90 days (first occurring).

- Gas meter volumes are verified at each traverse point by calculating the expected gas volume for each interval and comparing the gas volume metered during the interval.
- Pitot tubes are verified on an annual basis.
- Temperature device operation is confirmed for single point temperature and polarity for each test. Temperature devices undergo a full multipoint verification on an annual basis.
- Electronic barometers are verified for accuracy and calibrated on a semi-annual basis. Aneroid barometers are not used.
- Electronic Digital Manometers (EDMs) are verified for accuracy and calibrated on a semi-annual basis. EDMs are operationally confirmed and leak checked for each run.
- Sampling system leak-checks are performed before and after each run and prior to any component change during a run.
- Sampling is performed at an isokinetic rate between 90 and 110%.
- A field blank is collected to verify site conditions to be non-contaminating.
- Sampling and recovery reagents are reagent grade or better.
- Analytical balances are calibrated and certified on an annual basis by an external service provider and verified before each use using stainless steel reference weights traceable to national standards maintained by NIST.
- Field scales are verified for accuracy over the entire range of use on an annual basis and verified before each use using stainless steel reference weights traceable to national standards maintained by NIST.

The metering system verification cited above is a method QC alternative but considered more rigorous. Pace® FSD conducts the method as written with no routine sampling deviations.

EPA Method 202 defines procedures to determine organic and inorganic condensable particulate matter (CPM) emissions from stationary sources. The CPM is collected in a condensate knock-out impinger and Teflon filter after filterable PM has been collected by either Method 5 or Method 201A. The gas stream is sample isokinetically following EPA Method 5 or Method 201A procedures. The gas stream is initially cooled with a spiral condenser using recirculated cool water to maintain a sample gas temperature of 85°F or less. Condensate from the spiral condenser collects in glass, stemless, dropout impingers. The intent of the condenser and dropout impinger is to minimize gas/water contact to reduce collection of unintended artifacts. The dropout impinger is followed by a second impinger to provide overflow capacity. A Teflon™ filter, also maintained at 85°F or less is used to collect any remaining organic CPM. The filter is followed by an iced, water prepared impinger and desiccant packed drying column to quantitatively collect remaining moisture. Immediately after sampling, the Method 202 CPM condensate is purged with nitrogen (N₂) to liberate dissolved sulfur dioxide (SO₂) gases. The contents of the dropout and backup impingers prior to the CPM filter are measured, weighed, and transferred to an appropriate sample bottle. CPM is quantitatively

recovered with water, acetone, and hexane rinses. The CPM filter and water are extracted with hexane and combined with solvent rinses to determine the organic CPM. Following extraction, the water is dried and the residue measured as the inorganic CPM. The combination of both fractions represents the total condensable particulate matter (CPM). The train operator maintains comprehensive test records on appropriate Field Data Sheets.

Filter Holder Material:	Glass, Stainless Steel (316 or equivalent), or Fluoropolymer-coated Stainless Steel
Filter Media:	Teflon, >99.95% efficient at 0.3 um
Impinger Train Material:	Borosilicate Glass
Impinger Reagents:	Deionized Water
Recovery Reagents:	Acetone Hexane Deionized Water
Control Train:	EPA Method 5
Analytical Technique:	Gravimetric

Method Defined Quality Control:

- Dry gas meters are verified by wet test meter comparison for a three-point "as found" determination and a full five-point calibration every 500 CF, or 90 days (first occurring). The Pace® standard "as left" calibration factor is within $\pm 1\%$ (the method standard is $\pm 2\%$).
- Sample rate orifices are calibrated every 500 CF, or 90 days (first occurring).
- Gas meter volumes are verified at each traverse point by calculating the expected gas volume for each interval and comparing the gas volume metered during the interval.
- Pitot tubes are verified on an annual basis.
- Temperature device operation is confirmed for single point temperature and polarity for each test. Temperature devices undergo a full multipoint verification on an annual basis.
- Electronic barometers are verified for accuracy and calibrated on a semi-annual basis. Aneroid barometers are not used.
- Electronic Digital Manometers (EDMs) are verified for accuracy and calibrated on a semi-annual basis. EDMs are operationally confirmed and leak checked for each run.
- Sampling system leak-checks are performed before and after each run and prior to any component change during a run.
- Sampling is performed at an isokinetic rate between 90 and 110%.
- A field blank is collected to verify site conditions to be non-contaminating.
- Sampling and recovery reagents are reagent grade or better.
- Analytical balances are calibrated and certified on an annual basis by an external service provider and verified before each use using

stainless steel reference weights traceable to national standards maintained by NIST.

The metering system verification cited above is a method QC alternative but considered more rigorous. Pace® FSD conducts the method as written with no routine sampling deviations.

Reference Standards. Pace® implements a comprehensive program to verify and validate reference standards to further enhance and support method standards. Primary reference standards are directly comparable to a reference base. The National Institute of Standards and Technology (NIST) maintains primary reference materials or very closely traceable secondary standards. These materials are then used to certify secondary or transfer standards for use in quality management programs. Secondary reference standards are calibrated with primary standards using a high precision comparator. Materials that have a documented path to the primary standard are often referred to as traceable to NIST or NIST traceable. Where commercially and feasibly available, Pace® uses primary reference standards to perform calibrations and verifications. In other cases, Pace® maintains traceable secondary reference standards. Primary and secondary reference standards are used to calibrate and verify equipment and materials. Pace® reference standards are calibrated by external vendors that have a formal, registered quality system. Calibrations are performed with equipment and materials that are traceable to NIST.

Quality Controls (not defined in test methods):

- Sampling/Recovery Reagents are Reagent Grade or better.
- Reference Temperature Simulator is calibrated annually.
- Reference Pressure Transducer is calibrated annually.
- Reference DryCal airflow meter is calibrated annually.
- Mercury Barometer is a primary reference standard.
- Liquid Manometers are primary reference standards.
- Angle Blocks, Gauge Blocks, and Measuring Rods are verified every five years.
- Angle Gauges are verified each day of use.
- Calipers are verified annually.
- Stainless steel reference weights are verified every five years.
- Analytical balances are calibrated annually and verified at each use.
- Field balances are calibrated annually and verified at each use.

Quality Management System. To produce data that is complete, representative, and of known precision and accuracy, Pace® Analytical Field Services Division has designed and implemented a rigorous and innovative quality management system. The system was initially based on the USEPA Quality Assurance Handbook for Air Pollution Measurement Systems and continually developed as procedural complexities and standards progressed. The Field Services Division Quality Management System (Pace® FSD QMS) is now accredited by the American Association of Laboratory Accreditation (A2LA) to comply with three national accreditation standards:

- ASTM D7036 - Standard Practice for Competence of Air Emission Testing Bodies (AETB).
- ISO 17025 - General Requirements for the Competence of Testing and Calibration Laboratories
- The NELAC Institute - General Requirements for Field Sampling and Measurement Organizations (FSMO)

The Pace® FSD QMS includes:

- Quality Programs
 - Ethics policy and training.
 - Corrective Action and Preventative Action (CAPA).
 - Continuous Process Improvement.
 - Documented Demonstrations of Capability.
 - Internal and third party proficiency testing.
 - Qualified Individual program (QI)
 - Internal and external audits.
 - Annual management reviews.
- Documentation and Traceability
 - High quality traceable standards and reagents.
 - Reagent tracking and management system.
 - Use of matrix spikes, duplicate analysis, internal standards, and blanks.
 - Validated workbooks for data collection and results reporting.
 - Electronic quality, training, and safety documents available in-field.
 - Sample security and preservation procedures.
 - Chain of custody maintained from sample collection through laboratory analysis.
- Equipment Calibration
 - Full time staff dedicated to equipment maintenance and calibration.

All equipment and instruments are calibrated by trained personnel on a frequency that meets or exceeds method requirements.

