BTEC Inc.

Fuel Handling Systems (K20, K21, K22, and K23) Particulate Matter Emissions Test Report

Prepared for:

Lafarge Midwest Inc.

Alpena Plant
1435 Ford Avenue
Alpena, Michigan

Project No. 17-5056.00
August 15, 2017

BT Environmental Consulting, Inc.
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EXECUTIVE SUMMARY

Lafarge North America (Lafarge) operates five dry process cement kilns (Kilns 19-23) at its plant in Alpena, Michigan (EPA Facility ID #MID005379607). Kiln Nos. 19, 20, and 21 are collectively known as Kiln Group 5 (KG5). Kiln Nos. 22 and 23 are collectively known as Kiln Group 6 (KG6). The Kiln Group 5 kilns are smaller than the Kiln Group 6 kilns but are of similar overall design. Each kiln has had an indirect firing system added to the low side of the kiln to preheat the coal before it goes into the kiln.

Lafarge retained BT Environmental Consulting, Inc. (BTEC) to measure filterable and condensable particulate matter emission rates from each fuel handling system dust collector for each of the five kilns. BTEC measured filterable and condensable particulate matter emission rates from the Kilns 20-23 fuel handling system dust collectors on June 27-28, 2017.

The objective of the emissions test program was to demonstrate compliance with emission limitations for each stack for filterable particulate matter (0.15 lbs/1,000 lbs, dry) and particulate matter less than 10 microns in diameter (1.8 lbs/hr or 2.9 lbs/hr). The table below summarizes the results of the test program.

Table E-1
LafargeHolcim
Overall Emissions Summary

Source	Test Date	Pollutant	Average Test Result	Emission limitation
Kiln 20	6-27-17	Total PM	0.005 lb/1,000 lb, dry	0.15 lb/1,000 lb, dry
		PM 10	0.25 lb/hr	1.8 lb/hr
Kiln 21	6-27-17	Total PM*	0.032 lb/1,000 lb, dry	0.15 lb/1,000 lb, dry
		PM 10*	0.71 lb/hr	1.8 lb/hr
Kiln 22	6-28-17	Total PM	0.010 lb/1,000 lb, dry	0.15 lb/1,000 lb, dry
		PM 10	0.77 lb/hr	2.9 lb/hr
Kiln 23	6-28-17	Total PM	0.003 lb/1,000 lb, dry	0.15 lb/1,000 lb, dry
		PM 10	0.36 lb/hr	2.9 lb/hr

*Note: The first two Method 201A runs were outside of the 90-110 percent isokinetic requirement for determining total filterable PM. BTEC performed two extra method 17 tests to satisfy the requirements.

BTEC Inc.

1. Introduction

Lafarge North America (Lafarge) operates five dry process cement kilns (Kilns 19-23) at its plant in Alpena, Michigan (EPA Facility ID #MID005379607). Kiln Nos. 19, 20, and 21 are collectively known as Kiln Group 5 (KG5). Kiln Nos. 22 and 23 are collectively known as Kiln Group 6 (KG6). The Kiln Group 5 kilns are smaller than the Kiln Group 6 kilns but are of similar overall design. Each kiln has had an indirect firing system added to the low side of the kiln to preheat the coal before it goes into the kiln.

Lafarge retained BT Environmental Consulting, Inc. (BTEC) to measure filterable and condensable particulate matter emission rates from each fuel handling system dust collector for each of the five kilns. BTEC measured filterable and condensable particulate matter emission rates from the Kilns 20-23 fuel handling system dust collectors on June 27-28, 2017.

AQD has published a guidance document entitled "Format for Submittal of Source Emission Test Plans and Reports" (December 2013). The following is a summary of the emissions test program and results in the format suggested by the aforementioned document.

1.a Identification, Location, and Dates of Test

Sampling and analysis for the emission test program was conducted on June 27 and 28, 2017 at the Lafarge facility located in Alpena, Michigan.

1.b Purpose of Testing

The objective of the emissions test program was to demonstrate compliance with emission limitations for each stack for filterable particulate matter (0.15 lbs/1,000 lbs, dry) and particulate matter less than 10 microns in diameter (1.8 lbs/hr and 2.9 lbs/hr).

1.c Source Description

The control devices are baghouse dust collectors.

1.d Test Program Contacts

The contacts for the source and test report are:

Mr. Travis Weide
Area Environmental & Public Affairs Manager
Lafarge Midwest Inc.
1435 Ford Avenue
Alpena, Michigan 49707

Mr. Brian Joyce
Area Environmental Coordinator
Lafarge Midwest Inc.
1435 Ford Avenue
Alpena, Michigan 49707

Mr. Barry Boulianne
Senior Project Manager
BT Environmental Consulting, Inc.
4949 Fernlee Avenue
Royal Oak, Michigan 48073
(313) 449-2361

Names and affiliations for personnel who were present during the testing program are summarized by Table 1.

Table 1
Test Personnel

Name and Title	Affiliation	Telephone
Mr. Matthew Young Senior Project Manager	BTEC 4949 Fernlee Royal Oak, MI 48073	(248) 548-8070
Mr. Paul Molenda Environmental Technician	BTEC 4949 Fernlee Royal Oak, MI 48073	(248) 548-8070
Mr. Mike Nummer Environmental Technician	BTEC 4949 Fernlee Royal Oak, MI 48073	(248) 548-8070
Mr. Jake Zott Environmental Technician	BTEC 4949 Fernlee Royal Oak, MI 48073	(248) 548-8070
Mr. Shane Rabideau Environmental Technician	BTEC 4949 Fernlee Royal Oak, MI 48073	(248) 548-8070
Mr. Brian Joyce Lafarge Midwest Inc.	Lafarge – Alpena Plant 1435 Ford Avenue Alpena, Michigan 49707	(989) 916-4854
Mr. Jeremy Howe MDEQ	MDEQ AQD Cadillac District Office 120 West Chapin Street Cadillac, MI 49601	Office (231) 876-4416

2. Summary of Results

Sections 2.a through 2.d summarize the results of the emissions compliance test program.

2.a Operating Data

Kiln production rate and baghouse pressure drop is available in Appendix E.

2.b Applicable Permit

AQD issued Renewable Operating Permit MI-ROP-B1477-2012c to Lafarge North America.

2.c Results

The overall results of the emission test program are summarized by Table 2 (see Section 5.a). Detailed results for each run can be found in Tables 3-10.

3. Source Description

Sections 3.a through 3.e provide a detailed description of the process.

3.a Process Description

A mixture of pulverized bituminous coal, petroleum coke, and asphalt shingles with a heating value of approximately 11,750 Btu per pound, serves as the primary fuel fed to the kilns. Coal and coke are fed to a Raymond bowl mill and ground to a fineness of approximately 95% passing a 200-mesh sieve. Each kiln includes an indirectly fired fuel pre-heater system.

3.b Process Flow Diagram

A process flow diagram is available on request.

3.c Raw and Finished Materials

A mixture of pulverized bituminous coal, petroleum coke, and asphalt shingles with a heating value of approximately 11,750 Btu per pound, serves as the primary fuel fed to the kilns. Coal and coke are fed to a Raymond bowl mill and ground to a fineness of approximately 95% passing a 200-mesh sieve. Each kiln includes an indirectly fired fuel pre-heater system.

3.d Process Capacity

Each baghouse is rated for the maximum exhaust gas flowrate from each system and the efficiencies are equivalent to that necessary to achieve the corresponding emission limitations.

3.e Process Instrumentation

Proper operation of the baghouse dust collectors is verified by baghouse pressure drop monitoring.

4. Sampling and Analytical Procedures

Sections 4.a through 4.d provide a summary of the sampling and analytical procedures used.

4.a Sampling Train and Field Procedures

Measurement of exhaust gas velocity, molecular weight, and moisture content were conducted using the following reference test methods codified at Title 40, Part 60, Appendix A of the Code of Federal Regulations (40 CFR 60, Appendix A):

- Method 1 - *"Sample and Velocity Traverses for Stationary Sources"*
- Method 2 - *"Determination of Stack Gas Velocity and Volumetric Flowrate"*
- Method 3 - *"Determination of Oxygen and Carbon Dioxide Concentrations in Emissions from Stationary Sources" (Fyrite)*
- Method 4 - *"Determination of Moisture Content in Stack Gases"*

Stack gas velocity traverses were conducted in accordance with the procedures outlined in Method 1 and Method 2 (see Figures3-6 for a schematic of the sampling locations). S-type pitot tubes with thermocouple assemblies, calibrated in accordance with Method 2, Section 4.1.1, were used to measure exhaust gas velocity pressures (using a manometer) and temperatures during testing. The S-type pitot tube dimensions were within specified limits, therefore, a baseline pitot tube coefficient of 0.84 (dimensionless) was assigned. The pitot tubes used for M201A testing come pre-calibrated by Environmental Supply Company. The pitot tube coefficient for the Method 201A sampling trains was 0.768 and 0.769 (dimensionless).

A cyclonic flow check was performed at the sampling location. The existence of cyclonic flow is determined by measuring the flow angle at each sample point. The flow angle is the angle between the direction of flow and the axis of the stack. If the average of the absolute values of the flow angle is greater than 20 degrees, cyclonic flow exists. The null angle was determined to be less than 20 degrees at each sampling point.

Molecular weight was determined according to USEPA Method 3, "Gas Analysis for the Determination of Dry Molecular Weight." The equipment used for this evaluation consisted of a one-way squeeze bulb with connecting tubing and a set of Fyrite® combustion gas analyzers. Carbon dioxide and oxygen content were analyzed using the Fyrite® procedure.

Exhaust gas moisture content was evaluated using Method 4. Exhaust gas was extracted as part of the PM sampling trains and passed through the impinger configuration (see Figures 1-2). Exhaust gas moisture content was then determined gravimetrically.

4.b Particulate Matter (USEPA Method 201A/202)

40 CFR 60, Appendix A, Method 201A, *"Determination of PM_{10} and $PM_{2.5}$ Emissions From Stationary Sources"* and40 CFR 60, Appendix A, Method 202, *"Dry Impinger Method for Determining Condensable Particulate Emissions from Stationary Sources"* were used to measure PM concentrations and calculate PM emission rates (see Figure 1 for a schematic of the sampling train).

BTEC's Nutech® Model 2010 modular isokinetic stack sampling system consists of (1) a stainless-steel nozzle, (2) a stainless-steel PM_{10} head, (3) an in stack stainless-steel filter housing,(4) a borosilicate glass probe liner, (5) a vertical condenser, (6) an empty pot bellied impinger, (7) an empty modified Greenburg-Smith (GS) impinger, (8) unheated borosilicate filter holder with a teflon filter and Teflon filter support, (9) a second modified GS impinger with 100 ml of deionized water, and a third modified GS impinger containing approximately 300 g of silica gel desiccant, (10) a length of sample line, and (11) a Nutech® control case equipped with a pump, dry gas meter, and calibrated orifice.

A sampling train leak test was conducted before and after each test run. After completion of the final leak test for each test run, the filter was recovered, the nozzle, probe, PM_{10} head, and front half of the filter housing were brushed and triple rinsed with acetone. The acetone rinses were collected in a pre-cleaned sample container. The particulate matter greater than 10 microns was also recovered from the PM_{10} head and used for total filterable particulate matter analysis. The impinger train was then purged with nitrogen for one hour at a flow rate of 14 liters per minute. The CPM filter was recovered and placed in a petri dish. The back half of the filter housing, the condenser, the pot bellied impinger, the moisture drop out impinger, and the front half of the CPM filter housing and all connecting glassware were double rinsed with deionized water which was collected in a pre-cleaned sample container. The same glassware was then rinsed with acetone which was collected in a pre-cleaned sample container labeled as the organic fraction. The glassware was then double rinsed with hexane which was added to the same organic fraction sample bottle.

BTEC labeled each container with the test number, test location, and test date, and marked the level of liquid on the outside of the container. In addition, blank samples of the acetone, DI water, hexane, and filter were also collected.

BTEC labeled each container with the test number, test location, and test date, and marked the level of liquid on the outside of the container. In addition blank samples of the acetone and filter were collected. BTEC personnel carried all samples to BTEC's laboratory (for filter and acetone gravimetric analysis) in Royal Oak, Michigan. The method 202 samples were sent to Maxxam Analytical in Ontario, Canada.

4.c Particulate Matter (USEPA Method 17)

40 CFR 60, Appendix A, Method 17, *"Determination of Particulate Emissions from Stationary Sources"* was used to measure PM concentrations and calculate PM emission rates (see Figure 2) for a schematic of the sampling train). Two 60-minute test runs were conducted on kiln 21 to meet total filterable particulate matter sampling requirements.

BTEC's Nutech® Model 2010 modular isokinetic stack sampling system consisted of (1) a stainless-steel button-hook nozzle, (2) a stainless steel in stack filter holder with a tarred glass fiber filter(3) steel sample probe, (4) a set of four Greenburg-Smith (GS) impingers with the first and third modified and second standard GS impingers each containing 100 ml of deionized water, and a fourth modified GS impinger containing approximately 300 g of silica gel desiccant, (5) a length of sample line, and (6) a Nutech® control case equipped with a pump, dry gas meter, and calibrated orifice.

A sampling train and pitot tube leak test was conducted before and after each test run. Upon completion of the final leak check for each test run, the filter was recovered, and the nozzle and the front half of the filter holder assembly were brushed and triple rinsed with acetone. The acetone rinses were collected in a pre-cleaned sample container.

BTEC labeled each container with the test number, test location, and test date, and marked the level of liquid on the outside of the container. In addition blank samples of the acetone and filter were collected. BTEC personnel transported the filters and acetone fractions to BTEC's laboratory in Royal Oak, Michigan for gravimetric analysis.

4.d Recovery and Analytical Procedures

Filterable particulate matter samples were processed at BTEC's laboratory in Royal Oak, Michigan. Condensable particulate matter samples were sent to Maxxam Laboratories in Ontario, Canada.

4.e Sampling Ports

Diagrams of the stacks showing sampling ports in relation to upstream and downstream disturbances are included as Figures 3-6.

4.f Traverse Points

Diagrams of the stacks indicating traverse point locations and stack dimensions are included as Figures 3-6.

5. Test Results and Discussion

Sections 5.a through 5.k provide a summary of the test results.

5.a Results Tabulation

The results of the emissions test program are summarized by Table 2.

Table 2
LafargeHolcim
Overall Emissions Summary

Source	Test Date	Pollutant	Average Test Result	Emission limitation
Kiln 20	6-27-17	Total PM	0.005 lb/1,000 lb, dry	0.15 lb/1,000 lb, dry
		PM 10	0.25 lb/hr	1.8 lb/hr
Kiln 21	6-27-17	Total PM*	0.032 lb/1,000 lb, dry	0.15 lb/1,000 lb, dry
		PM 10*	0.71 lb/hr	1.8 lb/hr
Kiln 22	6-28-17	Total PM	0.010 lb/1,000 lb, dry	0.15 lb/1,000 lb, dry
		PM 10	0.77 lb/hr	2.9 lb/hr
Kiln 23	6-28-17	Total PM	0.003 lb/1,000 lb, dry	0.15 lb/1,000 lb, dry
		PM 10	0.36 lb/hr	2.9 lb/hr

*Note: The first two Method 201A runs were outside of the 90-110 percent isokinetic requirement for determining total filterable PM. BTEC performed two extra method 17 tests to satisfy the requirements.

Detailed data for each test run can be found in Tables 3-10.

5.b Discussion of Results

The objective of the emissions test program was to demonstrate compliance with emission limitations for each stack for filterable particulate matter (0.15 lbs/1,000 lbs, dry) and particulate matter less than 10 microns in diameter (1.8 lbs/hr and 2.9 lbs/hr).

All emission results are below the corresponding limits for all sources tested.

5.c Sampling Procedure Variations

The isokinetic variation of test Runs 1 and 2 on Kiln 21 were 116% and 113%, respectively. This is within the acceptable range of 80-120% required by Method 201a for PM_{10} results, but is outside the acceptable range of 90-100% required by Method 5/17 for total filterable PM results. It was decided onsite with the help of Jeremy Howe of the MDEQ, that an additional two test runs utilizing Method 17 would be performed to satisfy the testing requirement for total filterable PM.

Kiln 21 - Run 1 (M201A), Run 2 (M201A), and Run 3 (M201a) are averaged and reported for the PM_{10} emission rates.

Kiln 21 - Run 3 (M201A), Run 4 (M17), and Run 5 (M17) are averaged and reported for the total filterable PM emission rates.

5.d Process or Control Device Upsets

There were no process or control device upsets during the testing.

5.e Control Device Maintenance

No control device maintenance was performed on the kilns during the test program.

5.f Re-Test

The emissions test program was not a re-test as an alternative method 201A was employed to confirm compliance.

5.g Audit Sample Analyses

No audit samples were collected as part of the test program.

5.h Calibration Sheets

Relevant equipment calibration documents are provided in Appendix B.

5.i Sample Calculations

Sample calculations are provided in Appendix C.

5.j Field Data Sheets

Field documents relevant to the emissions test program are presented in Appendix A.

5.k Laboratory Data

Laboratory analytical results for this test program are presented in Appendix D.

Table 3
Kiln 20 Total Filterable Particulate Matter Emission Rates

Company	**LaFarge**			
Source Designation	**Kiln 20**			
Test Date	**6/27/2017**	**6/27/2017**	**6/27/2017**	
Meter/Nozzle Information	P-1	P-2	P-3	Average
Meter Temperature Tm (F)	68.8	75.6	80.2	74.8
Meter Pressure - Pm (in. Hg)	29.3	29.4	29.3	29.3
Measured Sample Volume (Vm)	44.0	54.2	50.1	49.4
Sample Volume (Vm-Std ft3)	43.0	52.3	48.0	47.8
Sample Volume (Vm-Std m3)	1.22	1.48	1.36	1.35
Condensate Volume (Vw-std)	2.838	3.362	3.291	3.164
Gas Density (Ps(std) lbs/ft3) (wet)	0.0728	0.0728	0.0727	0.0728
Gas Density (Ps(std) lbs/ft3) (dry)	0.0745	0.0745	0.0745	0.0745
Total weight of sampled gas (m g lbs) (wet)	3.34	4.06	3.73	3.71
Total weight of sampled gas (m g lbs) (dry)	3.20	3.90	3.58	3.56
Nozzle Size - An (sq. ft.)	0.000101	0.000124	0.000124	0.000117
Isokinetic Variation - I	119.8	90.1	98.1	102.6
Stack Data				
Average Stack Temperature - Ts (F)	153.3	149.9	157.3	153.5
Molecular Weight Stack Gas- dry (Md)	28.8	28.8	28.8	28.8
Molecular Weight Stack Gas-wet (Ms)	28.2	28.2	28.1	28.2
Stack Gas Specific Gravity (Gs)	0.973	0.973	0.972	0.972
Percent Moisture (Bws)	6.19	6.03	6.41	6.21
Water Vapor Volume (fraction)	0.0619	0.0603	0.0641	0.0621
Pressure - Ps ("Hg)	29.3	29.3	29.3	29.3
Average Stack Velocity -Vs (ft/sec)	70.6	75.7	70.4	72.2
Area of Stack (ft2)	4.3	4.3	4.3	4.3
Exhaust Gas Flowrate				
Flowrate ft^3(Actual)	18,109	19,421	18,042	18,524
Flowrate ft^3 (Standard Wet)	15,258	16,472	15,111	15,614
Flowrate ft^3 (Standard Dry)	14,313	15,478	14,141	14,644
Flowrate m^3 (standard dry)	405	438	400	415
Total Particulate Weights (mg)				
Nozzle/Probe/Filter	5.8	8.8	9.9	8.2
Total Particulate Concentration				
lb/1000 lb (wet)	0.004	0.005	0.006	0.005
lb/1000 lb (dry)	0.004	0.005	0.006	0.005
mg/dscm (dry)	4.8	5.9	7.3	6.0
gr/dscf	0.0021	0.0026	0.0032	0.0026
Total Particulate Emission Rate				
lb/ hr	0.26	0.35	0.39	0.33

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Table 4
Kiln 20 PM_{10} Emission Rates

Company	**LaFarge**			
Source Designation	**Kiln 20**			
Test Date	**6/27/2017**	**6/27/2017**	**6/27/2017**	
Meter/Nozzle Information	P-1	P-2	P-3	Average
Meter Temperature Tm (F)	68.8	75.6	80.2	74.8
Meter Pressure - Pm (in. Hg)	29.3	29.4	29.3	29.3
Measured Sample Volume (Vm)	44.0	54.2	50.1	49.4
Sample Volume (Vm-Std ft3)	43.0	52.3	48.0	47.8
Sample Volume (Vm-Std m3)	1.22	1.48	1.36	1.35
Condensate Volume (Vw-std)	2.838	3.362	3.291	3.164
Gas Density (Ps(std) lbs/ft3) (wet)	0.0728	0.0728	0.0727	0.0728
Gas Density (Ps(std) lbs/ft3) (dry)	0.0745	0.0745	0.0745	0.0745
Total weight of sampled gas (m g lbs) (wet)	3.34	4.06	3.73	3.71
Total weight of sampled gas (m g lbs) (dry)	3.20	3.90	3.58	3.56
Nozzle Size - An (sq. ft.)	0.000101	0.000124	0.000124	0.000117
Isokinetic Variation - I	119.8	90.1	98.1	102.6
Stack Data				
Average Stack Temperature - Ts (F)	153.3	149.9	157.3	153.5
Molecular Weight Stack Gas- dry (Md)	28.8	28.8	28.8	28.8
Molecular Weight Stack Gas-wet (Ms)	28.2	28.2	28.1	28.2
Stack Gas Specific Gravity (Gs)	0.973	0.973	0.972	0.972
Percent Moisture (Bws)	6.19	6.03	6.41	6.21
Water Vapor Volume (fraction)	0.0619	0.0603	0.0641	0.0621
Pressure - Ps ("Hg)	29.3	29.3	29.3	29.3
Average Stack Velocity -Vs (ft/sec)	70.6	75.7	70.4	72.2
Area of Stack (ft2)	4.3	4.3	4.3	4.3
Exhaust Gas Flowrate				
Flowrate ft^3(Actual)	18,109	19,421	18,042	18,524
Flowrate ft^3 (Standard Wet)	15,258	16,472	15,111	15,614
Flowrate ft^3 (Standard Dry)	14,313	15,478	14,141	14,644
Flowrate m^3 (standard dry)	405	438	400	415
Total Particulate Weights (mg)				
Total Nozzle/Probe/Filter	2.6	3.5	4.9	3.7
Organic Condensible Particulate	1.0	1.7	1.0	1.2
Inorganic Condensible Particulate	3.5	3.6	2.9	3.3
Condensible Blank Correction	2.0	2.0	2.0	2.0
Total Condensible Particulate	2.5	3.3	1.9	2.6
Total Filterable and Condensible Particulate	5.1	6.8	6.8	6.2
Filterable Particulate Concentration				
lb/1000 lb (wet)	0.002	0.002	0.003	0.002
lb/1000 lb (dry)	0.002	0.002	0.003	0.002
mg/dscm (dry)	2.1	2.4	3.6	2.7
gr/dscf	0.0009	0.0010	0.0016	0.0012
Filterable Particulate Emission Rate				
lb/ hr	0.11	0.14	0.19	0.15
Condensible Particulate Concentration				
lb/1000 lb (wet)	0.002	0.002	0.001	0.002
lb/1000 lb (dry)	0.002	0.002	0.001	0.002
mg/dscm (dry)	2.1	2.2	1.4	1.9
gr/dscf	0.0009	0.0010	0.0006	0.0008
Condensible Particulate Emission Rate				
lb/ hr	0.11	0.13	0.07	0.10
Total Particulate Concentration				
lb/1000 lb (wet)	0.003	0.004	0.004	0.004
lb/1000 lb (dry)	0.004	0.004	0.004	0.004
mg/dscm (dry)	4.2	4.6	5.0	4.6
gr/dscf	0.0018	0.0020	0.0022	0.0020
Total Particulate Emission Rate				
lb/ hr	0.23	0.27	0.27	0.25

Table 5
Kiln 21 Total Filterable Particulate Matter Emission Rates

Company	**Lafarge**			
Source Designation	**Kiln 21**			
Test Date	**6/27/2017**	**6/27/2017**	**6/27/2017**	
Meter/Nozzle Information	P-3	P-4	P-5	Average
Meter Temperature Tm (F)	96.9	94.8	93.3	95.0
Meter Pressure - Pm (in. Hg)	29.4	29.5	29.5	29.4
Measured Sample Volume (Vm)	47.6	54.8	54.7	52.4
Sample Volume (Vm-Std ft3)	43.8	50.8	50.8	48.5
Sample Volume (Vm-Std m3)	1.24	1.44	1.44	1.37
Condensate Volume (Vw-std)	3.715	4.432	3.480	3.876
Gas Density (Ps(std) lbs/ft3) (wet)	0.0723	0.0723	0.0727	0.0725
Gas Density (Ps(std) lbs/ft3) (dry)	0.0745	0.0745	0.0745	0.0745
Total weight of sampled gas (m g lbs) (wet)	3.44	3.99	3.95	3.79
Total weight of sampled gas (m g lbs) (dry)	3.26	3.79	3.78	3.61
Nozzle Size - An (sq. ft.)	0.000126	0.000245	0.000245	0.000205
Isokinetic Variation - I	90.3	98.9	98.7	95.9
Stack Data				
Average Stack Temperature - Ts (F)	157.3	158.7	155.3	157.1
Molecular Weight Stack Gas- dry (Md)	28.8	28.8	28.8	28.8
Molecular Weight Stack Gas-wet (Ms)	28.1	28.0	28.1	28.1
Stack Gas Specific Gravity (Gs)	0.972	0.966	0.972	0.970
Percent Moisture (Bws)	7.82	8.02	6.41	7.42
Water Vapor Volume (fraction)	0.0782	0.0802	0.0641	0.0742
Pressure - Ps ("Hg)	29.3	29.3	29.3	29.3
Average Stack Velocity -Vs (ft/sec)	71.1	75.7	74.2	73.7
Area of Stack (ft2)	4.0	4.0	4.0	4.0
Exhaust Gas Flowrate				
Flowrate ft^3(Actual)	16,962	18,058	17,685	17,568
Flowrate ft^3 (Standard Wet)	14,215	15,091	14,860	14,722
Flowrate ft^3 (Standard Dry)	13,103	13,880	13,907	13,630
Flowrate m^3 (standard dry)	371	393	394	386
Total Particulate Weights (mg)				
Nozzle/Probe/Filter	66.6	37.7	52.4	52.2
Total Particulate Concentration				
lb/1000 lb (wet)	0.043	0.021	0.029	0.031
lb/1000 lb (dry)	0.045	0.022	0.031	0.032
mg/dscm (dry)	53.7	26.2	36.4	38.8
gr/dscf	0.0235	0.0115	0.0159	0.0170
Total Particulate Emission Rate				
lb/ hr	2.65	1.37	1.91	1.97

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Table 6
Kiln 21 PM_{10} Emission Rates

Company	Lafarge			
Source Designation	Kiln 21			
Test Date	6/27/2017	6/27/2017	6/27/2017	
Meter/Nozzle Information	P-1	P-2	P-3	Average
Meter Temperature Tm (F)	87.2	95.3	96.9	93.1
Meter Pressure - Pm (in. Hg)	29.4	29.4	29.4	29.4
Measured Sample Volume (Vm)	46.1	46.9	47.6	46.9
Sample Volume (Vm-Std ft3)	43.1	43.2	43.8	43.4
Sample Volume (Vm-Std m3)	1.22	1.22	1.24	1.23
Condensate Volume (Vw-std)	3.131	2.994	3.715	3.280
Gas Density (Ps(std) lbs/ft3) (wet)	0.0726	0.0727	0.0723	0.0726
Gas Density (Ps(std) lbs/ft3) (dry)	0.0745	0.0745	0.0745	0.0745
Total weight of sampled gas (m g lbs) (wet)	3.36	3.36	3.44	3.38
Total weight of sampled gas (m g lbs) (dry)	3.21	3.22	3.26	3.23
Nozzle Size - An (sq. ft.)	0.000108	0.000108	0.000126	0.000114
Isokinetic Variation - I	116.1	112.9	90.3	106.4
Stack Data				
Average Stack Temperature - Ts (F)	157.1	155.5	157.3	156.6
Molecular Weight Stack Gas- dry (Md)	28.8	28.8	28.8	28.8
Molecular Weight Stack Gas-wet (Ms)	28.0	28.0	28.1	28.0
Stack Gas Specific Gravity (Gs)	0.966	0.966	0.972	0.968
Percent Moisture (Bws)	6.77	6.48	7.82	7.02
Water Vapor Volume (fraction)	0.0677	0.0648	0.0782	0.0702
Pressure - Ps ("Hg)	29.3	29.3	29.3	29.3
Average Stack Velocity -Vs (ft/sec)	66.8	67.4	71.1	68.4
Area of Stack (ft2)	4.0	4.0	4.0	4.0
Exhaust Gas Flowrate				
Flowrate ft^3(Actual)	15,933	16,069	16,962	16,321
Flowrate ft^3 (Standard Wet)	13,358	13,507	14,215	13,693
Flowrate ft^3 (Standard Dry)	12,454	12,632	13,103	12,729
Flowrate m^3 (standard dry)	353	358	371	360
Total Particulate Weights (mg)				
Total Nozzle/Probe/Filter	15.7	12.9	19.6	16.1
Organic Condensible Particulate	1.0	1.0	1.0	1.0
Inorganic Condensible Particulate	3.1	3.0	3.3	3.1
Condensible Blank Correction	2.0	2.0	2.0	2.0
Total Condensible Particulate	2.1	2.0	2.3	2.1
Total Filterable and Condensible Particulate	17.8	14.9	21.9	18.2
Filterable Particulate Concentration				
lb/1000 lb (wet)	0.010	0.008	0.013	0.010
lb/1000 lb (dry)	0.011	0.009	0.013	0.011
mg/dscm (dry)	12.9	10.5	15.8	13.1
gr/dscf	0.0056	0.0046	0.0069	0.0057
Filterable Particulate Emission Rate				
lb/ hr	0.60	0.50	0.78	0.63
Condensible Particulate Concentration				
lb/1000 lb (wet)	0.001	0.001	0.001	0.001
lb/1000 lb (dry)	0.001	0.001	0.002	0.001
mg/dscm (dry)	1.7	1.6	1.9	1.7
gr/dscf	0.0008	0.0007	0.0008	0.0008
Condensible Particulate Emission Rate				
lb/ hr	0.08	0.08	0.09	0.08
Total Particulate Concentration				
lb/1000 lb (wet)	0.012	0.010	0.014	0.012
lb/1000 lb (dry)	0.012	0.010	0.015	0.012
mg/dscm (dry)	14.6	12.2	17.7	14.8
gr/dscf	0.0064	0.0053	0.0077	0.0065
Total Particulate Emission Rate				
lb/ hr	0.68	0.58	0.87	0.71

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Table 7
Kiln 22 Total Filterable Particulate Matter Emission Rates

Company	**LaFarge**			
Source Designation	**Kiln 22**			
Test Date	**6/28/2017**	**6/28/2017**	**6/28/2017**	
Meter/Nozzle Information	P-1	P-2	P-3	Average
Meter Temperature Tm (F)	83.8	91.8	95.7	90.4
Meter Pressure - Pm (in. Hg)	29.3	29.3	29.3	29.3
Measured Sample Volume (Vm)	42.6	42.9	43.4	43.0
Sample Volume (Vm-Std ft3)	40.9	40.5	40.8	40.7
Sample Volume (Vm-Std m3)	1.16	1.15	1.15	1.15
Condensate Volume (Vw-std)	2.089	1.999	2.296	2.128
Gas Density (Ps(std) lbs/ft3) (wet)	0.0732	0.0732	0.0730	0.0731
Gas Density (Ps(std) lbs/ft3) (dry)	0.0745	0.0745	0.0745	0.0745
Total weight of sampled gas (m g lbs) (wet)	3.15	3.11	3.15	3.14
Total weight of sampled gas (m g lbs) (dry)	3.05	3.02	3.04	3.04
Nozzle Size - An (sq. ft.)	0.000099	0.000099	0.000099	0.000099
Isokinetic Variation - I	93.2	93.9	94.3	93.8
Stack Data				
Average Stack Temperature - Ts (F)	163.3	162.6	162.9	162.9
Molecular Weight Stack Gas- dry (Md)	28.8	28.8	28.8	28.8
Molecular Weight Stack Gas-wet (Ms)	28.3	28.3	28.3	28.3
Stack Gas Specific Gravity (Gs)	0.978	0.978	0.976	0.977
Percent Moisture (Bws)	4.86	4.70	5.33	4.96
Water Vapor Volume (fraction)	0.0486	0.0470	0.0533	0.0496
Pressure - Ps ("Hg)	29.3	29.3	29.3	29.3
Average Stack Velocity -Vs (ft/sec)	86.9	86.0	86.5	86.5
Area of Stack (ft2)	7.5	7.5	7.5	7.5
Exhaust Gas Flowrate				
Flowrate ft^3(Actual)	38,897	38,493	38,751	38,714
Flowrate ft^3 (Standard Wet)	32,235	31,939	32,136	32,104
Flowrate ft^3 (Standard Dry)	30,669	30,438	30,423	30,510
Flowrate m^3 (standard dry)	868	862	861	864
Total Particulate Weights (mg)				
Nozzle/Probe/Filter	17.9	13.9	10.7	14.2
Total Particulate Concentration				
lb/1000 lb (wet)	0.013	0.010	0.007	0.010
lb/1000 lb (dry)	0.013	0.010	0.008	0.010
mg/dscm (dry)	15.5	12.1	9.3	12.3
gr/dscf	0.0068	0.0053	0.0041	0.0054
Total Particulate Emission Rate				
lb/ hr	1.78	1.39	1.06	1.41

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Table 8
Kiln 22 PM_{10} Emission Rates

Company	**LaFarge**			
Source Designation	**Kiln 22**			
Test Date	**6/28/2017**	**6/28/2017**	**6/28/2017**	
Meter/Nozzle Information	P-1	P-2	P-3	Average
Meter Temperature Tm (F)	83.8	91.8	95.7	90.4
Meter Pressure - Pm (in. Hg)	29.3	29.3	29.3	29.3
Measured Sample Volume (Vm)	42.6	42.9	43.4	43.0
Sample Volume (Vm-Std ft3)	40.9	40.5	40.8	40.7
Sample Volume (Vm-Std m3)	1.16	1.15	1.15	1.15
Condensate Volume (Vw-std)	2.089	1.999	2.296	2.128
Gas Density (Ps(std) lbs/ft3) (wet)	0.0732	0.0732	0.0730	0.0731
Gas Density (Ps(std) lbs/ft3) (dry)	0.0745	0.0745	0.0745	0.0745
Total weight of sampled gas (m g lbs) (wet)	3.15	3.11	3.15	3.14
Total weight of sampled gas (m g lbs) (dry)	3.05	3.02	3.04	3.04
Nozzle Size - An (sq. ft.)	0.000099	0.000099	0.000099	0.000099
Isokinetic Variation - I	93.2	93.9	94.3	93.8
Stack Data				
Average Stack Temperature - Ts (F)	163.3	162.6	162.9	162.9
Molecular Weight Stack Gas- dry (Md)	28.8	28.8	28.8	28.8
Molecular Weight Stack Gas-wet (Ms)	28.3	28.3	28.3	28.3
Stack Gas Specific Gravity (Gs)	0.978	0.978	0.976	0.977
Percent Moisture (Bws)	4.86	4.70	5.33	4.96
Water Vapor Volume (fraction)	0.0486	0.0470	0.0533	0.0496
Pressure - Ps ("Hg)	29.3	29.3	29.3	29.3
Average Stack Velocity -Vs (ft/sec)	86.9	86.0	86.5	86.5
Area of Stack (ft2)	7.5	7.5	7.5	7.5
Exhaust Gas Flowrate				
Flowrate ft^3(Actual)	38,897	38,493	38,751	38,714
Flowrate ft^3 (Standard Wet)	32,235	31,939	32,136	32,104
Flowrate ft^3 (Standard Dry)	30,669	30,438	30,423	30,510
Flowrate m^3 (standard dry)	868	862	861	864
Total Particulate Weights (mg)				
Total Nozzle/Probe/Filter	5.5	5.2	3.8	4.8
Organic Condensible Particulate	1.0	1.3	1.0	1.1
Inorganic Condensible Particulate	5.1	3.2	3.1	3.8
Condensible Blank Correction	2.0	2.0	2.0	2.0
Total Condensible Particulate	4.1	2.5	2.1	2.9
Total Filterable and Condensible Particulate	9.6	7.7	5.9	7.7
Filterable Particulate Concentration				
lb/1000 lb (wet)	0.004	0.004	0.003	0.003
lb/1000 lb (dry)	0.004	0.004	0.003	0.004
mg/dscm (dry)	4.7	4.5	3.3	4.2
gr/dscf	0.0021	0.0020	0.0014	0.0018
Filterable Particulate Emission Rate				
lb/ hr	0.55	0.52	0.38	0.48
Condensible Particulate Concentration				
lb/1000 lb (wet)	0.003	0.002	0.001	0.002
lb/1000 lb (dry)	0.003	0.002	0.002	0.002
mg/dscm (dry)	3.5	2.2	1.8	2.5
gr/dscf	0.0015	0.0010	0.0008	0.0011
Condensible Particulate Emission Rate				
lb/ hr	0.41	0.25	0.21	0.29
Total Particulate Concentration				
lb/1000 lb (wet)	0.007	0.005	0.004	0.005
lb/1000 lb (dry)	0.007	0.006	0.004	0.006
mg/dscm (dry)	8.3	6.7	5.1	6.7
gr/dscf	0.0036	0.0029	0.0022	0.0029
Total Particulate Emission Rate				
lb/ hr	0.96	0.77	0.58	0.77

Table 9
Kiln 23 Total Filterable Particulate Matter Emission Rates

Company	**LaFarge**			
Source Designation	**Kiln 23**			
Test Date	**6/28/2017**	**6/28/2017**	**6/28/2017**	
Meter/Nozzle Information	P-1	P-2	P-3	Average
Meter Temperature Tm (F)	86.3	96.1	96.5	93.0
Meter Pressure - Pm (in. Hg)	29.3	29.3	29.3	29.3
Measured Sample Volume (Vm)	52.7	53.3	51.8	52.6
Sample Volume (Vm-Std ft3)	49.9	49.5	48.0	49.2
Sample Volume (Vm-Std m3)	1.41	1.40	1.36	1.39
Condensate Volume (Vw-std)	2.886	2.928	2.777	2.864
Gas Density (Ps(std) lbs/ft3) (wet)	0.0730	0.0730	0.0730	0.0730
Gas Density (Ps(std) lbs/ft3) (dry)	0.0745	0.0745	0.0745	0.0745
Total weight of sampled gas (m g lbs) (wet)	3.85	3.83	3.71	3.80
Total weight of sampled gas (m g lbs) (dry)	3.72	3.69	3.58	3.66
Nozzle Size - An (sq. ft.)	0.000101	0.000101	0.000101	0.000101
Isokinetic Variation - I	101.7	98.1	103.1	101.0
Stack Data				
Average Stack Temperature - Ts (F)	160.7	161.9	161.8	161.4
Molecular Weight Stack Gas- dry (Md)	28.8	28.8	28.8	28.8
Molecular Weight Stack Gas-wet (Ms)	28.2	28.2	28.2	28.2
Stack Gas Specific Gravity (Gs)	0.975	0.975	0.975	0.975
Percent Moisture (Bws)	5.47	5.58	5.47	5.50
Water Vapor Volume (fraction)	0.0547	0.0558	0.0547	0.0550
Pressure - Ps ("Hg)	29.3	29.3	29.3	29.3
Average Stack Velocity -Vs (ft/sec)	83.9	85.4	82.0	83.8
Area of Stack (ft2)	7.3	7.3	7.3	7.3
Exhaust Gas Flowrate				
Flowrate ft^3(Actual)	36,563	37,219	35,750	36,511
Flowrate ft^3 (Standard Wet)	30,475	30,928	29,704	30,369
Flowrate ft^3 (Standard Dry)	28,808	29,202	28,081	28,697
Flowrate m^3 (standard dry)	816	827	795	813
Total Particulate Weights (mg)				
Nozzle/Probe/Filter	4.5	4.7	4.1	4.4
Total Particulate Concentration				
lb/1000 lb (wet)	0.003	0.003	0.002	0.003
lb/1000 lb (dry)	0.003	0.003	0.003	0.003
mg/dscm (dry)	3.2	3.4	3.0	3.2
gr/dscf	0.0014	0.0015	0.0013	0.0014
Total Particulate Emission Rate				
lb/ hr	0.35	0.37	0.32	0.34

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Table 10
Kiln 23 PM_{10} Emission Rates

Company	**LaFarge**			
Source Designation	**Kiln 23**			
Test Date	**6/28/2017**	**6/28/2017**	**6/28/2017**	
Meter/Nozzle Information	P-1	P-2	P-3	Average
Meter Temperature Tm (F)	86.3	96.1	96.5	93.0
Meter Pressure - Pm (in. Hg)	29.3	29.3	29.3	29.3
Measured Sample Volume (Vm)	52.7	53.3	51.8	52.6
Sample Volume (Vm-Std ft3)	49.9	49.5	48.0	49.2
Sample Volume (Vm-Std m3)	1.41	1.40	1.36	1.39
Condensate Volume (Vw-std)	2.886	2.928	2.777	2.864
Gas Density (Ps(std) lbs/ft3) (wet)	0.0730	0.0730	0.0730	0.0730
Gas Density (Ps(std) lbs/ft3) (dry)	0.0745	0.0745	0.0745	0.0745
Total weight of sampled gas (m g lbs) (wet)	3.85	3.83	3.71	3.80
Total weight of sampled gas (m g lbs) (dry)	3.72	3.69	3.58	3.66
Nozzle Size - An (sq. ft.)	0.000101	0.000101	0.000101	0.000101
Isokinetic Variation - I	101.7	98.1	103.1	101.0
Stack Data				
Average Stack Temperature - Ts (F)	160.7	161.9	161.8	161.4
Molecular Weight Stack Gas- dry (Md)	28.8	28.8	28.8	28.8
Molecular Weight Stack Gas-wet (Ms)	28.2	28.2	28.2	28.2
Stack Gas Specific Gravity (Gs)	0.975	0.975	0.975	0.975
Percent Moisture (Bws)	5.47	5.58	5.47	5.50
Water Vapor Volume (fraction)	0.0547	0.0558	0.0547	0.0550
Pressure - Ps ("Hg)	29.3	29.3	29.3	29.3
Average Stack Velocity -Vs (ft/sec)	83.9	85.4	82.0	83.8
Area of Stack (ft2)	7.3	7.3	7.3	7.3
Exhaust Gas Flowrate				
Flowrate ft^3(Actual)	36,563	37,219	35,750	36,511
Flowrate ft^3 (Standard Wet)	30,475	30,928	29,704	30,369
Flowrate ft^3 (Standard Dry)	28,808	29,202	28,081	28,697
Flowrate m^3 (standard dry)	816	827	795	813
Total Particulate Weights (mg)				
Total Nozzle/Probe/Filter	1.4	1.1	1.1	1.2
Organic Condensible Particulate	1.0	1.0	1.0	1.0
Inorganic Condensible Particulate	6.3	3.6	3.6	4.5
Condensible Blank Correction	2.0	2.0	2.0	2.0
Total Condensible Particulate	5.3	2.6	2.6	3.5
Total Filterable and Condensible Particulate	6.7	3.7	3.7	4.7
Filterable Particulate Concentration				
lb/1000 lb (wet)	0.001	0.001	0.001	0.001
lb/1000 lb (dry)	0.001	0.001	0.001	0.001
mg/dscm (dry)	1.0	0.8	0.8	0.9
gr/dscf	0.0004	0.0003	0.0004	0.0004
Filterable Particulate Emission Rate				
lb/ hr	0.11	0.09	0.09	0.09
Condensible Particulate Concentration				
lb/1000 lb (wet)	0.003	0.001	0.002	0.002
lb/1000 lb (dry)	0.003	0.002	0.002	0.002
mg/dscm (dry)	3.8	1.9	1.9	2.5
gr/dscf	0.0016	0.0008	0.0008	0.0011
Condensible Particulate Emission Rate				
lb/ hr	0.41	0.20	0.20	0.27
Total Particulate Concentration				
lb/1000 lb (wet)	0.004	0.002	0.002	0.003
lb/1000 lb (dry)	0.004	0.002	0.002	0.003
mg/dscm (dry)	4.7	2.6	2.7	3.4
gr/dscf	0.0021	0.0012	0.0012	0.0015
Total Particulate Emission Rate				
lb/ hr	0.51	0.29	0.29	0.36

Figures

BTEC Inc.

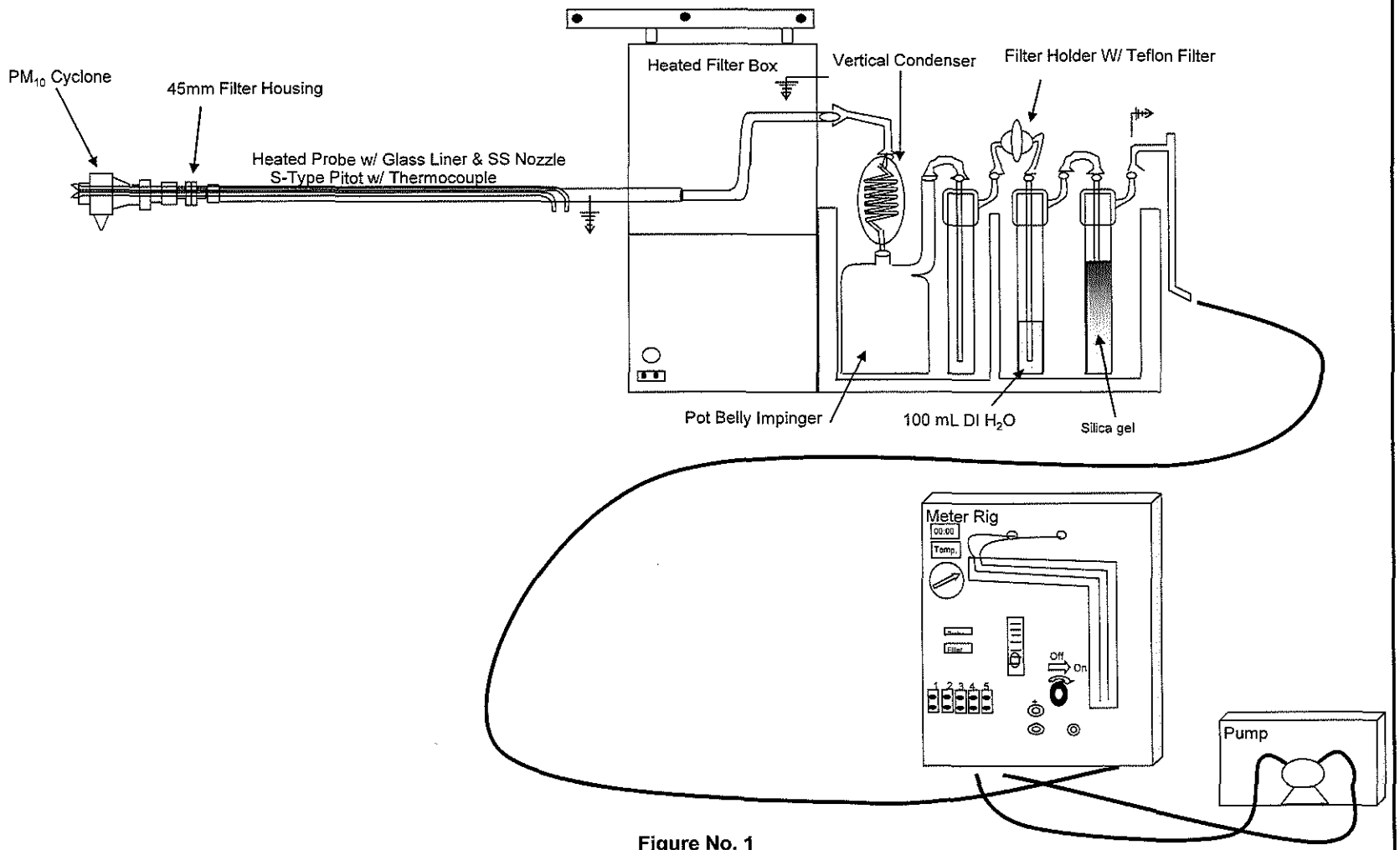


Figure No. 1

Site: **USEPA Method 201A/202** **Lafarge North America** **Alpena, Michigan**	**Sampling Date:** **June 27-28, 2017**	**BT Environmental Consulting, Inc.** **4949 Fernlee Avenue** **Royal Oak, Michigan 48073**

BTEC Inc.

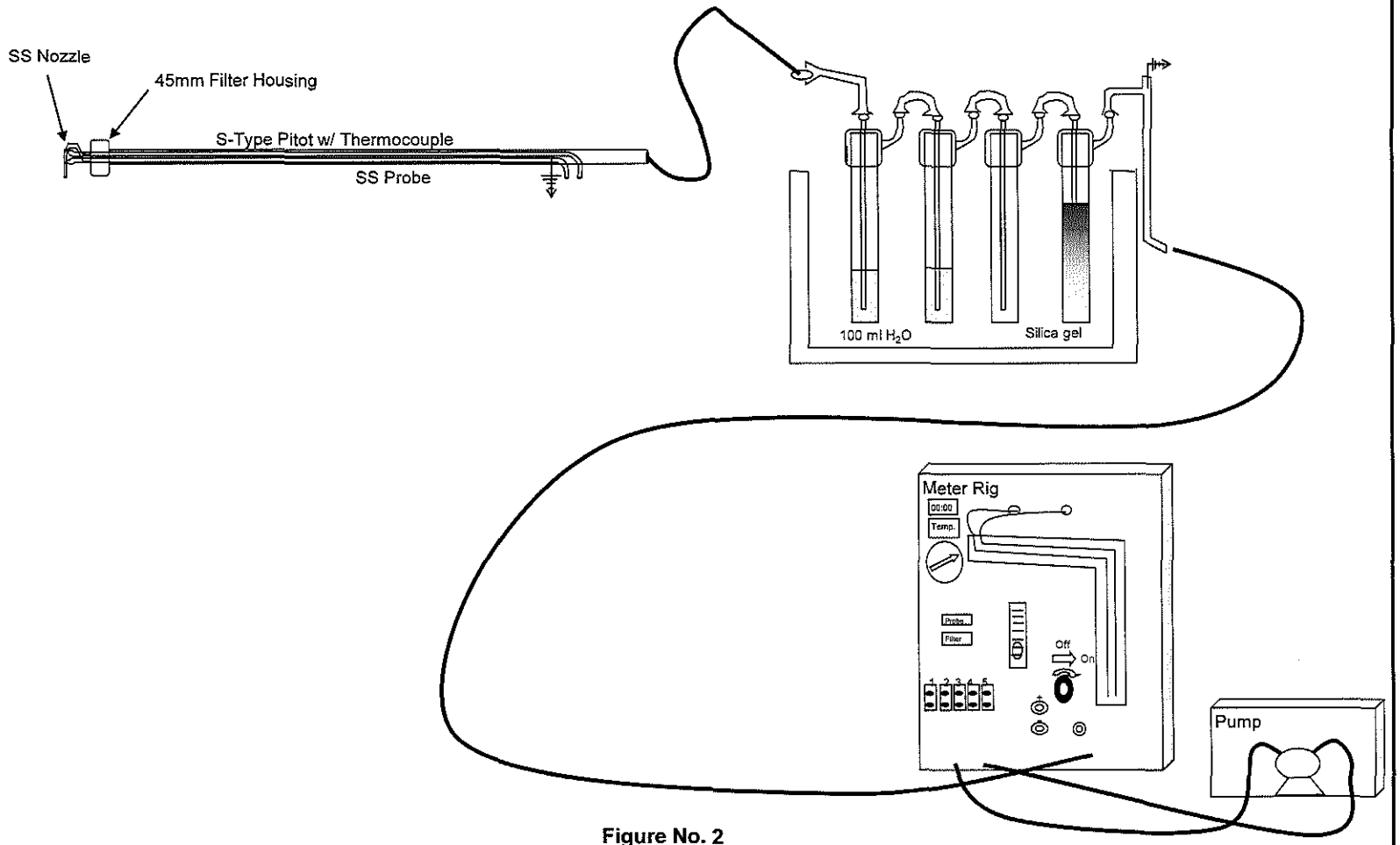
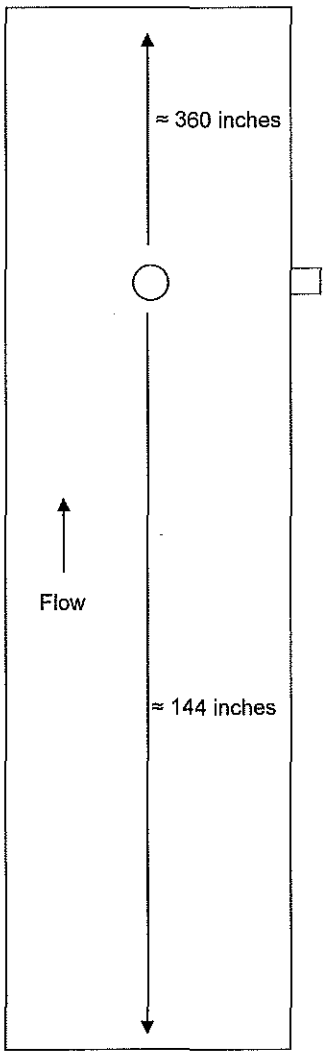


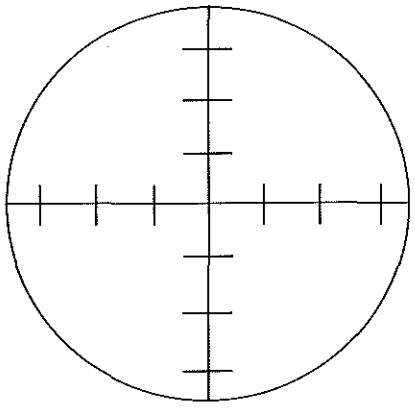
Figure No. 2

Site: **USEPA Method 17** **Lafarge North America** **Alpena, Michigan**	**Sampling Date:** **June 27, 2017**	**BT Environmental Consulting, Inc.** **4949 Fernlee Avenue** **Royal Oak, Michigan 48073**

BTEC Inc.

diameter = 28 inches





Not to Scale

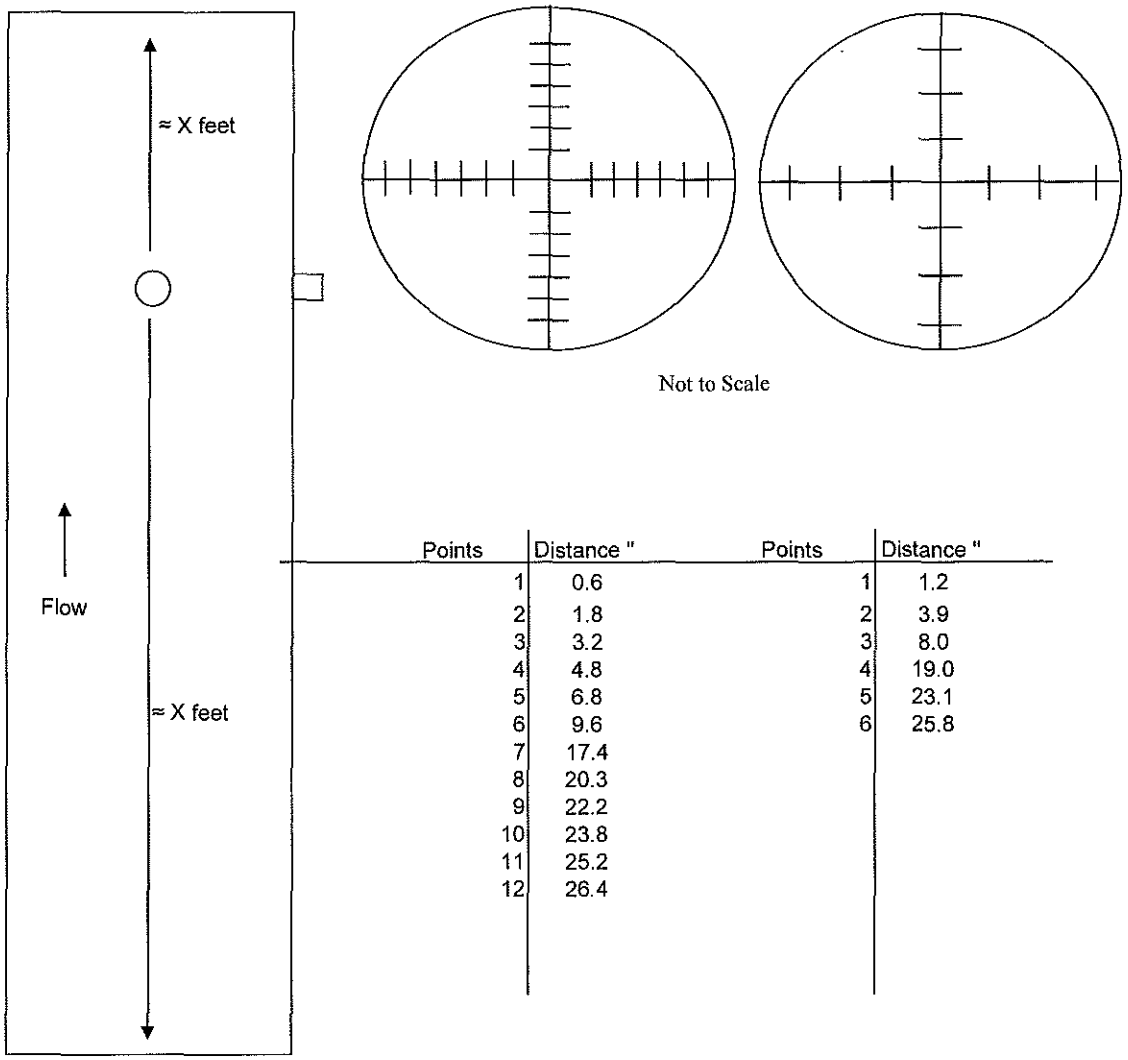
Points	Distance "
1	1.2
2	4.1
3	8.3
4	19.7
5	23.9
6	26.8

Figure No. 3

Site: **Kiln 20** **Lafarge North America** **Alpena, MI**	**Sampling Date:** **June 27, 2017**	**BT Environmental Consulting, Inc.** **4949 Fernlee Avenue** **Royal Oak, Michigan 48073**

BTEC Inc.

diameter = 27 inches



Not to Scale

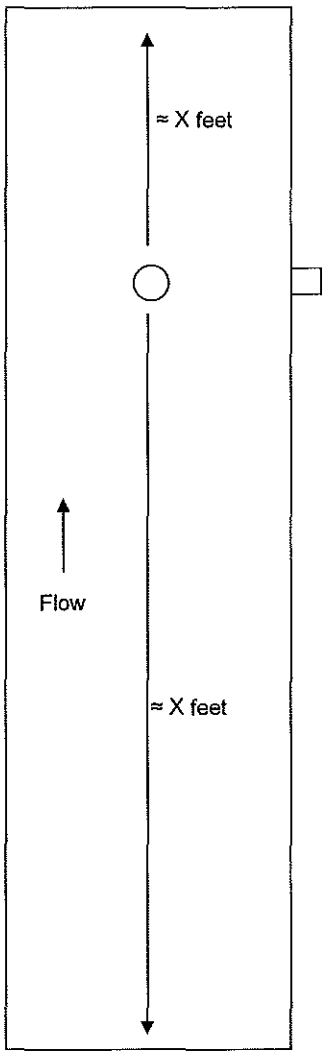
Points	Distance "	Points	Distance "
1	0.6	1	1.2
2	1.8	2	3.9
3	3.2	3	8.0
4	4.8	4	19.0
5	6.8	5	23.1
6	9.6	6	25.8
7	17.4		
8	20.3		
9	22.2		
10	23.8		
11	25.2		
12	26.4		

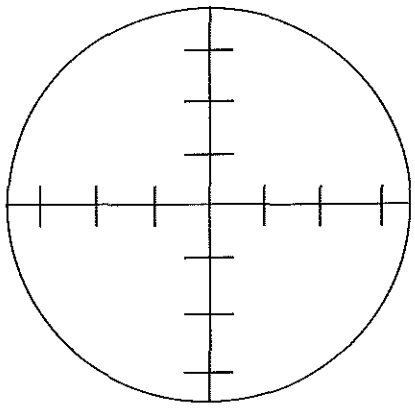
Figure No. 4

Site: **Kiln 21** **Lafarge North America** **Alpena, MI**	**Sampling Date:** **June 27, 2017**	**BT Environmental Consulting, Inc.** **4949 Fernlee Avenue** **Royal Oak, Michigan 48073**

BTEC Inc.

diameter = 35.75 inches





Not to Scale

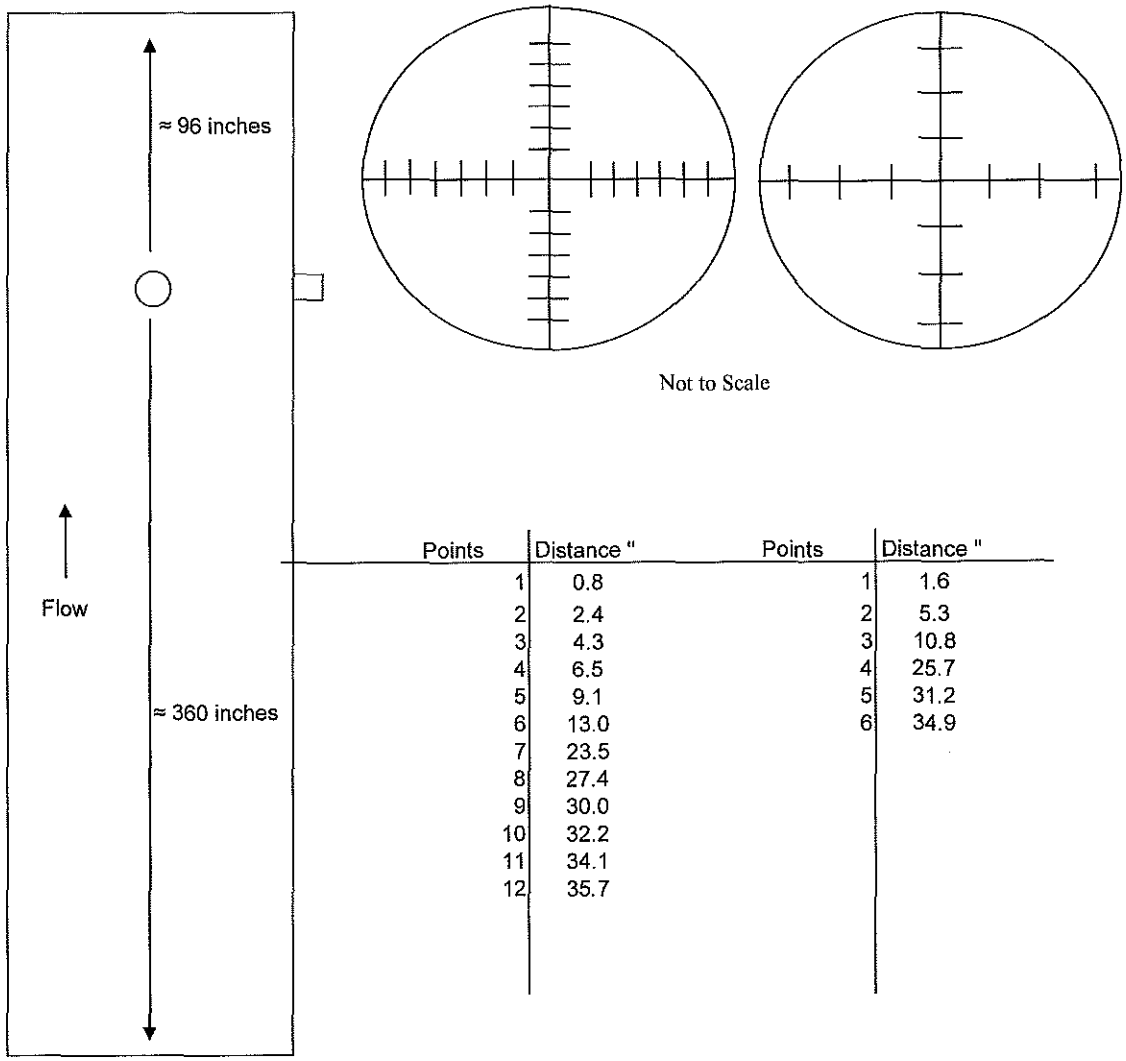
Points	Distance "
1	1.6
2	5.2
3	10.6
4	25.2
5	30.5
6	34.2

Figure No. 5

Site:	Sampling Date:	
Kiln 22	June 28, 2017	BT Environmental Consulting, Inc.
Lafarge North America		4949 Fernlee Avenue
Alpena, MI		Royal Oak, Michigan 48073

BTEC Inc.

diameter = 36.5 inches



Not to Scale

Points	Distance "	Points	Distance "
1	0.8	1	1.6
2	2.4	2	5.3
3	4.3	3	10.8
4	6.5	4	25.7
5	9.1	5	31.2
6	13.0	6	34.9
7	23.5		
8	27.4		
9	30.0		
10	32.2		
11	34.1		
12	35.7		

Figure No. 6

Site: **Kiln 23** **Lafarge North America** **Alpena, MI**	**Sampling Date:** **June 28, 2017**	**BT Environmental Consulting, Inc.** **4949 Fernlee Avenue** **Royal Oak, Michigan 48073**