

**COMPLIANCE TEST REPORT
FOR THE KILN BAGHOUSE STACK
AT THE PONCE PLANT
WHILE BURNING TIRE-DERIVED FUEL**

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List of Acronyms

Cemex	Cemex de Puerto Rico
CFR	Code of Federal Regulations
CO ₂	Carbon Dioxide
D/F	Dibenzodioxins/furans
EPA	U.S. Environmental Protection Agency
MACT	Maximum Achievable Control Technology
NESHAPS	National Emission Standards for Hazardous Air Pollutants
O ₂	Oxygen
PM	Particulate Matter
PC	Portland Cement
QA	Quality Assurance
QC	Quality Control
scf	standard cubic foot
scm	standard cubic meter
URS	URS Corporation

1.0 Introduction

Cemex de Puerto Rico (CEMEX) operates a Portland cement manufacturing facility in Ponce, Puerto Rico. URS Corporation (URS) was contracted by CEMEX to conduct particulate and dioxin/furan compliance testing on the kiln baghouse exhaust stack. The compliance testing was conducted from April 17-19, 2008.

The primary objective of the compliance testing was to determine if the Kiln meets the particulate matter (PM) and polychlorinated dibenzodioxins/furans (D/F) requirements of performance standards of Title 40 of the Code of Federal Regulations Part 63 (40 CFR 63), Subpart LLL, "National Emission Standards for Hazardous Air Pollutants (NESHAP) for Source Categories; Portland Cement Manufacturing Industry" while supplementing their primary kiln fuel with Tire-derived fuel. The standards required by this rule are based on maximum achievable control technology (MACT) which is the reason that this rule is often called the Portland Cement (PC) MACT Standards. This test report provides the test procedures that were used to collect and characterize the emissions data.

Section 2.0 describes the methods and techniques that were used to conduct the compliance testing. Section 3.0 is a discussion of the compliance test results for the kiln. Section 4.0 discusses the quality assurance (QA) and quality control (QC) procedures that were followed in the performance of the testing. Appendix A contains the Cemex process data applicable to the compliance testing. Appendix B contains the summary of the D/F analytical report. Appendix C contains the Method 23 D/F field data sheets and calculations. Appendix D contains the Method 5 PM field data sheets and calculations. Appendix E contains the Method 201A/202 PM¹⁰ field data sheets and calculations. Appendix F contains the calibration data of the URS test equipment that was used in the compliance test.

2.0 *Test Conditions and Technical Approach*

The following sections describe the methods and techniques that were used to complete the compliance testing on the Start-up Boiler stack.

2.1 *Test Conditions and Schedule*

On April 17, 2008 URS performed three 3-hour D/F test runs with the raw mill in operation. On April 18, 2008 URS performed three 3-hour D/F test runs with the raw mill down. On April 19, 2008 URS performed three 1-hour PM and PM₁₀ test runs with the raw mill operating, and three 1-hour PM and PM₁₀ test runs with the raw mill down. The exhaust gas volumetric flow rate, molecular weight, and moisture were also determined during each compliance test run. All the testing was observed by Mr. Weldin Ortiz of the Environmental Quality Board.

2.2 *Sample Locations*

All of the compliance sampling was performed on the kiln baghouse exhaust stack. Samples and velocity measurements were collected by accessing four perpendicular test ports located approximately 188 feet (12D) downstream of the nearest duct transition or flow disturbance, and 37 feet (2.4D) upstream of the stack exit. Compliance sampling and gas flow measurements were performed using a 12-point traverse (3 points per port). Appendix C contains a spreadsheet with the dimensions of the velocity traverse layout.

2.3 *Technical Approach*

The methodologies that were utilized for data collection are presented and summarized in Tables 3-1, 3-2 and 3-3. The sampling procedures included in the technical approach were selected to accurately determine the properties and composition of the kiln's gas stream. The selected methodologies were consistent with those recommended and referenced in Title 40 of the Code of Federal Regulations Part 60 (40 CFR Part 60), Appendix A, and 40 CFR Part 63, Subpart LLL.

Table 2-1
Reference Method Test Procedures

Source	Pollutant	Reference Procedures for Performance Test
Kiln Baghouse Stack	PM	EPA Title 40 CFR Part 60, Appendix A, Method 5, Determination of Particulate Matter Emissions from Stationary Sources
		EPA Title 40 CFR Part 60, Appendix A, Methods 1 and 2, Determination of Stack Gas Volumetric Flow Rate
		EPA Title 40 CFR Part 60, Appendix A, Method 3, Gas Analysis for Determination of Dry Molecular Weight
		EPA Title 40 CFR Part 60, Appendix A, Method 4, Determination of Moisture Content in Stack Gases
		EPA Method 201A, Determination of PM ₁₀ Emissions (Continuous Sampling Rate Procedure)
		EPA Method 202, Determination of Condensable Particulate From Stationary Sources
	D/F	EPA Title 40 CFR Part 60, Appendix A, Method 23, Determination of Polychlorinated Dibenzo-p-Dioxins and Polychlorinated Dibenzofurans From Stationary Sources
		EPA Title 40 CFR Part 60, Appendix A, Methods 1 and 2, Determination of Stack Gas Volumetric Flow Rate
		EPA Title 40 CFR Part 60, Appendix A, Method 3, Gas Analysis for Determination of Dry Molecular Weight
		EPA Title 40 CFR Part 60, Appendix A, Method 4, Determination of Moisture Content in Stack Gases

The following are summary descriptions of the sampling methodologies that were followed to complete the sampling program.

2.3.1 EPA Methods 1 and 2, Determination of Stack Gas Volumetric Flow Rate

U.S. Environmental Protection Agency (EPA) Methods 1 and 2 were used to determine the stack gas volumetric flow rate at the sampling location. An integrated velocity traverse was conducted at discrete points during each compliance test run. An S-type pitot tube and an incline manometer were used to measure the velocity pressure. A calibrated type “K” thermocouple was used to measure the stack gas temperature at each traverse point. Utilizing the stack gas molecular weight and the moisture content, the standard (Q_{std}) and actual volumetric flow rates were calculated in accordance with the formulas found in EPA Reference Method 2.

2.3.2 EPA Method 3A, Determination of Stack Gas Molecular Weight

The stack gas O₂ and CO₂ concentrations were determined for the kiln stack gas during each test run in accordance with EPA Method 3A sampling procedures. Sampling was performed using a Servomex 1400 paramagnetic O₂/CO₂ continuous emission monitor. The resulting O₂ and CO₂ concentrations were used to calculate the molecular weight of the stack gas.

2.3.3 EPA Method 4, Determination of Stack Gas Moisture Content

The moisture content (%), B_{w_o}, of the kiln outlet exhaust gas was determined in accordance with EPA Method 4. The moisture tests were combined with each compliance sampling train. The moisture sample was collected by drawing a sample of the exhaust gas from the stack and passing it through the chilled glass impingers in the compliance sampling train. The moisture content of the stack gas was then determined by measuring the weight gain of the chilled impingers after the completion of the test run.

2.3.4 EPA Method 5, Determination of Stack Gas Particulate Matter Emissions

The solid particulate matter testing was performed in accordance to EPA Method 5. Sampling was performed by extracting a sample of the stack exhaust gas stream through a stainless steel button-hook nozzle attached to a glass-lined, heat-traced, probe. The probe was attached to a heated glass filter holder containing a pre-weighed glass-fiber filter. The probe and filter heater box were maintained at a temperature of 248°F ± 25°F. After leaving the filter holder, the gas stream sample passed through a series of four glass impingers. The first impinger was a Smith-Greenburg filled with 100 ml of distilled water. The second impinger was a modified Smith-Greenburg and filled with 100 ml of distilled water. The third impinger was a modified Smith-Greenburg and was initially empty. The fourth impinger contained approximately 200 grams of indicating silica gel. The impingers were weighed prior to assembling the sampling train to permit gravimetric moisture determination. After exiting the impingers, the exhaust gas sample traveled through an umbilical cord to the control console and was then exhausted to atmosphere.

The control console contained the sample pump, dry gas meter, calibrated orifice meter, and heat controls for the probe and filter box.

At the conclusion of each test run, the sample train was recovered by washing the sample probe and nozzle three times with acetone into a sample container. The filter was removed from the filter holder and placed into a Petri dish and sealed for transport. The front half of the glass filter holder and connecting elbow were washed with acetone into the probe wash sample container. A sample of the acetone used in the sample recovery was collected and analyzed as a reagent blank. The impinger train was then disassembled and each impinger was weighed to determine the moisture gained during the sample run. At the conclusion of sampling, all the particulate samples were packaged and returned to the URS facility for subsequent analysis.

The particulate samples were analyzed by URS personnel. The analysis was performed by placing the filters into a desiccator for a minimum of 24 hours. The filters were then weighed to a constant weight. The acetone rinses were transferred to pre-weighed cups and allowed to dry in a laboratory hood at ambient temperature. The acetone cups were then transferred to a desiccator and allowed to dry for a minimum of 24 hours. The acetone cups were then weighed to a constant weight. The combined weights of the filter and probe wash were used to calculate the mass emission rate of solid particulates.

2.3.5 EPA Method 23, Determination of Polychlorinated Dibenzo-P-Dioxin and Polychlorinated Dibenzofurans from Stationary Sources

The stack gas from the kiln stack was sampled for dioxins and furans (D/F) using a Method 23 sampling train and procedures. The sampling train is based on the EPA Method 5 configuration as described previously, but with several modifications. The primary addition to the train was a sorbent cartridge containing XAD-2. Stack gases were isokinetically extracted and pulled through a Teflon-lined stainless steel button-hook nozzle into a heated glass probe and heated glass fiber filter. The filtered gas then passed through an XAD sample-conditioning system consisting of a water-jacketed, spiral condenser and XAD-2 sorbent trap. The gas stream was cooled in the spiral condenser to less than 68 °F to enhance the absorbing capability of the XAD sorbent trap.

The gas stream was then pulled through a set of four impingers that removed moisture from the gas stream. Four impingers were used due to the low level of moisture expected in this process. The impinger train was prepared by adding organic free distilled/deionized water to the second and third impingers. The first impinger was stemless and was initially empty to serve as a moisture trap. The fourth impinger contained approximately 200 grams of indicating silica gel, weighed to the nearest 0.1 grams. All the glassware was cleaned prior to testing in accordance with the EPA's "Manual of Analytical Methods for the Analysis of Pesticides in Human and Environmental Samples".

In accordance with the PC MACT, 40 CFR 63.1349(b)(3)(i), each Method 23 test run was a minimum of 3-hours and a minimum sample volume of 90 dry standard cubic feet (dscf) was collected.

The sample volume was measured and recorded at each of the traverse point locations. The temperature of the gas stream as it passed through the dry gas meter was measured in order to correct the sample volume to standard conditions. Other data collected for each traverse point included: XAD outlet temperature, stack temperature, filter box temperature, last impinger temperature, stack gas velocity differential pressure and the system vacuum at the pump inlet.

The sorbent cartridges were prepared for sampling by the analytical laboratory. The XAD sorbent was cleaned by soxhlet extraction and oven dried. An extract from a portion of the prepared resin was analyzed to confirm that it was free of significant background contamination. The sorbent cartridges were delivered to the test site wrapped in aluminum foil, sealed in resealable bags in a dedicated insulated chest. While on site the chest remained in a clean area designated for sample storage and recovery. The cartridges were removed from the chest only when necessary for installation in the sampling train. After sampling, the cartridges were wrapped in clean aluminum foil and stored on ice in a separate chest, in an area free from organic contamination. The samples remained on ice until removed by the analyst in the laboratory.

The sample was recovered from each of the D/F sampling runs as follows:

- The particulate filter was removed from the filter holder and carefully placed into its original glass petri dish, which was sealed with Teflon[®] tape and placed in a resealable plastic bag.
- The internal surfaces of the nozzle, probe, front half of the filter holder and all connecting glassware were cleaned by rinsing then brushing each component three times with acetone and a Teflon[®] bristle brush. The acetone was then placed into a sample collection jar. A final rinse with toluene completed the cleaning procedure. The toluene rinse was then placed into a separate container, but was combined with the acetone rinsate for analysis at the laboratory.
- Each impinger was reweighed intact to the nearest 0.1 gram to determine the weight gained due to the sampling in order to calculate stack gas moisture content. The liquid content of the impingers were then discarded.
- The silica gel impinger was reweighed to the nearest 0.1 grams, and then the silica gel was discarded. The moisture gain by the silica gel was used only in stack moisture determinations.
- The sorbent cartridge was removed from the sampling train, the end caps sealed with Teflon[®] tape, wrapped in aluminum foil, sealed in a plastic bag and stored on ice for shipment to the laboratory.

Reagent blanks for the acetone, toluene, filters and XAD sorbent traps were provided to the laboratory with the field samples. All the blanks were archived at the laboratory and were not analyzed unless the actual sample analysis indicated issues with the reagents.

2.3.6 EPA Methods 201A & 202, Determination of PM₁₀ & Condensable Particulate Emissions (Continuous Sampling Rate Procedure)

The PM₁₀ particulate emitted from the kiln stack was measured according to EPA Method 201A using a PM₁₀ sampling system manufactured by Apex Instruments. The PM₁₀ fraction was collected by the cyclone system of the sampling head, which separates the particle sizes at a 10

micron level. The condensable particulate was measured using the same sample train according to procedures in EPA Method 202.

The sampling train consisted of a stainless steel nozzle connected to a stainless steel PM₁₀ sizer, capable of separating the PM₁₀ fraction by passing the sample gas stream through a cyclone separator. The separator is designed to allow particles, and vapors, smaller than 10 microns to pass through the cyclone, where the solid particles are collected on a glass fiber filter and the vapors are condensed in the impinger train. Particles larger than 10 microns fall out of the cyclone and collect in a cup attached to the bottom of the cyclone.

The cyclone is designed to operate at a constant sample rate, which is controlled by the opening size of the nozzle placed on the cyclone inlet. The nozzle size was selected by performing a velocity traverse at each sampling point prior to starting the test run. The velocity traverse data was then entered into a computer program that provided the correct nozzle size to use for the test run. The computer program also provided the dwell time that was to be used at each traverse point during the test run. The sample dwell time variation allowed the test to be performed within the method specified isokinetic sampling rate of 80-120%.

The PM₁₀ sizer is connected to a stainless steel 63mm filter holder, which connects to a glass-lined, heat-traced probe which was maintained at 248°F ± 25°F. After leaving the probe, the sample gas passed through a series of four impingers. The first impinger was a Smith-Greenburg filled with 100 ml of distilled water. The second impinger was a modified Smith-Greenburg filled with 100 ml of distilled water. The third impinger was a modified Smith-Greenburg initially left empty. The fourth impinger was a modified Smith-Greenburg containing approximately 200 grams of indicating silica gel. The impingers were weighed prior to assembling the sampling train to permit gravimetric moisture determination. The sample train was followed by a standard Method 5-type pump, dry gas meter, and calibrated orifice meter. Method 202 did not influence the manner in which the test was operated, only the recovery, and subsequent analysis, of the samples collected.

At the conclusion of the PM₁₀ sample run the train was recovered by removing the filter from the 47mm filter holder and placing into a Petri dish. The Petri dish was sealed to prevent loss of sample during shipment. The cyclone was then disassembled and the larger particles collected in the separator chamber were collected. The particles from the cyclone chamber were collected but not analyzed as directed by Method 201A. The exit of the cyclone, all the way to the front half of the 63mm filter holder was washed with acetone into a sample container for subsequent analysis.

The impinger train was disassembled and each impinger was weighed to determine the moisture gained during the test run. According to Method 201A, any condensable particulate collected in the impingers should be considered PM₁₀ and included in the sample collection. To determine the condensable fraction, the water was collected from each of the first three impingers into a sample container. The impingers and connecting glassware were rinsed twice with methylene chloride into a separate sample container. The samples were then sealed and returned to URS for analysis.

The analysis of the particulate samples included desiccating the filters for 24 hours and weighing the filters to a constant weight. The cyclone exit samples were poured into pre-weighed sample cups and allowed to dry in a sample hood at ambient conditions. The sample cups were then desiccated for 24 hours and then weighed to a constant weight. The weight gain of the filter and cyclone exit were combined and used to calculate the PM₁₀ emission rate.

The impinger water samples were placed individually into a 1,000 ml separatory funnel along with the impinger methylene chloride rinse. The sample was then shaken and allowed to separate. The methylene chloride fraction was poured into a pre-weighed sample cup. A 75 ml aliquot of methylene chloride was then added to the water. The shaking and decanting process was repeated. Another 75 ml methylene chloride aliquot was added and the process repeated. At the conclusion of the extraction process, the sample cups were placed into a sample hood and allowed to dry at ambient conditions. The weight gain of the condensable fraction was added to the PM₁₀ fraction during the PM₁₀ mass emission rate calculation.

3.0 Compliance Test Results

3.1 Particulate Emissions

The particulate compliance test results for the kiln baghouse are summarized below in Tables 3-1 and 3-2. According to the particulate test results, the kiln baghouse is operating in compliance with the PM Subpart LLL performance standard of 0.30 lb/ton dry feed. The overall average PM emission rate, for the compliance test was 0.0215 lb/ton dry feed, or 0.0435 lb/ton clinker.

Table 3-1. Kiln Baghouse Particulate Matter Test Results Summary (Raw Mill On)

Parameters	Run # 1	Run # 2	Run # 3	Average
Sample Date	4/19/2008	4/19/2008	4/19/2008	
Run Times	13:10 14:17	14:50 – 15:58	16:20 – 17:26	
Sample Time	60	60	60	60
Vol. Sampled @ STP (ft ³)	39.469	41.358	36.546	39.124
Moisture Content (% Vol.)	11.6	10.8	12.9	11.8
O ₂ (%)	14.0	13.9	13.9	13.9
CO ₂ (%)	11.0	10.9	11.0	11.0
Stack Gas Temperature (°F)	278	258	272	270
Stack Velocity (ft/min.)	2,656	2,636	2,603	2,632
Gas Flow Rate (ACFM)	494,194	490,445	484,244	489,628
Gas Flow Rate (DSCFM)	315,116	324,505	307,009	315,543
Percent Isokinetic	104.5	106.4	99.4	103.4
Particulate Conc. (grains/DSCF)	0.0010	0.0044	0.0029	0.0028
Particulate Conc. (mg/DSCM)	2.3	10.2	6.7	6.4
Particulate Mass Rate (lb/hr)	2.7	12.4	7.7	7.6
Kiln Dry Feed Rate (ton/hr)	272.0	239.2	257.8	256.3
Part. Mass Rate (lb/ton dry feed)	0.010	0.052	0.030	0.030
Clinker Production Rate (ton/hr)	121.6	121.6	121.6	121.6
Part. Mass Rate 9lb/ton clinker)	0.023	0.102	0.063	0.062

Table 3-2. Kiln Baghouse Particulate Matter Test Results Summary (Raw Mill Off)

Parameters	Run # 4	Run # 5	Run # 6	Average
Sample Date	4/20/2008	4/20/2008	4/20/2008	
Run Times	18:30 – 19:38	20:00 – 21:10	21:30 – 22:37	
Sample Time	60	60	60	60
Vol. Sampled @ STP (ft3)	36.012	35.014	33.946	34.991
Moisture Content (% Vol.)	16.7	16.9	16.5	16.7
O2 (%)	10.6	10.4	10.8	10.6
CO2 (%)	16.5	16.5	16.4	16.5
Stack Gas Temperature (°F)	324	320	324	323
Stack Velocity (ft/min.)	2,283	2,272	2,213	2,256
Gas Flow Rate (ACFM)	424,703	422,757	411,849	419,770
Gas Flow Rate (DSCFM)	287,469	287,741	279,065	284,758
Percent Isokinetic	109.0	106.1	105.6	106.9
Particulate Conc. (grains/DSCF)	0.0018	0.0013	0.0023	0.0018
Particulate Conc. (mg/DSCM)	4.0	3.0	5.2	4.1
Particulate Mass Rate (pounds/hr)	3.6	2.7	4.5	3.6
Kiln Dry Feed Rate (tons/hr)	277.8	278.0	278.0	277.9
Part Mass Rate (lbs/ton dry feed)	0.013	0.010	0.016	0.013
Clinker Production Rate (ton/hr)	147.5	147.5	147.5	147.5
Part. Mass Rate 9lb/ton clinker)	0.024	0.018	0.031	0.025

3.2 Dioxin/Furan Emissions

The dioxin/furan compliance test results for the kiln baghouse are summarized below in Table 3-3 and 3-4. According to the D/F test results, the kiln baghouse is operating in compliance with the D/F Subpart LLL performance standard of 8.7×10^{-11} gr TEQ/dscf, corrected to 7% O₂. The overall average D/F emission rate, for the six compliance tests was 1.517×10^{-14} gr TEQ/dscf, corrected to 7% O₂. The D/F emissions were non-detectable during the raw mill on testing.

Table 3-3. Kiln Baghouse Dioxin/ Furan Test Results Summary (Raw Mill Off)

Parameters	Run # 1	Run # 2	Run # 3	Average
Sample Date	4/17/2008	4/17/2008	4/17/2008	
Run Times	8:30 – 11:40	12:05 – 15:15	15:40 – 18:50	
Sample Time	180	180	180	180
Vol. Sampled @ STP (ft3)	90.954	90.199	90.343	90.499
Moisture Content (% Vol.)	13.2	13.4	13.5	13.4
O2 (%)	12.3	10.9	11.3	11.5
CO2 (%)	14.3	16.1	15.8	15.4
Stack Gas Temperature (°F)	355	359	359	358
Stack Velocity (ft/min.)	2,238	2,207	2,211	2,219
Gas Flow Rate (ACFM)	416,492	410,686	411,379	412,852
Gas Flow Rate (DSCFM)	235,890	230,700	230,824	232,471
Percent Isokinetic	107.3	108.8	108.9	108.3
Total PCDD/F (TEQ, pg)	0.177	0.000	0.184	0.120
Total TEQ Gas Conc. (gr/dscf)	3.00E-14	0.00E-14	3.14E-14	2.05E-14
- corrected to 7% O ₂	4.85E-14	0.00E-14	4.55E-14	3.03E-14
Total TEQ Gas Conc. (ng/dscm)	0.00007	0.00000	0.00007	0.00005
- corrected to 7% O ₂	0.00011	0.00000	0.00010	0.00007

Table 3-4. Kiln Baghouse Dioxin/Furan Test Results Summary (Raw Mill On)

Parameters	Run # 4	Run # 5	Run # 6	Average
Sample Date	4/18/2008	4/18/2008	4/18/2008	
Run Times	9:17 – 12:17	12:40 – 15:46	16:05 – 19:12	
Sample Time	180	180	180	180
Vol. Sampled @ STP (ft3)	113.015	121.509	115.988	116.837
Moisture Content (% Vol.)	10.7	10.9	11.2	10.9
O2 (%)	13.2	13.4	14.0	13.5
CO2 (%)	12.5	12.2	11.2	12.0
Stack Gas Temperature (°F)	277	280	278	278
Stack Velocity (ft/min.)	2,607	2,652	2,678	2,646
Gas Flow Rate (ACFM)	485,157	493,383	498,323	492,288
Gas Flow Rate (DSCFM)	351,047	355,680	360,053	355,593
Percent Isokinetic	100.3	106.7	100.9	102.6
Total PCDD/F (TEQ, pg)	0.000	0.000	0.000	0.000
Total TEQ Gas Conc. (gr/dscf)	0.00E-14	0.00E-14	0.00E-14	0.00E-14
- corrected to 7% O ₂	0.00E-14	0.00E-14	0.00E-14	0.00E-14
Total TEQ Gas Conc. (ng/dscm)	0.00000	0.00000	0.00000	0.00000
- corrected to 7% O ₂	0.00000	0.00000	0.00000	0.00000

3.3 *PM₁₀ & Condensable Particulate Emissions*

The PM₁₀ and condensable particulate compliance test results for the kiln baghouse are summarized below in Table 3-5 and 3-6. The average PM₁₀, including condensable particulate, mass emission rate was 0.032 lb/ton dry feed, or 0.063 lb/ton clinker. Based on the operating permit limit of 0.109 lb/ton clinker, the kiln baghouse is operating within the permit limits.

Table 3-5. Kiln Baghouse PM₁₀ and Condensable PM Test Results Summary (Raw Mill On)

Parameters	Run # 1	Run # 2	Run # 3	Average
Sample Date	4/19/2008	4/19/2008	4/19/2008	
Run Times	13:10 – 14:17	14:50 – 15:58	16:20 – 17:26	
Sample Time	59.99	59.99	59.98	59.99
Vol. Sampled @ STP (ft ³)	23.644	23.795	23.739	23.726
Moisture Content (% Vol.)	11.8	10.9	11.1	11.3
O ₂ (%)	14.0	13.9	13.9	13.9
CO ₂ (%)	11.0	10.9	11.0	11.0
Stack Gas Temperature (°F)	279	278	258	272
Stack Velocity (ft/min.)	2,603	2,669	2,653	2,642
Gas Flow Rate (ACFM)	484,338	496,614	493,644	491,532
Gas Flow Rate (DSCFM)	308,004	319,236	325,520	317,587
Percent Isokinetic	112.5	109.2	106.9	109.5
Kiln Dry Feed Rate (tons/hr)	272.0	239.2	257.8	256.3
Clinker Production Rate (tons/hr)	121.6	121.6	121.6	121.6
PM ₁₀ Conc. (mg/dscf)	0.0127	0.0336	0.0505	0.0323
PM ₁₀ Mass Rate (lb/hr)	0.53	1.45	2.23	1.40
PM ₁₀ Mass Rate (lb/ton dry feed)	0.0019	0.0061	0.0086	0.0055
PM ₁₀ Mass Rate (lb/clinker)	0.0043	0.0019	0.0183	0.0082
Cond. PM Conc. (mg/dscf)	0.1311	0.1681	0.1853	0.1615
Cond. PM Mass Rate (lb/hr)	5.46	7.26	8.16	6.96
Cond. Mass Rate (lb/ton dry feed)	0.0201	0.0303	0.0317	0.0274
Cond. Mass Rate (lb/ton clinker)	0.0449	0.0597	0.0672	0.0573
Total Particulate <10 microns Conc. (mg/dscf) ⁽¹⁾	0.1438	0.2017	0.2359	0.1938
Total Particulate <10 microns Mass Rate (lb/hr) ⁽¹⁾	5.99	8.71	10.39	8.36
Total Particulate <10 microns Mass Rate (lb/ton dry feed) ⁽¹⁾	0.0220	0.0364	0.0403	0.0329
Total Particulate <10 microns Mass Rate (lb/ton clinker) ⁽¹⁾	0.0493	0.0716	0.0855	0.0688

⁽¹⁾ – Includes both PM¹⁰ and condensable particulate emissions.

Table 3-6. Kiln Baghouse PM₁₀ and Condensable PM Test Results Summary (Raw Mill Off)

Parameters	Run # 4	Run # 5	Run # 6	Average
Sample Date	4/19/2008	4/19/2008	4/19/2008	
Run Times	18:30 – 19:38	20:00 – 21:10	21:30 – 22:37	
Sample Time	59.95	59.98	59.99	59.97
Vol. Sampled @ STP (ft ³)	22.673	22.784	22.789	22.749
Moisture Content (% Vol.)	15.6	16.8	15.6	16.0
O ₂ (%)	10.6	10.4	10.8	10.6
CO ₂ (%)	16.5	16.5	16.4	16.5
Stack Gas Temperature (°F)	311	324	320	318
Stack Velocity (ft/min.)	2,261	2,297	2,279	2,279
Gas Flow Rate (ACFM)	420,610	427,312	424,001	423,974
Gas Flow Rate (DSCFM)	244,651	240,906	243,772	243,110
Percent Isokinetic	97.1	99.1	97.9	98.0
Kiln Dry Feed Rate (tons/hr)	274.5	274.8	274.8	274.7
Clinker Production Rate (tons/hr)	147.5	147.5	147.5	147.5
PM ₁₀ Conc. (mg/dscf)	0.0926	0.0439	0.0570	0.0645
PM ₁₀ Mass Rate (lb/hr)	3.07	1.43	1.88	2.13
PM ₁₀ Mass Rate (lb/ton dry feed)	0.0112	0.0052	0.0068	0.0077
PM ₁₀ Mass Rate (lb/ton clinker)	0.0208	0.0097	0.0128	0.0144
Cond. PM Conc. (mg/dscf)	0.1588	0.2238	0.1975	0.0193
Cond. PM Mass Rate (lb/hr)	5.26	7.30	6.51	6.36
Cond. Mass Rate (lb/ton dry feed)	0.0192	0.0266	0.0237	0.0231
Cond. Mass Rate (lb/ton clinker)	0.0356	0.0495	0.0442	0.0431
Total Particulate <10 microns Conc. (mg/dscf) ⁽¹⁾	0.2514	0.2677	0.2545	0.2579
Total Particulate <10 microns Mass Rate (lb/hr) ⁽¹⁾	8.32	8.73	8.40	8.48
Total Particulate <10 microns Mass Rate (lb/ton dry feed) ⁽¹⁾	0.0303	0.0318	0.0306	0.0309
Total Particulate <10 microns Mass Rate (lb/ton clinker) ⁽¹⁾	0.0564	0.0592	0.0569	0.0575

⁽¹⁾ – Includes both PM¹⁰ and condensable particulate emissions.

4.0 *Quality Assurance/Quality Control Procedure*

The objective of URS's QA Program was to ensure the accuracy and precision, as well as reliability, of the data collected and generated for URS's clients and to meet the data quality objectives of regulatory or accrediting bodies. Management, administrative, statistical, investigative, preventative, and corrective techniques were employed to maximize the reliability of data.

During the compliance testing, a strict QA/QC program was adhered to. Before actual sampling on-site, all the sampling equipment was thoroughly checked to ensure that each component was clean and operable. Any damaged or faulty equipment was tagged and removed from service until it could be repaired. If any corrective actions were taken in response to these QC checks or in response to supervisor review of QC procedures, the corrective action taken was documented in a field QA/QC logbook.

Proper equipment calibration is essential in maintaining the desired data quality level. All calibrations of the equipment used in the stack sampling portion of the testing conformed to the guidelines outlined in the EPA quality assurance handbook, *Quality Assurance Handbook for Air Pollution Measurement Systems, Volume III, Stationary Source Specific Methods* (EPA-600/4-77-027a). The following sections give a synopsis of the calibration procedures for the main components of the stack sampling systems.

4.1 *Dry Gas Meters/Orifice Meters*

The dry gas meters and orifice meters in each control box to be used during the testing were calibrated before the test in order to ensure accurate measurements of the sample gas volumes. The dry gas meters and orifice meters are normally housed as a set inside each control box and were calibrated as such. These sets of meters were calibrated against a secondary calibration standard dry gas.

The dry gas meter/orifice meter sets were calibrated at predetermined nominal volume flow settings. For each of these flow rates, an accuracy ratio factor to the calibration standard (Y_i)

was computed for the individual dry gas meters. A successful calibration for a particular dry gas meter would be achieved if each value of Y_i was within 2 percent of the average value of Y_i ($Y_i = Y \pm 0.02Y$).

In order to establish calibration for the orifice meter, a calibration coefficient ($\Delta H@_1$) was calculated for each flow rate. This coefficient is the orifice pressure differential (in inches H_2O) at a distinct orifice manometer setting that gives a flow of $0.75 \text{ ft}^3/\text{min}$ of air at standard conditions. The desired tolerance for this coefficient is ± 0.2 of the average value of the four values of $\Delta H@_1$ ($\Delta H@ \pm 0.2$). If any of the pre-test calibration coefficients for a particular meter violates the acceptance criteria, the meter in question would be adjusted and recalibrated.

4.2 Thermocouples and Thermocouple Readouts

All thermocouples used during the stack sampling tests were calibrated to ensure accurate temperature measurements. All of the sensors utilized were type "K" thermocouples, which have a working range of approximately $-300 \text{ }^\circ\text{F}$ to approximately $2,500 \text{ }^\circ\text{F}$. The thermocouples were calibrated against an NITS traceable mercury-in-glass thermometer at predetermined temperatures. In order to obtain the calibration data from each sensor, a single, recently calibrated thermocouple readout was used.

The thermocouple readout on the control console was calibrated using a thermocouple simulator. This calibration apparatus generates a voltage signal that mimics the signal an ideal "K" type thermocouple would exhibit at a particular temperature. The signal can be changed via a slide switch. The readouts were calibrated at ten different points from $200 \text{ }^\circ\text{F}$ through $2,000 \text{ }^\circ\text{F}$, at increments of $200 \text{ }^\circ\text{F}$.

4.3 Barometer

The field barometer used during the test was an digital type barometer. This barometer was calibrated by comparing it to a standard mercury column barometer and adjusting it if any deviation existed between it and the standard. This exercise was performed both before and after the testing activities.

4.4 Analytical Balance

The field analytical balance was calibrated before the test with certified standard weights. The balance was adjusted for any deviation from the standard weights. In the field, periodic checks were made to insure data validity. This balance was used to measure the impinger weight changes due to moisture gain during the stack sampling (determination of stack moisture content).

4.5 Pitot Tubes

The S-type pitot tubes used on each isokinetic sampling train were calibrated in a wind tunnel against a standard pitot, which is considered a reference source. The basis for the calibration is described in 40 CFR, Part 60, Appendix A, Method 2.