RESULTS OF OCTOBER 2002 EMISSIONS TESTING OF THE CLINKER COOLER AND KILN SYSTEM (Revision 1)

LAFARGE NORTH AMERICA
HARLEYVILLE, SOUTH CAROLINA

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Signature Page

This document, entitled "Results of October 2002 Emissions Testing of The Clinker Cooler and Kiln System," has been prepared under the supervision of A. Kirk Alexander, at the request of and for the exclusive use of Lafarge North America located in Harleyville, South Carolina. It has been prepared in accordance with accepted quality control practices, and it has been reviewed by the undersigned. This revision, dated March 14, 2003, supercedes all previous versions of this report.

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Harleyville, South Carolina

1.0 INTRODUCTION

Stationary source sampling of three sources located at the Lafarge North America (Lafarge) facility in Harleyville, South Carolina, was performed by General Engineering personnel in October of 2002. The following list summarizes the sources and their respective test dates.

- Kiln Baghouse Stack - October 15 and 28, 2002
- Precalciner Coal Mill (PCM) Stack - October 15 and 28, 2002
- Clinker Cooler Stack – October 16, 2002

Since the Kiln Baghouse stack and the PCM stack are considered part of the Kiln System, both sources were tested simultaneously during the vertical spindle mill off condition. Sampling of the PCM was not conducted during normal operation of the kiln system (vertical spindle mill in operation) since gas is diverted from the PCM stack to the Kiln stack during normal operation. The purpose of these tests was to partially satisfy the requirements of Lafarge's Title V Operating Permit Number 0900-0004 issued by the South Carolina Department of Health and Environmental Control (DHEC).

Test parameters and sampling methods for the test program are summarized in Tables 1 and 6 for the Kiln System and the Clinker Cooler, respectively. Testing was performed by Mr. Kirk Alexander, Mr. Robert Griffin, Mr. Patrick Turner, Mr. Craig McKenzie, and Mr. James Huber of General Engineering. The client representative for the stationary source sampling at Lafarge was Ms. Debra Henry, and a portion of the test program was witnessed by Mr. Jason Hobbs of DHEC.

2.0 SUMMARY OF TEST RESULTS

Emissions testing for each of the referenced sources was conducted in accordance with the approved site specific test plan dated August 23, 2000 (attached as Appendix IX), and using the United States Environmental Protection Agency (EPA) methodologies and modifications listed below.

Clinker Cooler Stack

Parameter	Test Method(s)	Duration
Gas Flow Rates and Temperature	1 & 2	3 two-hour runs
Dry Molecular Weight	3	3 runs
Moisture Content	4	3 two-hour runs
Hydrochloric Acid and Fluoride	26A	3 one-hour runs
Antimony, Arsenic, Beryllium, Cadmium, Chromium, Cobalt, Lead, Mercury, and Nickel Phosphorus, and Selenium	29	3 two-hour runs

The Clinker Cooler was tested on October 16, 2002, during normal operating conditions. The sample measurement sites were selected so that EPA Method 1 criteria was satisfied for the Clinker Cooler Stack. A cyclonic flow check was conducted in 1998, which confirmed the absence of cyclonic flow conditions.

Kiln Baghouse Stack and Precalciner Coal Mill Stack

Parameter	Test Method(s)	Duration
Gas Flow Rates and Temperature	1 & 2	3 two-hour runs
Dry Molecular Weight	3	3 runs
Moisture Content	4	3 two-hour runs
Sulfur Dioxide (SO_2)	6C	3 one-hour runs
Nitrogen Oxides (NO_x)	7E	3 one-hour runs
Opacity	9	3 one-hour runs
Carbon Monoxide (CO)	10	3 one-hour runs
Volatile Organic Compounds (VOCs)	25A	3 one-hour runs
Hydrochloric Acid and Fluoride	26A	3 one-hour runs
Antimony, Arsenic, Beryllium, Cadmium, Chromium, Cobalt, Lead, Mercury, and Nickel Phosphorus, and Selenium	29	3 two-hour runs

Variances from the August 23, 2000 site specific test plan included: 1) Neither total particulate matter (PM) nor PM_{10} testing was conducted on any of the sources at Lafarge's

request. Lafarge requested permission from DHEC to use testing conducted previously during 2002 for this data (PC MACT test program). 2) EPA Method 26A was conducted in place of EPA Method 13B due to the fact that HCl was an added parameter on the 2002 testing. This was communicated with and approved verbally by Jason Hobbes of SCDHEC. 3) The laboratories performing the metals analysis changed to:

Element One, Inc.
5022C Wrightsville Ave.
Wilmington, NC 28403
Contact: Bruce Hawks
Tel: 910-793-0128

The test program for the Kiln System consisted of two phases, testing with the Vertical Spindle Mill (VSM) "on" and "off." The sample measurement sites were selected so that EPA Method 1 criteria was satisfied for each source. While conducting a cyclonic flow check, in 1998, for the initial sampling location on the PCM stack, it was determined that cyclonic flow existed at the selected test location. Therefore, the metals and fluoride tests were conducted along a section of horizontal duct in the PCM as presented in the current site-specific test plan.

Testing of the Kiln System with the VSM "on" was completed on October 15, 2002. Testing of the Kiln System with the VSM "off" was completed on October 28, 2002.

In accordance with the approved test plan submitted to DHEC on August 23, 2000, testing for SO_2, NO_x, CO, and VOCs was conducted only on the Kiln Baghouse stack. The remaining parameters were measured simultaneously at both the Kiln Baghouse stack and the PCM stack. The dry molecular weight of the stack gas was assumed to be 30.0 as allowed in EPA Method 3, paragraph 1.1.2, and approved by DHEC. This is part because no data is corrected to a specified oxygen concentration. As part of the previous sampling scheme, EPA Method 3A was used to continuously record oxygen concentrations in order to calculate heat input in million Btu per hour. While oxygen readings were taken as part of this test program, they were not used to determine molecular weight (since carbon dioxide readings were not taken) or heat input. Historically, the dry oxygen readings were used in conjunction with fuel factors to calculate heat input to the Kiln System. This is no longer required, as Lafarge monitors and provides heat input with their production data. DHEC monitored the visible emissions during the test program as requested by Lafarge.

The test results obtained for this sampling program are summarized in Tables 2 through 10. Tables 2 and 7 present the pollutant capture summary for the Kiln System and the Clinker Cooler, respectively. Tables 3 and 8 contain the pollutant concentration

summary for the Kiln System and the Clinker Cooler, respectively. Tables 4 and 9 present the calculated emission rates for the Kiln System and the Clinker Cooler, respectively. Tables 5 and 10 contain the production based emission summary for the Kiln System and the Clinker Cooler, respectively.

Various notes on the analytical data are: 1) One-half of all analytical values that were reported as "less than" were used in the emission calculations. 2) The $KMnO_4$ fraction of Run 1 sample from the PCM stack was broken in shipment to the laboratory. 3) The samples were analyzed for the additional metals antimony, cobalt, manganese, phosphorus and selenium at a later date (January 29, 2003) than the original analysis performed on November 2-8, 2002. 4) Selenium spike recoveries were slightly below the accepted recovery range (75%-125%) on three of the four samples checked. This should not significantly affect the results, however, since all selenium results were below or near the detection limit. 5) Phosphorus was slightly above (132%) the recovery range on one of the four samples checked.

Based on the results of this test program, the emissions from the referenced sources met the limits established in Lafarge's Title V operating permit.

A summary of test results, test method equations and nomenclature, production data, field data sheets, instrument analyzer tabulated data, instrument and equipment calibration records, Certificates of Analysis and Chain of Custody Records, gas cylinder certifications, and the site specific test plan are presented in Appendices I through IX, respectively.

3.0 PROCESS DESCRIPTION AND OPERATION

Kiln System Particulate Emissions Controlled by the Kiln Baghouse and the Precalciner Coal Mill Dust Collector

Process raw materials consisting of a fine powdered mixture of marl, clay, mill scale, bottom ash, and pulverized fly ash are progressively heated to 2,800 degrees F as the kiln feed passes through the kiln system, comprised of the preheater, precalciner, and rotary kiln, to produce cement clinker product. To generate the heat required for this process, pulverized coal is burned in the front-end of the rotary kiln and in the precalciner. Tires are burned in the back-end of the kiln. Appendix III provides information on types of fuels and their corresponding feed rates utilized by the kiln system. The kiln system emissions that result from this process consist of combustion emissions and some entrained cement kiln dust. These hot kiln system gases are used in the process to dry the kiln system raw materials in the vertical spindle mill and to dry precalciner coal in the PCM. Particulate emissions entrained with the kiln system gases exiting

these two processes are controlled by the kiln baghouse and the precalciner coal mill dust collector, respectively.

When the VSM is down for maintenance and repair, the kiln system gases bypass the VSM and are routed directly to the kiln baghouse. The stack tests were conducted in both the VSM "on"-mode and the VSM "off" (bypass)-mode.

Only a small fraction of the kiln system gases are actually used in the PCM. It is estimated that 2.5 percent of the kiln system gases are used in the PCM when the VSM is in the on-mode and 5.0 percent of the kiln system gases are used in the PCM when the VSM is in the off-mode.

Clinker Cooler Particulate Emissions Controlled by the Clinker Cooler Baghouse

Hot clinker from the rotary kiln is cooled in a reciprocating grate-type clinker cooler using forced ambient air. The majority of the air exiting from the clinker cooler is routed to the rotary kiln and precalciner to supply the requisite combustion air for the burning of kiln system fuels. However, a portion of the clinker cooler air can not be used in the kiln and is routed to the clinker cooler baghouse for control of particulate emissions.

4.0 SAMPLING METHODS AND ANALYTICAL PROCEDURES

Sampling methods and analytical procedures recommended by the EPA were used during this test program. The sampling and analytical methodologies are described below.

4.1 Stack Sampling Locations

EPA Method 1 was followed to determine the number and location of the sampling points used for velocity measurements during the test program. As specified by Method 1, an appropriate number of sampling points were selected. Since the PCM Stack was oriented horizontally, only one traverse was conducted for the isokinetic test runs.

4.2 Velocity and Volumetric Flow Rates

EPA Method 2 was used to determine the stack gas velocity and volumetric flow rate of the stack exhaust for each test run. The velocity measurements were conducted using an "S" type pitot attached to the probes employed for EPA Methods 26A and 29. As specified by Method 2, the calculated mean of the velocity measurements performed at the sampling points was used to calculate the volumetric flow rate. The temperature of the stack was measured using a calibrated Type K Thermocouple positioned on the probe.

4.3 Dry Molecular Weight

EPA Method 3 was used to determine the stack gas composition and dry molecular weight of the exit gases during the performance of the test program. As prescribed in EPA Method 3, paragraph 1.1.2, and approved by DHEC, the dry molecular weight of the stack gas was assumed to be 30.0.

4.4 Moisture Content

EPA Method 4 was used to determine the moisture content of the stack gas. Following the protocol given in Method 4, the volume of the condensed water vapor collected in the impingers was measured using a graduated cylinder, and the silica gel was weighed before and after sample collection. The difference in the two weights of the silica gel, the volume of condensed water vapor captured in the impingers, and the volume of air sampled with the impinger train were used to calculate the moisture content of the stack gas.

4.5 Emissions Determinations

Three test runs were conducted using EPA methodologies to determine the emission rates for the parameters outlined in Section 2.0 for each source. The sampling and analytical methodology employed for each analyte is described below.

4.5.1 Multi-metals

Three test runs were conducted using EPA Method 29 to determine the emission rates for multi-metals from all three sources. The original target metals were as follows: arsenic, beryllium, cadmium, chromium, lead, mercury and nickel. The samples were later re-analyzed on January 29, 2003 for the following metals: antimony, cobalt, manganese, phosphorus, and selenium. The sampling train was equipped with a glass nozzle, a glass probe liner, a quartz fiber filter, four Greenburg-Smith impingers charged with nitric acid and hydrogen peroxide solution, two impingers charged with potassium permanganate for mercury, and an impinger charged with silica gel. The multi-metals emissions were collected isokinetically through a heated sampling probe onto the heated filters. After completion of each sampling run, the sample train components including the nozzle, probe, and filter housing were rinsed and scrubbed with a nitric acid solution until clean. The impinger solutions, the rinse solutions, and the filters collected from each run and a field blank were then submitted to the laboratory, and analyzed to determine multi-metals emissions.

4.5.2 Hydrochloric Acid and Fluoride

Three test runs were conducted using EPA Method 26A to determine the emission rates for hydrochloric acid and fluoride (as hydrogen fluoride) from all exhaust stacks. The sampling train was equipped with a glass nozzle, a glass probe liner, a Teflon fiber filter, two impingers charged with 0.1 N sulfuric acid, an empty knock-out impinger, and an impinger charged with silica gel. The hydrochloric acid and fluoride emissions were collected isokinetically through a heated sampling probe onto the heated filters. After completion of each sampling run, the sample train components including the nozzle, probe, and filter housing were rinsed and scrubbed with de-ionized water until clean. The impinger solutions collected from each run and a field blank were then submitted to the laboratory, and analyzed to determine hydrochloric acid and fluoride emissions.

4.5.3 Volatile Organic Compounds

Three one-hour test runs were conducted using EPA Method 25A to determine the concentration of VOCs present in the gases exiting the Kiln Stack. Hydrocarbon emissions were collected through a heated sampling line and analyzed by a J.U.M. Model VE-7 flame ionization detector (FID). In order to correct emissions for methane, another J.U.M. FID, Model 109A, with an internal catalyst system was utilized during the Kiln exhaust "mill off" testing. This instrument was calibrated with methane and analyzed methane and non-methane VOCs in the stack gases. Outputs from the FIDs were recorded every 60 seconds on a Genie™ data collection system. These results are included in Appendix VI. VOC emissions were determined by averaging the values recorded on the data collection system.

Method 25A calibration gases were generated using an Environics Gas Dilution System in accordance with EPA Method 205. As specified by Method 205, a high-level calibration gas was used as the supply gas and a mid-level calibration gas was used as an independent check of the dilution system. Dilution's from the high-level supply gas were prepared and checked against the FID instrument response. The VOC data and instrument calibration data are included in Appendices V and VI, respectively.

4.5.4 Nitrogen Oxides

Three one-hour test runs were conducted using EPA Method 7E to determine the concentration of NO_X present in the gases exiting the Kiln Stack. During testing, a gas sample was pulled continuously through a filter and through a gas conditioning system to remove moisture. The gas sample then passed through a Teflon sample line, an air pump with Teflon coated surfaces, through a Teflon sampling manifold, through the gas analyzer,

and exhausted to the atmosphere. The data from the gas analyzer was recorded for processing by a Genie™ data collection system. NO_X was measured with an Advanced pollution Instrumentation, Inc. (API) Model 200-AH chemiluminescent NO_X analyzer that was calibrated before and after each test run with EPA Protocol 1 calibration gas.

Method 7E calibration gases were generated using an Environics Gas Dilution System in accordance with EPA Method 205. The NO_X data and instrument calibration data are included in Appendices V and VI, respectively.

4.5.5 Sulfur Dioxide

Three one-hour test runs were conducted using EPA Method 6C to determine the concentration of SO_2 in the gases exiting the Kiln Stack. An API Model 100-AH ultraviolet analyzer was used to determine SO_2 emissions on a ppm basis. During testing, a gas sample was pulled continuously through a filter and through a gas conditioning system to remove moisture. The gas sample then passed through a Teflon sample line, an air pump with Teflon coated surfaces, through a Teflon sampling manifold, through the gas analyzer, and exhausted to atmosphere. The data from the gas analyzer was recorded for processing by a Genie™ data collection system.

The gas analyzer employed for this program was calibrated before and after each test run with EPA Protocol gases. Method 6C calibration gases were generated using an Environics Gas Dilution System in accordance with EPA Method 205. The SO_2 data and equipment calibration data are included in Appendices V and VI, respectively.

4.5.6 Carbon Monoxide

Three test runs were conducted using EPA Method 10 to determine the concentration of CO in the gases exiting the Kiln Stack. A California Analytics Model 100 infrared analyzer was used to determine CO emissions on a ppm basis. During testing, a gas sample was pulled continuously through a filter and through a gas conditioning system to remove moisture. The gas sample then passed through a Teflon sample line, an air pump with Teflon coated surfaces, through a Teflon sampling manifold, through the gas analyzer, and exhausted to the atmosphere. The data from the gas analyzer was recorded for processing by a Genie™ data collection system.

The gas analyzer employed for this program was calibrated before and after each test rum with EPA Protocol gases. Method 10 calibration gases were generated using an Environics Gas Dilution System in accordance with EPA Method 205. The CO data and equipment calibration data are included in Appendices V and VI, respectively.

5.0 CALIBRATION PROCEDURES

5.1 Nozzles

Each nozzle is purchased from a stack testing equipment supplier and inspected and calibrated before putting it into field use. Thereafter, it is inspected prior to use and if damaged, the nozzle is not used. In the event the nozzle is damaged, General Engineering will attempt to repair the nozzle. If unable to repair the nozzle properly, it is returned to the manufacturer for re-machining. A set of three measurements is made prior to use and must be within 0.004 inches. Nozzles are checked prior and after each source test. This data is recorded on the back of all field data sheets. Refer to Appendix VI.

5.2 Pitot Tubes

All pitot tubes used by General Engineering are purchased along with the probe assembly from a stack testing equipment supplier. Prior to being used, the pitot tubes are calibrated as per Method 2. If a type "S" pitot tube is constructed properly it will have a Cp (pitot coefficient) of 0.84. Pitot tubes are checked before each source test and receive a complete calibration once per year. This information is included in Appendix VI.

5.3. Dry Gas Meter

Complete dry gas meter calibrations are performed annually. After a source test, a single point calibration is conducted at the average orifice meter (DH) and maximum vacuum readings encountered during the test. If the dry gas meter calibration factor differs from the annual calibration by more than +/- 0.02, it is repaired and given another annual calibration. The post-test and annual calibrations are included in Appendix VI.

5.4 Thermocouples

Each new thermocouple purchased by General Engineering is checked and calibrated prior to use. After each source test, all temperature-sensing devices used receive a one-point calibration check as per Method 2. This information is recorded on the back of the field data sheets.

5.5 Balance

General Engineering technicians utilize the Mettler balance Serial #1121320091P located in the laboratory. The laboratory personnel perform a daily calibration on this balance using weight set Serial #39325. This information will be provided upon request.

5.6 Barometer

General Engineering utilizes the National Weather Service to determine the current

Barometric Pressure. This is obtained either by telephone or using the Internet.