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LAFARGE NORTH AMERICA, Inc.
ALPENA, MICHIGAN

TEST REPORT:

EMISSIONS OF HYDROGEN CHLORIDE AND MERCURY
From Kiln, Raw Mill and Clinker Cooler Exhausts

PREPARED FOR:

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1.0 SUMMARY

1.1 Introduction

Lafarge North America (Lafarge) operates five dry process cement kilns (Kilns 19-23) at its plant in Alpena, Michigan (EPA Facility ID #MID005379607). Kilns 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). All five kilns operate with waste-heat boilers for energy recovery and fabric filter baghouses for control of particulate matter emissions.

Table 1-1 addresses the test program parameters that were tested in the June 2014 test program. Lafarge operates under the Renewable Operating Permit (ROP) MI-ROP-B1477-2012 as well as the Permit to Construct (PTC) Number 195-10B, requiring testing for hydrogen chloride (HCl) and mercury (Hg) on multiple sources. Testing was performed to both confirm compliance with the kiln's HCl emission limits and to assess the current levels of Mercury (Hg) on Kilns 19-21, the Wet Gas Scrubber (WGS) which is now the emissions point for Kiln 22 and Kiln 23, raw mill 14 (RG14) and raw mill 15 (RG15) as well as satisfying the requests of the MDEQ for mercury testing on Clinker Cooler 22 (CC22), Clinker Cooler 23(CC23), KG5 clinker cooler emission points (92N) and South (93S). The clinker coolers receive bleed water from the WGS blowdown.

Table 1-1. Test Program Parameters and Locations

Parameter	Kiln 19	Kiln 20	Kiln 21	Kiln 22	Kiln 23	WGS	Clinker Cooler KG5 (92N)	Clinker Cooler KG5 (93S)	Clinker Cooler 22 (CC22)	Clinker Cooler 23 (CC23)	Raw Mill 14	Raw Mill 15
Flow Rate	•	•	•	•	•	•	•	•	•	•	•	•
Moisture	•	•	•	•	•	•	•	•	•	•	•	•
HCl	•	•	•			•						
Hg	•	•	•			•	•	•	•	•	•	•

A URS test team consisting of Bob Jongleux, Willie Lea, Robert Griffin, Sam Warnock, Fran Cobo, and Pat Turner performed the emissions testing. Josh Strapec of Lafarge provided oversight to the sampling. Rob Dickman of MDEQ observed a portion of the field testing activities.

Section 2 includes a summary of the results, Section 3 contains the source and process descriptions, Section 4 discusses sampling locations, Section 5 describes the sampling and analytical procedures, Section 6 discusses the test results in detail, and Section 7 discusses quality assurance and quality control practices. Questions regarding this test report should be directed to the following individuals:

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2.0 HCL AND MERCURY RESULTS

Testing for mercury on Kilns 19-21 were run concurrently with the continuous emissions rate monitoring (CERMS) testing to determine flow rates during those tests. The WGS stack volumetric flow rate was determined by using an average flow rate based on testing performed during the HCl and CERMS runs. The Raw Mills 14 and 15 (Raw Grinds) flows were determined by running EPA Method 2 concurrently with Method 30B sampling. The CC22, CC23, 92N and 93S stack volumetric flows were derived from the EPA Method 5 volumetric flow results that were run subsequently on each source clinker cooler emission point for an in-house engineering oriented purpose.

The average mercury concentration at each source was determined by 3 sets of pair runs. Emission rate in pounds per hour is based on 8760 hours of operation and a constant stack gas volumetric flow rate as measured during the test period. Michigan Rule 1003 (R 336.2003) Section 2, states: "for purposes of determining compliance with an applicable emission limit, rule, or permit condition, the arithmetic mean of results of the three samples shall apply." The kilns and raw mill stacks are to be tested periodically for mercury to demonstrate compliance with the plant wide mercury mass emission limits as well as the source specific limits for both the ROP and the PTC. Tables 2-1 and 2-7 summarizes the test results and operating conditions of the each source tested.

Table 2-1. Summary of Kiln HCl Test Results (June 2014)

Source	O_2 (%)	HCl Concentration (ppmvd)		Cl⁻ Concentration (ppmvd @7%O_2)	(ppmvd @7%O_2)	HCl Equivalent Permit Limit (ppmvd @7%O_2)	HCl Equivalent Emission Rate (lb/hr)	HCl[a] Equivalent Emission Permit Limit (lb/hr)
K19	7.7	6.58	6.93	0.01	0.01	**65**	2.80	**36**
K20	9.9	18.98	24.08	0.01	0.02	**65**	10.67	**36**
K21	9.6	11.19	13.47	0.01	0.01	**65**	5.35	**36**
WGS	8.4	0.24	0.27	0.02	0.03	**170[a]**	0.54	**162[a]**

[a] HCl + 2 x (Cl2) = HCL Equivalents

Table 2-2. Summary of Kiln Operating Conditions During HCl Testing (2014)

Kiln	Date	Fuel Used	Burning Zone Temperature (°C)	Raw Material Feed Rate (Metric tons/hr)	Kiln Dust Recycle Rate (Metric tons/hr)
K19	6/16 – 6/17	Coal/coke	1416	74.5	2.8
K20	6/21	Coal/coke/plastic	1387	78.9	5.5
K21	6/17 – 6/18	Coal/coke/plastic	1531	65.5	7.3
WGS – K22[a]	6/25	Coal/coke[b]	1373	127.3	6.1
WGS – K23[a]	6/25	Coal/coke[b]	1357	98.1	8.6

[a] Wet Gas Scrubber is based on an average of Kiln 22 and Kiln 23 operating conditions.
[b] Plastic was not included in the feed during the WGS testing

Table 2-3. Summary of Fuel Usage and Production Data During HCl Testing (2014)

Kiln	Date	Fuel Used[ab]	Clinker Produced (Metric Tons)[c]	Plastics Feed (mt/h)	Coal/Coke Feed (mt/h)
K19	6/16 – 6/17	Coal/coke	440.36	0.00	7.10
K20	6/21	Coal/coke/plastic	677.78	1.18	6.18
K21	6/17 – 6/18	Coal/coke/plastic	620.23	1.18	7.03
WGS – K22	6/25	Coal/coke	1065.53	0.00	12.48
WGS – K23	6/25	Coal/coke	1071.85	0.00	10.91

[a] Wet Gas Scrubber feed did not contain plastics during HCl test runs

[b] Kiln 19 is not currently physically capable of burning plastics.

[c] Supporting data in Appendix D

Table 2-4. Summary of Mercury Results for Lafarge Alpena (June 2014)

Source	Average Stack Volumetric Flow Rate (dscfm)	Average Hg Concentration (ug/m^3)	Average Hg Concentration (lb/hr)
RG 14	52,426	0.009	1.74E -06
RG 15	50,970	0.019	3.26E -06
K19	74,330	20.60	5.74E -03
K20	97,979	7.87	2.89E -03
K21	85,526	14.53	4.69E -03
CC22	42,705	1.46	2.36E -04
CC23	41,178	2.56	3.98E -04
92N	26,529	0.12	1.23E -05
93S	60,868	0.09	2.10E -05
WGS	285,946	1.22	1.31E -03

Table 2-5. Summary of KG5 Operating Conditions During Mercury Testing

Kiln	Date	Burning Zone Temperature (°C)	Raw Material Feed Rate (Metric tons/hr)	Kiln Dust Recycle Rate (Metric tons/hr)
K19	6/16 – 6/17	1401.4	74.2	2.8
K20	6/21	1275.8	78.1	5.5
K21	6/17 – 6/18	1530.7	65.5	7.3

Table 2-6. Summary of Fuel Usage and Production Data During Mercury Testing

Source	Date	Fuel Used	Clinker [c] Produced (Metric Tons)	Bleed Water (L/min)	Coal/Coke Feed (mt/h)
K19	6/16 – 6/17	Coal/coke[b]	449.10	--	6.84
K20	6/21	Coal/coke/plastic	643.77	--	6.23
K21	6/17 – 6/18	Coal/coke/plastic	620.23	12.24	7.03
WGS – K22[a]	6/25	Coal/coke	1467.3	8.01	10.46
WGS – K23[a]	6/25	Coal/coke	1334.2	--	10.58
CC22	6/25	Coke	1201.2	8.01	2.24
CC23	6/23 – 6/24	Coke/shingles	966.7	6.57	1.79
92N	6/24	Coal/coke	4322.0	10.65	9.08
93S	6/23	Coal/coke	5306.6	9.50	9.31

[a] The coal/coke ratio for Kilns 19, 20, and 21 was 20/80% mass basis, respectively.

[b] Kiln 19 is not currently physically capable to burn plastics.

[c] Supporting data in Appendix D

Table 2-7. Summary of Raw Grind Operating Data during Mercury Testing

Source	Date	Test	Tons of Raw Feed (mt/hr)	Baghouse Inlet Differential Pressure (kpa)	Baghouse Inlet Temp. (C°)
RG14	6/23 – 6/24	Hg	211.5	0.91	80.69
RG15	6/23	Hg	323.0	0.89	86.74

3.0 SOURCE AND PROCESS DESCRIPTIONS

Lafarge's Alpena, Michigan plant operates five rotary kilns, which manufacture Portland cement clinker using the dry process. A mixture of pulverized bituminous coal and petroleum coke, with a heating value of approximately 11,750 Btu per pound, serves as the primary fuel fed to the kilns. Coal and coke were fed to a Raymond bowl mill and ground to a fineness of approximately 95% passing a 200-mesh sieve.

3.1 Kiln Group 5

Kiln Group 5 at the Lafarge Alpena plant consists of three rotary kilns (#19, #20, and #21). Specific components of Kiln Group 5 were:

- Coal/petroleum coke and combustion air delivery;
- Raw mix preparation and delivery;
- Three rotary kilns;
- Kiln burners;
- Waste heat recovery boilers and
- Air pollution control system, consisting of the following components:

    - Multiclone dust collectors;
    - Baghouses;
    - DAA (hydrated lime) injection
    - SNCR
    - Induced draft (ID) fans; and
    - Exhaust stacks.

Allis Chalmers manufactured all kilns identified as #19, #20, and #21. Each kiln is 460.5 feet long. Each kiln shell has an inside diameter of 15 feet at the feed end and 13 feet at the firing end. The kilns in Kiln Group 5 rotate at speeds of greater than 40 revolutions per hour and were driven by an electric motor.

Dracco manufactured the baghouse for Kiln 19. The baghouse has two parallel sets of six chambers and design airflow of 175,000 cubic feet per minute (cfm) at 400°F. The maximum operating temperature is 550°F. The baghouses for kilns 20 and 21, manufactured by Wheelabrator-Frye were identical in design and construction, with two parallel sets of six chambers. Each baghouse has a design air flow of 166,000 cfm at 400°F. The maximum operating temperature is 550°F.

3.2 Kiln Group 6

Kiln Group 6 at the Lafarge Alpena plant consists of two rotary kilns (#22 and #23). Specific components of Kiln Group 6 were:

- Coal/petroleum coke and combustion air delivery;
- Raw mix preparation and delivery;
- Two rotary kilns

- Kiln burners;
- Waste heat recovery boiler and
- Air pollution control system, consisting of the following components:

  - SNCR (mid-kiln);
  - Multiclone dust collectors;
  - Baghouses;
  - Induced draft (ID) fans;
  - Wet gas Scrubber (WGS); and
  - Common exhaust stack.

The pulverized coal/coke is pneumatically conveyed by heated air, recycled from the clinker cooler, through the outer ring of a concentric burner torch. Both rotary kilns in Kiln Group 6 were manufactured by Fuller Co. and are identical in design and operation. The kilns are 500 feet long and have a 19.6-foot inner diameter and 17 feet for the remainder. The kilns were lined with high-temperature refractory brick. The kiln design is based on a throughput of 4.8 million Btu per ton of clinker. An induced draft fan pulls combustion gases from each kiln. After exiting the kiln, the gases pass through a drop out chamber, a boiler then a set of multiclones before entering a fabric filter baghouse. After exiting the baghouse, the gases were routed through a breaching duct that connects the baghouse to a common reinforced concrete stack.

The kilns rotate at a rate up to 80 revolutions per hour using two 350-hp motors. The kilns' associated air pollution control systems (APCS) are identical in all aspects of design, operation, and maintenance. The APCS for Kilns 22 and 23 are identical ten-compartment baghouses. Each baghouse, manufactured by Wheelabrator-Frye, consists of two parallel sets of five chambers and has design airflow of 285,000 cfm at 400°F. Figure 2-2 provides a process flow diagram of Kiln Group 6.

3.3 Kiln Process Instrumentation

Instruments used to monitor kiln operating parameters were located throughout the kiln system. Parameters that were recorded during testing were the baghouse inlet temperature, production rate, and baghouse change in pressure (delta P). Each kiln system is equipped with a differential pressure indicator system, with measurement points located in the duct prior to and exiting the baghouse. The differential pressure devices are used to monitor the pressure drop across the baghouse.

Figure 3-1 is a detailed diagram of the process flow indicating where the air quality control equipment is located for KG5 and KG6 as well as the identification numbers of each device. Figure 3-2 is a schematic of the plant's SNCR system and Figure 3-3 is an example diagram of the raw mill process.

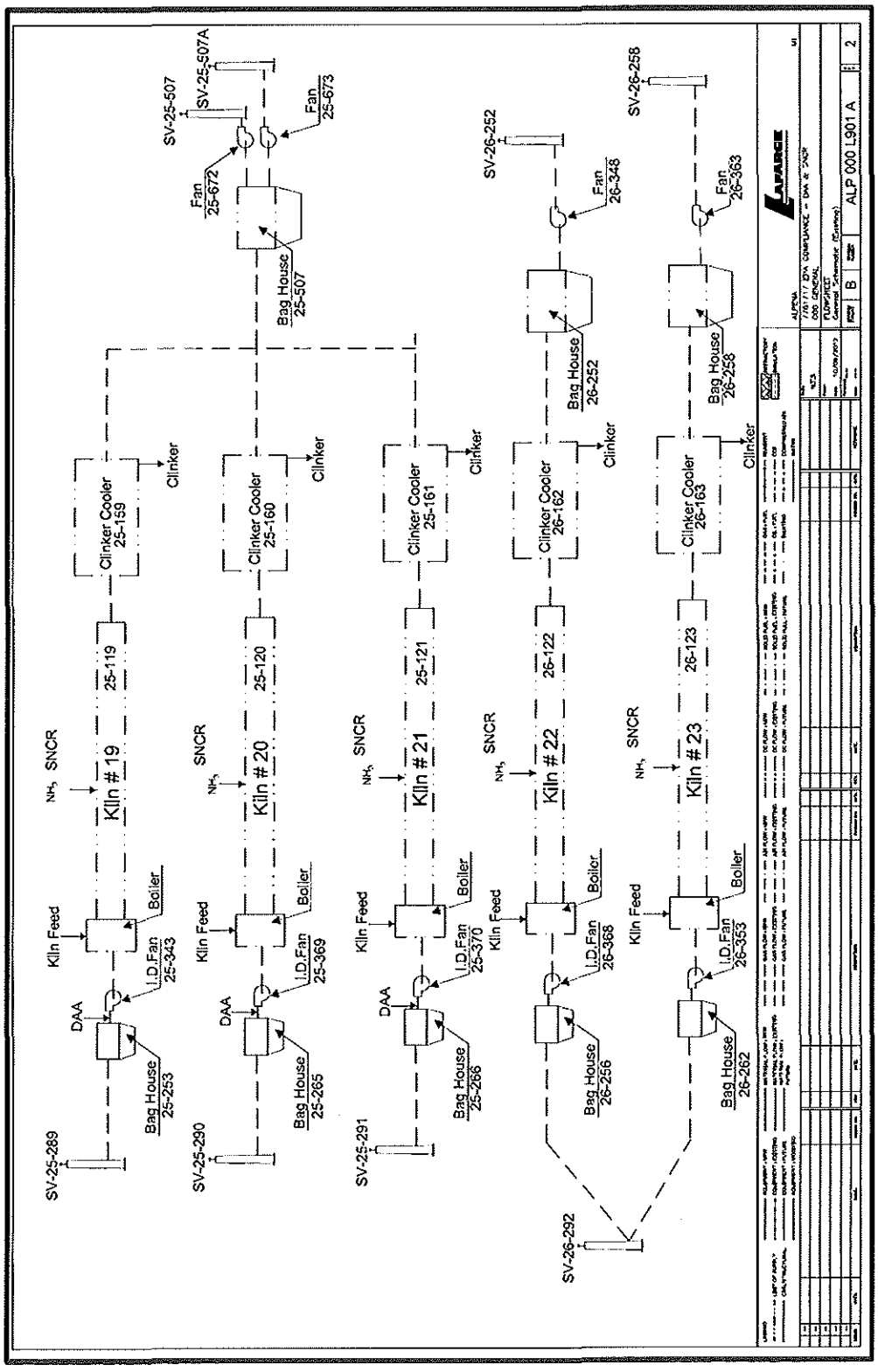

Figure 3-1. Detailed Process Flow Diagram for Kiln Group 5 and Kiln Group 6

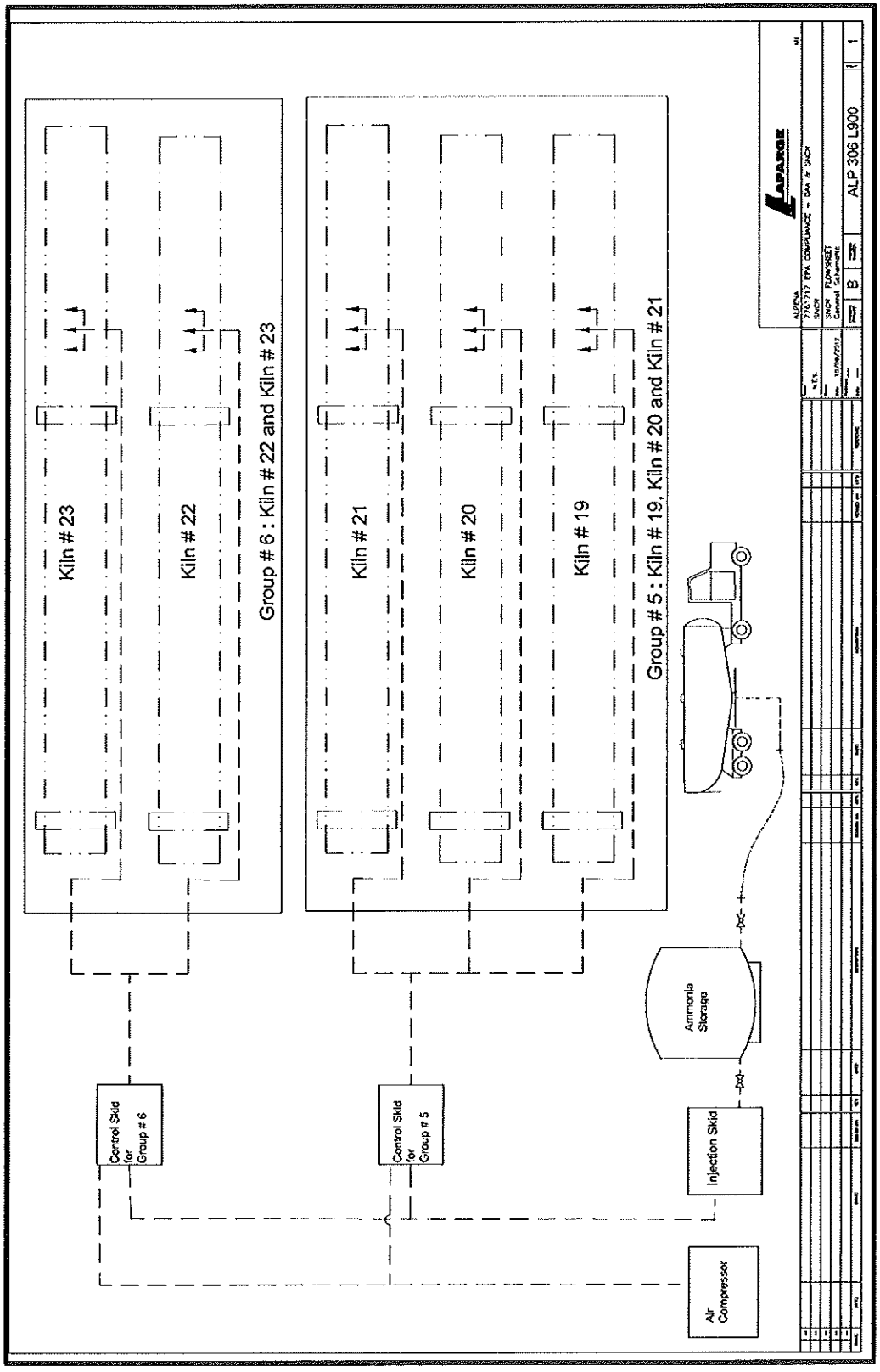

Figure 3-2. Schematic of Kiln Group 5 and Kiln Group 6 SNCR System

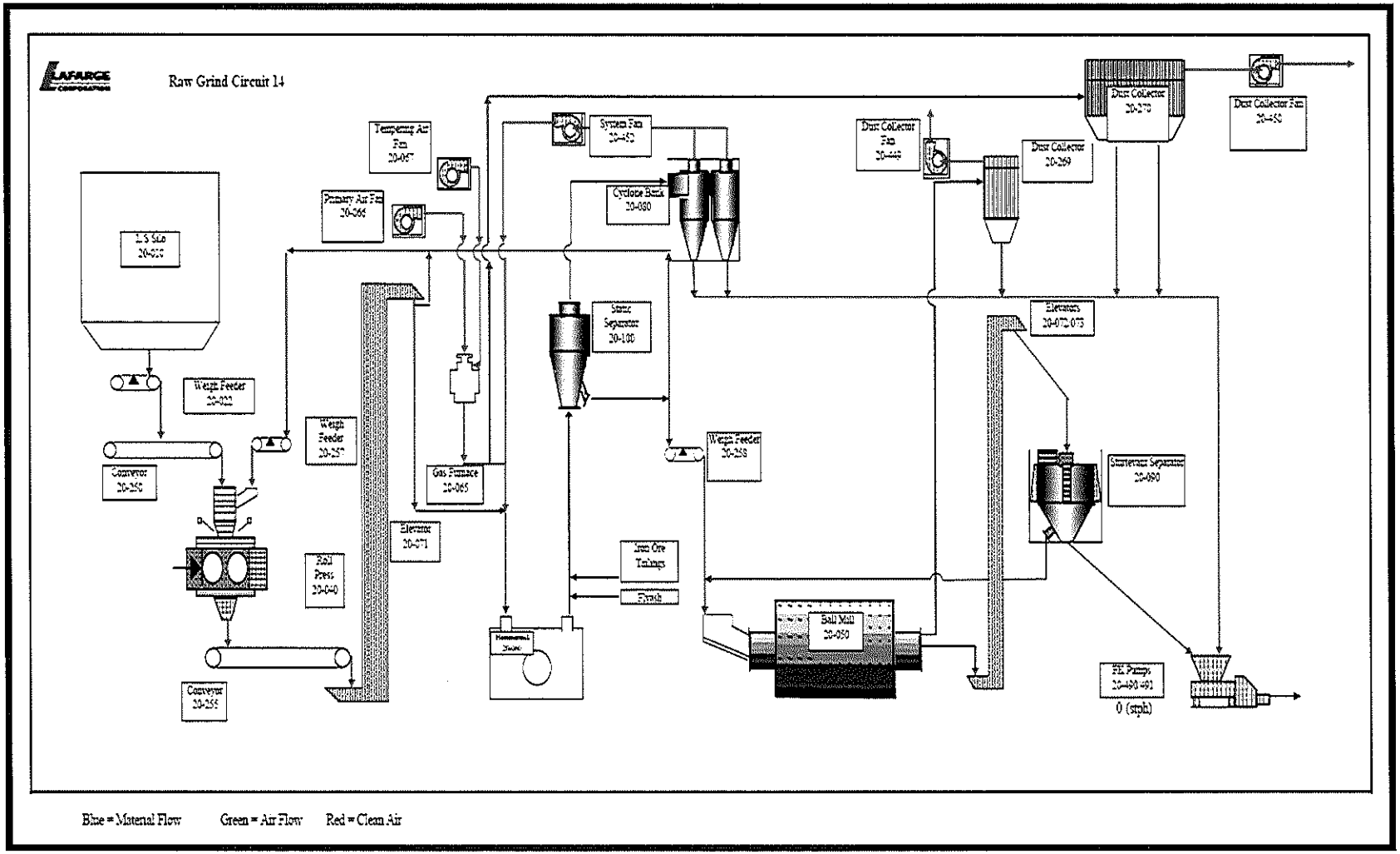

Figure 3-3. Raw Mill Process Diagram

4.0 SAMPLING LOCATIONS

For all kilns, the sampling location was in the breeching duct between each kiln's baghouse and discharge stack.

The sampling locations for the Kilns are illustrated in Figure 4-1 through Figure 4-5.

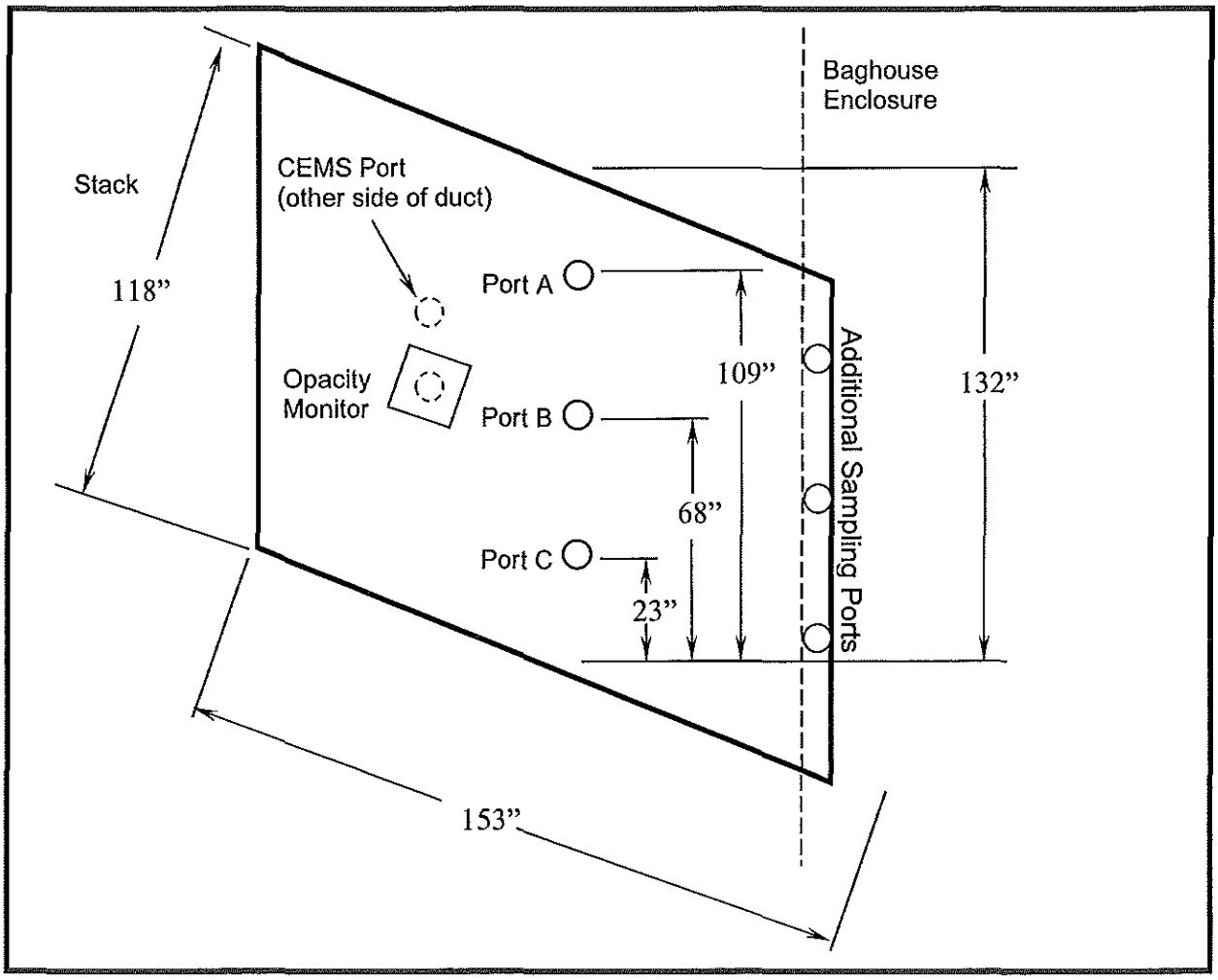

Figure 4-1. Kiln 19 Test Port Locations (side view)

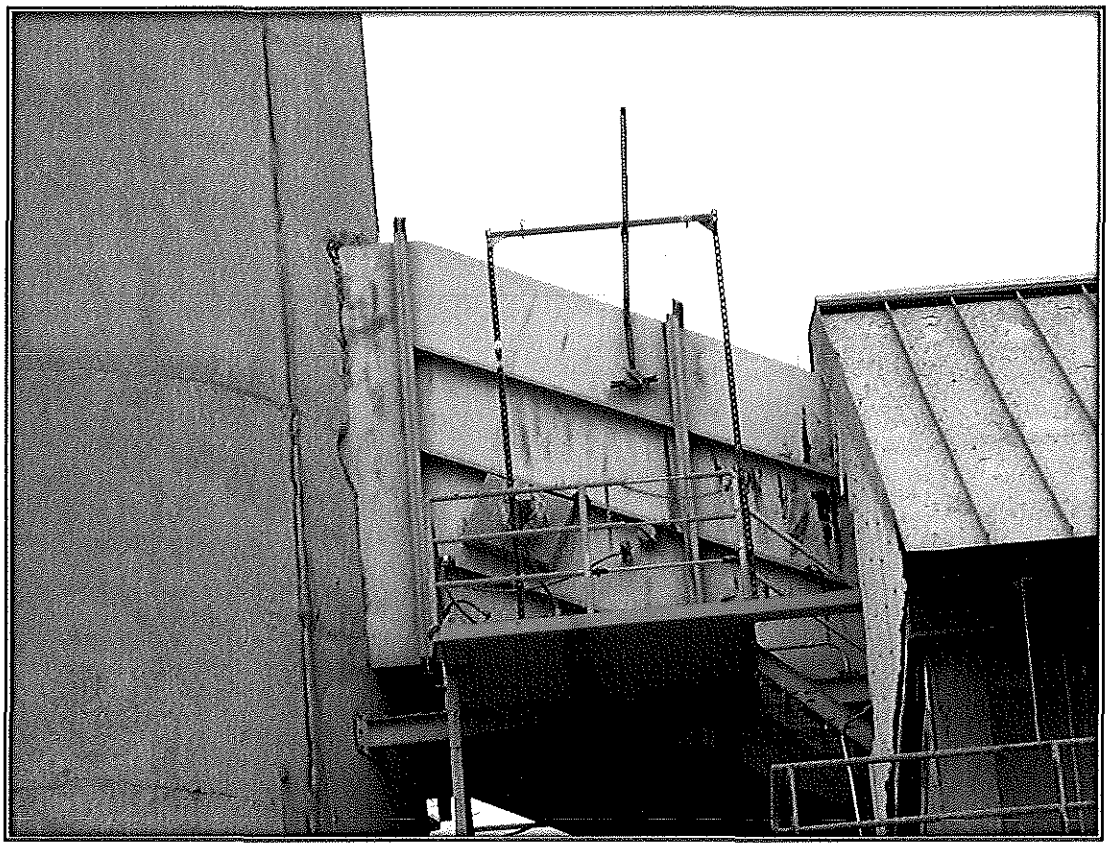

Figure 4-2. Kiln 19 Breeching Duct

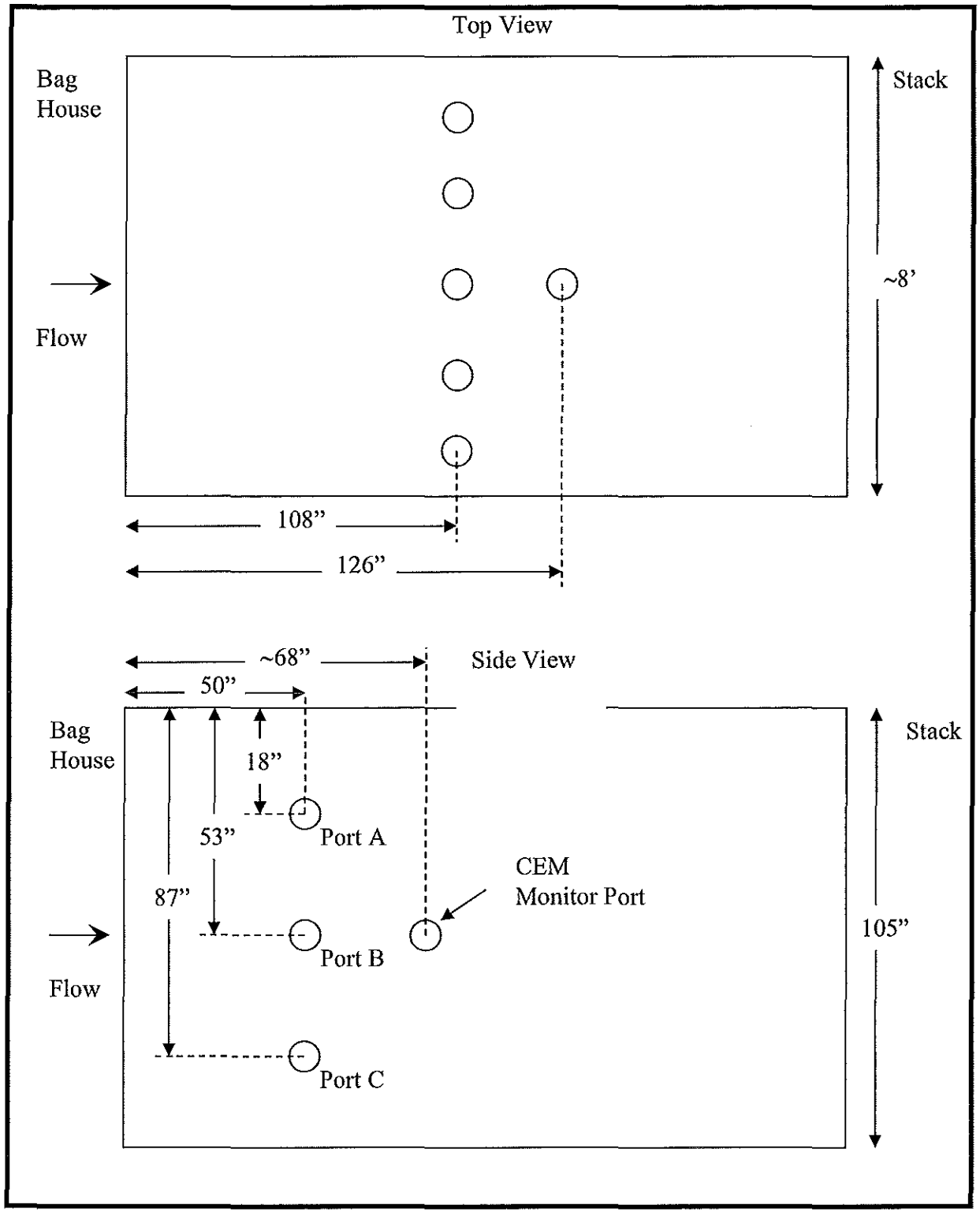

Figure 4-3. Lafarge Alpena Kilns 20 and 21 Breeching - Test Port Locations

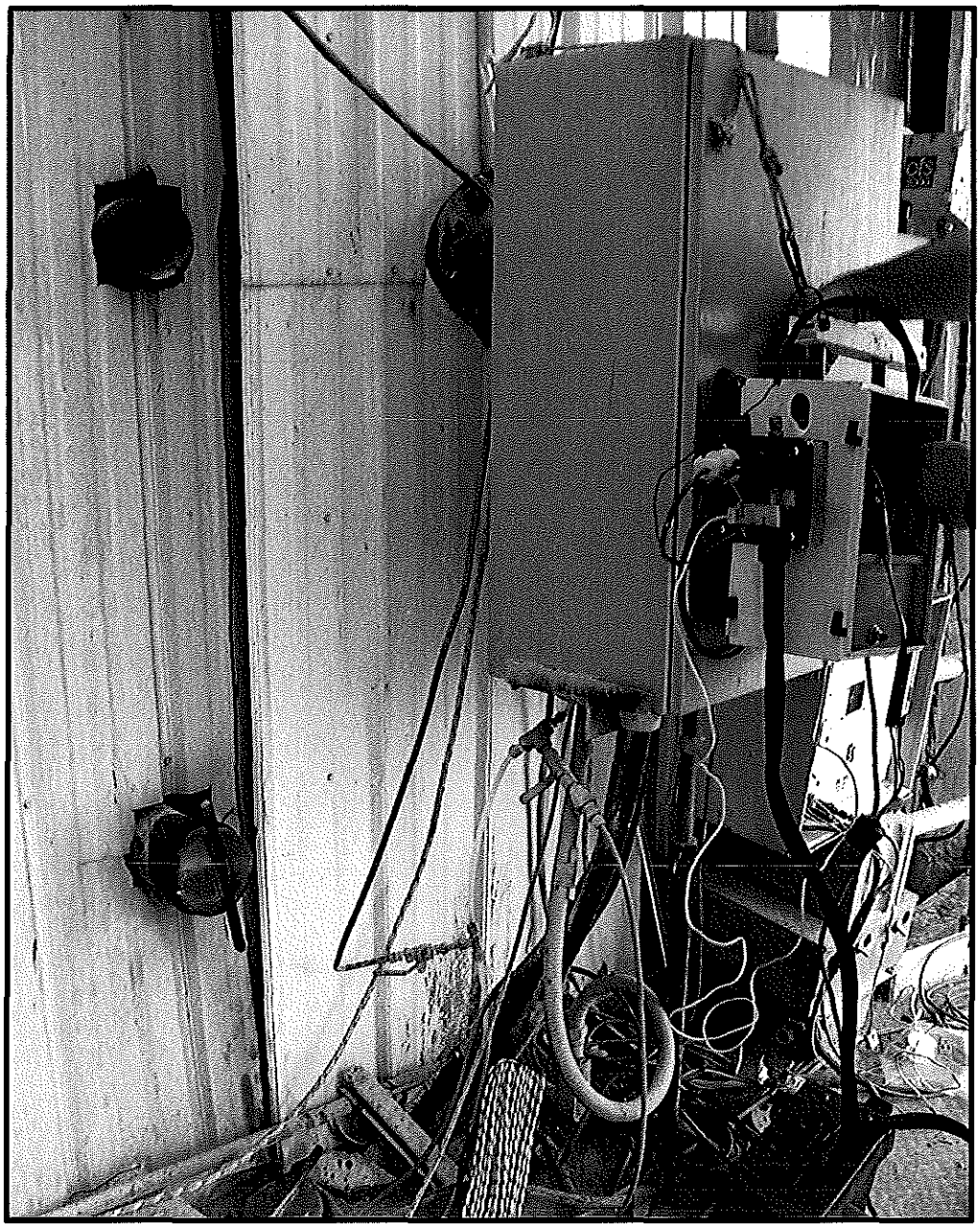

Figure 4-4. Kiln 21 Breaching Duct – Lower Test Ports

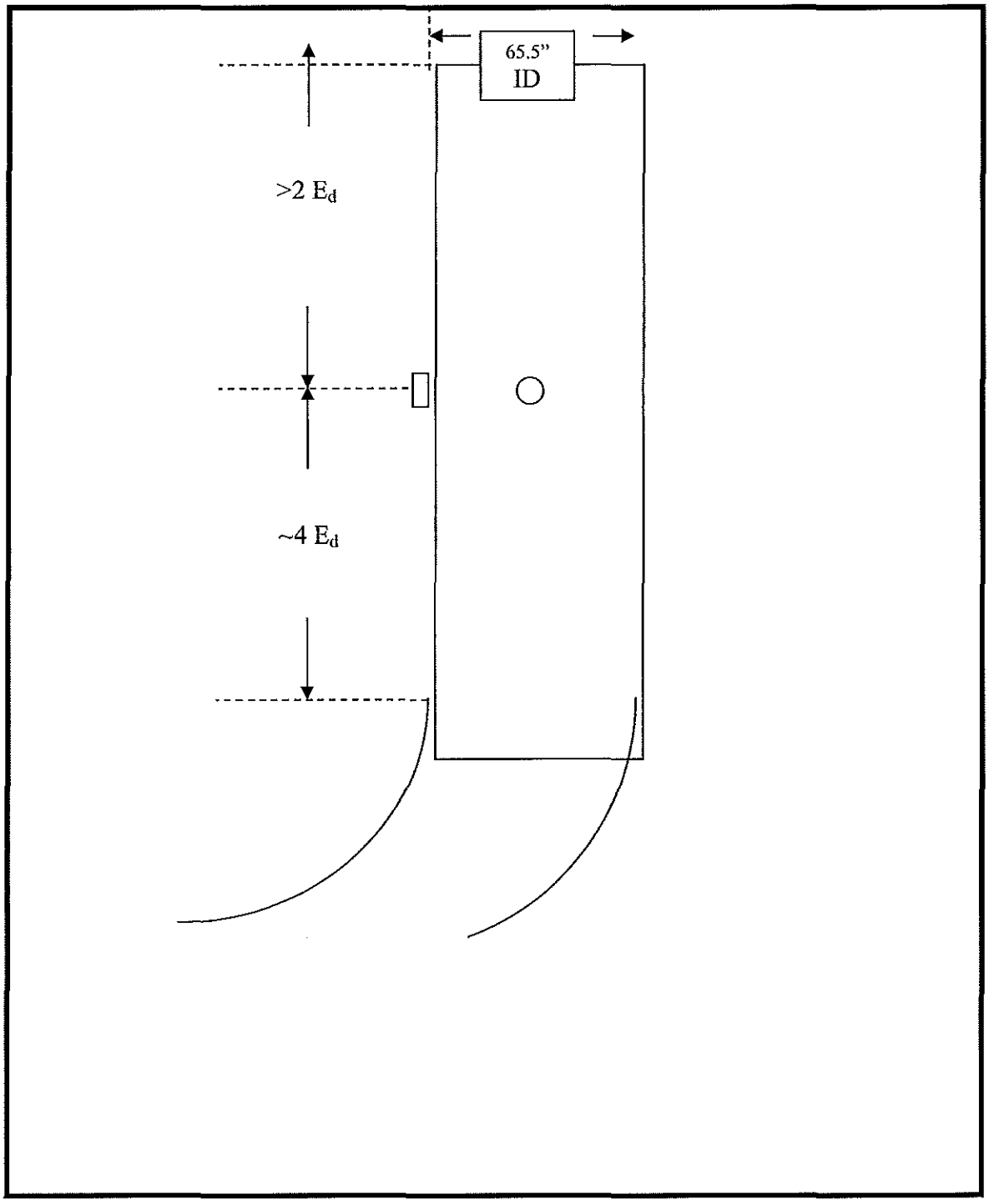

Figure 4-5. Raw Mill Stack Locations

5.0 SAMPLING AND ANALYTICAL PROCEDURES

URS Corporation (URS) conducted emissions measurements in accordance with procedures specified in the United States Environmental Protection Agency's (U.S. EPA's), and MDEQ's "General Rules, Part 10, Intermittent Testing and Sampling." The test methods used to perform the sampling and analysis are provided in Table 5-1.

Table 5-1. Test Methods

Parameter Measured	Method	Method Description
Mercury	EPA Method 30B	Determination of Mercury Emissions From Stationary Sources
Hydrogen Chloride	EPA Method 26A	Determination of Hydrogen Chloride Emissions From Stationary Sources
Velocity	Certified Plant Instrumentation / EPA Method 2	Determination of Stack Gas Velocity and Volumetric Flow Rate
Oxygen and Carbon Dioxide	Certified Plant Instrumentation / 40 CFR 60 Appendix A: Method 3A	Certified Plant Instrumentation monitoring for Oxygen and Carbon Dioxide
Moisture	40 CFR 60 Appendix A: Method 4	Determination of Moisture Content In Stack Gases in conjunction with EPA Method 26A

5.1 Audit Sample

Audit samples through the newly instituted Source Sampling Audit Sample (SSAS) program were acquired from an Accredited Audit Sample Provider (AASP). One HCl audit sample was requested for this element of the test program (2014). The SSAS was analyzed in conjunction with the field samples in the laboratory. Table 5-2 summarizes the results from the SSAS. Both SSAS results were "acceptable" by definition from the AASP.

Table 5-2. Summary of SSAS Audit Results

Parameter	Units	Laboratory Result	Acceptable Range	Assigned Value
Hydrogen Chloride	mg/L (ppm)	127	116-142	129

There was no audit sample for the mercury testing as the test method (30B) is considered to be self-validating by the regulatory authorities (US EPA).

6.0 TEST RESULTS AND DISCUSSION

Table 6-1 summarizes the results of the HCl emission testing program. Example calculations can be found in Appendix E. Both HCl and Cl- concentration were determined, and that HCl equivalent concentrations are reported using the following equation:

$$\text{HCl Equivalents (Cl-)} = \text{HCl} + 2 \times \text{Cl}_2$$

The O_2 concentrations were used to correct the as-measured results to obtain 7% O_2 as specified in the Title V permit.

Only the kiln average results are compared to the permit limit in accordance with Michigan Rule 1003 (R 336.2003) Section 2, which states: "for purposes of determining compliance with an applicable emission limit, rule, or permit condition, the arithmetic mean of the results of the three samples shall apply. " The process operating data conditions during the entire emission testing program were recorded by Lafarge. Table 6-2 presents the kiln operating conditions during each test run.

The EPA Method 26A testing for HCl and Cl_2 met all sampling and analytical QA/QC parameters. The measured HCl concentration continues to be the predominate species which comprises over 99.9 % of the measured HCl equivalents. The Cl_2 measured component of the EPA Method 26A sampling train is negligible and is at or below the method analytical reporting limit.

The EPA Method 30B sampling and analytical results met strict specifications for Kiln 20 and the WGS emission points based on the spike recovery, duplicate pairs, sorbent breakthrough, and spike levels. An initial test on the WGS concluded that the chosen spike levels were too low for the resulting concentrations. A second test was performed to provide better data quality and a more accurate spike level for mercury testing on the WGS. The initial data set for the WGS location was collected on sorbent tubes spiked at 500 ng. Calculations were performed based on concentrations from the initial test to determine the most appropriate spike levels. A second set of sorbent tubes was collected using a spike level of 100 ng. Based on the lower spike level and last round of testing, sorbent tubes at the WGS demonstrated greater than 90 % removal.

Mercury results for Kiln 19 and Kiln 21 were fair based on greater variability between sample runs and duplicate pair agreement. The spike level chosen were based on historical data but were not optimum, which caused the duplicate pair agreement to be higher than desired. A lower spike level should be considered in the future.

The raw grind sources (RG14 and RG15) are consistent with past sampling efforts with low concentrations at or below the analytical reporting limits. The spike recovery and duplicate pair agreement is greater than desired by the methodology but is acceptable based on the low levels encountered.

The Hg results for the clinker cooler sources are not as consistent as desired, but are acceptable to indicate relative concentrations from these previous untested sources. The KG5 clinker coolers sources (92S and 93N) resulted in very low concentrations with poor spike recovery and duplicate pair agreement. The measured sorbent tube spiked and unspiked amounts are variable. The root cause is unknown at this time, but the sorbent spike levels (labelled from the analytical spiking lab) are suspect and thought to be in error. Lower level spikes and longer sampling duration should be used in future events. (Note: Test protocol specified spike levels and duration (2 hour sample periods) were implemented as planned, but these assumptions were not borne out for the field test results for KG5 coolers.

The Hg results for the KG6 clinker coolers are better quality. The Hg results were more consistent between sampling runs, which may be due to the slightly higher Hg level measured (above MDL). Although under spiked at 23-25 ng, the paired tube agreement for CC22 was within duplicate and breakthrough specifications. The CC22 data set was consistent at 1.2- 1.6 ug/dscm. The CC23 data set was not as consistent with results ranging from 0.39 – 4.72 ug/dscm. The variability of Hg results for CC23 test sequence may be due to process inconsistency as the kiln was unsteady during the Hg testing and subject to several upsets during the Hg testing.

Table 6-1. Hydrogen Chloride Annual Verification Test Results (June 2014)

Kiln	Run	O_2 Conc. (% dry basis)	HCl Concentrations		Cl⁻ Concentrations		HCl Equivalent Permit Limit (ppmv,dry @7% O_2)	HCl Equivalent Emission Rate (lb/hr)	HCl Equivalent Emission Rate Permit Limit (lb/hr)[b]
			Uncorrected (ppmv, dry)	Corrected (ppmv,dry @7% O_2)	Uncorrected (ppmv, dry)	Corrected (ppmv,dry @7% O_2			
19	1	7.7	5.8	6.13	<0.01	<0.007		2.44	
	2	7.7	3.5	3.67	<0.01	<0.007		1.49	
	3	7.7	10.4	10.99	<0.01	<0.007		4.42	
	Avg	**7.7**	**6.58**	**6.93**	**<0.01**	**<0.007**	**65**	**2.79**	**36**
20	1	9.7	8.9	11.07	<0.007	<0.009		4.86	
	2	9.9	24.5	31.06	<0.007	<0.009		14.02	
	3	10.0	23.5	30.11	<0.028	<0.036		13.12	
	Avg	**9.9**	**18.9**	**24.08**	**<0.014**	**<0.018**	**65**	**10.66**	**36**
21	1	9.6	2.4	3.01	<0.006	<0.008		1.26	
	2	9.9	3.7	4.67	<0.011	<0.014		1.76	
	3	9.2	27.5	32.72	<0.007	<0.008		13.02	
	Avg	**9.6**	**11.19**	**13.47**	**<0.008**	**<0.010**	**65**	**5.35**	**36**
WGS	1	8.4	0.32	0.36	<0.05	<0.06		0.85	
	2	8.4	0.20	0.23	<0.01	<0.01		0.39	
	3	8.4	0.21	0.23	<0.01	<0.01		0.39	
	Avg	**8.4**	**0.24**	**0.27**	**<0.02**	**<0.03**	**170[a]**	**0.54**	**162[a]**

[a] WGS now controls Kiln 22 and Kiln 23 emission points to the atmosphere. Existing permit limit is for each kiln.
[b] HCl + 2 x (Cl2) = HCl Equivalents.

Table 6-2. Detailed Operating Conditions during HCl Testing (June 2014)

Kiln	Run	Date	Run Start Time (EDT)	Run End Time (EDT)	Kiln BZT (°C)	Kiln Feed (Metric tons/hr)	Kiln Dust (Metric tons/hr)	Baghouse Inlet Temp (°C)	Opacity (%)
19	1	6/16/2014	14:48	15:48	1482.3	74.3	2.8	239.2	6.3
	2	6/17/2014	08:17	09:17	1432.5	74.5	2.8	241.6	6.3
	3	6/17/2014	10:02	11:02	1333.0	74.6	2.8	246.3	6.6
	Average				**1415.9**	**74.5**	**2.8**	**242.4**	**6.4**
20	1	6/21/2014	14:45	16:07	1309.6	78.6	5.5	265.5	3.3
	2	6/21/2014	17:15	18:15	1451.4	79.2	5.5	255.9	3.8
	3	6/21/2014	18:32	19:32	1399.5	78.8	5.6	257.6	3.4
	Average				**1386.8**	**78.9**	**5.5**	**259.7**	**3.5**
21	1	6/17/2014	17:10	18:10	1464.3	58.1	6.4	239.3	2.9
	2	6/17/2014	18:50	19:50	1599.3	64.8	7.3	241.9	4.3
	3	6/18/2014	10:10	11:10	1528.4	73.6	8.2	242.6	2.6
	Average				**1530.7**	**65.5**	**7.3**	**241.3**	**3.3**

7.0 QUALITY ASSURANCE/QUALITY CONTROL

Specific quality assurance and quality control (QA/QC) procedures that were identified in the test plan were followed during this test episode to ensure collection of useful and valid data. Table 7-1 lists the acceptance criteria and control limits for the program, ion chromatography QC results for the test period. Leak checks were performed on the sampling trains before and after every sample run. The measured leakage rate for all of the checks was within the allowable method rate for all reported samples.

7.1 Laboratory QC

Enthalpy Analytical of Durham North Carolina analyzed the acid and basic fractions of the Method 26A samples by ion chromatography (IC), following EPA Method 300.1 procedures. The caustic samples were collected and archived per agreement with MDEQ. Table 7- lists the results of all of the QC procedures that were conducted as part of the analysis. QC results were within the acceptance criteria. All samples were analyzed within their required hold times. Method blank results were less than the method detection limit.

The correlation coefficient is indicative of the linearity of the curve. An acceptable calibration curve has a correlation coefficient ≥ 0.995. The correlation curve for all analyses met this requirement. Also, the daily calibration verification results were all within the acceptance criteria. All samples were analyzed in duplicate. RPD is then calculated for each duplicate pair of samples to indicate the precision of the analyses. RPD is calculated from the equation:

$$RPD=\frac{|R1-R2|}{(R1+R2)/2}\times 100$$

Where:

R1 and R2 represent initial and duplicate analytical results, respectively.

Table 7-1. Summary of QA/QC Procedures and Results for Chloride Analysis

Calibration and QC Analysis	Description	Frequency	Acceptance Criteria	Laboratory IC Result
Initial Calibration (ICAL)	5-point calibration proceeding from lowest to highest.	Daily, preceding and again following sample analysis.	Correlation coefficient ≥0.995.	$R^2 \geq 0.9999$
Duplicate Analyses	Duplicate analyses of all field samples.	Every sample and blank.	<10% RPD	≤ 0.5 % RPD
LCS/LCSD Duplicate	Extracted blank matrix samples spiked with second source standard.	One LCS per standard calibration preparation.	85 – 115% recovery.	92.5-95.8 % recovery for H_2SO_4 fraction 109 % for NaOH fraction
Method Blank	Analysis of eluent used for dilutions and standards.	Daily.	Measured concentrations must be < MDL.	Method blank results were < reporting limit*

*Method blanks were less than the lowest level standard of the initial calibration.
LCS Laboratory Control Sample
LCSD Laboratory Control Sample Duplicate
RPD Relative Percent Difference
H_2S0_4 Sulfuric Acid
IC Ion Chromatography
QC Quality Control