Section 114 Information Collection Request Emissions Test Report

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Heidelberg Materials US Cement, LLC
Union Bridge Cement
Manufacturing Facility
EPA Registry ID: 110003507385
675 Quaker Hill Road
Union Bridge, MD 21791
Report No. M234208A

mostardi platt

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EPA Registry ID: 110003507385
675 Quaker Hill Road
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Report Submittal Date:
March 4, 2024

Report No. M234208A

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1.0 INTRODUCTION

Mostardi Platt conducted an air emissions test program for Heidelberg Materials US Cement, LLC at the Union Bridge Cement Manufacturing Facility located in Union Bridge, Maryland. All testing was performed as described in the *Code of Federal Regulations*, Title 40, Part 60, Appendix A (40CFR60), Methods 1, 2, 3A, 4, 26A, and 40CFR63, Appendix A, (40CFR63) Method 320.

The Union Bridge facility operates a Portland cement kiln of the preheater/precalciner type. The pyro-processing system consists of an in-line raw mill and a 5-stage preheater kiln system. The kiln line consists of the in-line raw mill, and in-line coal mill, kiln, baghouse, baghouse stack, and associated duct work. The kiln typically produces 7000 tons per day (tpd) of clinker.

The kiln is fired with pulverized coal and fuel oil (startup fuel). The kilns can also fire a supplemental dried biosolids fuel.

The kiln line consists of the existing kiln with a gas conditioning tower, selective noncatalytic reduction (SNCR) technology, activated carbon injection, and a baghouse with associated ductwork and stack. The kiln system also has a dedicated subsystem to handle material collected at the fabric-filter baghouse. This dust is returned to the kiln system or transported to the finish mills.

This test program was completed to satisfy the requirements of the United States Environmental Protection Agency (USEPA) Section 114 Information Collection Request for Portland Cement Manufacturing facilities as described in “Attachment 3 Source Testing Request for Portland Cement: Reporting Requirements”.

The identification of individuals associated with the test program is summarized below:

Location	Address	Contact
Facility Representative	Heidelberg Materials US Cement, LLC Union Bridge Manufacturing Facility 675 Quaker Hill Road Union Bridge, MD 21791	Kurt Deery (410)-386-1229 kurt.deery@heidelbergmaterials.com
Testing Company Representative	Mostardi Platt 888 Industrial Drive Elmhurst, Illinois 60126	Eric Ehlers VP, Field Operations (630) 993-2100 eehlers@mp-mail.com

2.0 TEST REQUIREMENTS

Testing was performed at the Main Kiln stack during two separate operating conditions: “mill on” and “mill off”. The following table presents a list of the parameters tested, the applicable methodologies utilized, and average test results:

Source	Parameter Tested	Test Results	Method/Regulation Citation
Main Kiln Mill ON[1]	Hydrogen Fluoride (HF)	≤ 0.10 ppmvw	USEPA Method 320, 40CFR63, Appendix A
		≤ 0.11 ppmvd @7% O_2	
		≤ 0.12 lb/hr	
		≤ 0.0004 lb/ton clinker	
	HF[2]	≤ 0.13 ppmvd	Method 26A, 40CFR60, Appendix A
		≤ 0.13 ppmvd @7% O_2	
		≤ 0.13 lb/hr	
		≤ 0.0004 lb/ton clinker	
	Chlorine (Cl_2)[2]	≤ 0.04 ppmvd	USEPA Method 26A, 40CFR60, Appendix A
		≤ 0.04 ppmvd @7% O_2	
		≤ 0.15 lb/hr	
		≤ 0.0005 lb/ton clinker	
	Hydrogen Cyanide (HCN)	3.39 ppmvw	USEPA Method 320, 40CFR63, Appendix A
		3.87 ppmvd @7% O_2	
		5.48 lb/hr	
		0.0176 lb/ton clinker	
	Oxygen (O_2)	7.2 % (dry)	USEPA Method 3A, 40CFR60, Appendix A
	Carbon Dioxide (CO_2)	24.6 % (dry)	USEPA Method 320, 40CFR63, Appendix A
	Moisture (H_2O)	11.4 %	USEPA Method 320, 40CFR63, Appendix A
	Cyclonic Flow Determination	PASS	USEPA Method 1, 40CFR60, Appendix A, Section 11.4
	Three-point O_2 Stratification Determination	< 5 %	USEPA Method 3A, 40CFR60, Appendix A and Method 7E, Section 8.1.2

[1] During Run 3 the raw mill on went down approximately 25 minutes into the test run. The run was resumed at 17:10 once the raw mill was brought back into operation.

[2] HF and Cl_2 Method 26A results are reported as the average from Train A and Train B.

Source	Parameter Tested	Test Results	Method/Regulation Citation
Main Kiln Mill OFF	Hydrogen Fluoride (HF)	≤ 0.10 ppmvw	USEPA Method 320, 40CFR63, Appendix A
		≤ 0.10 ppmvd @7% O_2	
		≤ 0.10 lb/hr	
		≤ 0.0003 lb/ton clinker	
	HF[3]	≤ 0.15 ppmvd	Method 26A, 40CFR60, Appendix A
		≤ 0.12 ppmvd @7% O_2	
		≤ 0.13 lb/hr	
		≤ 0.0004 lb/ton clinker	
	Chlorine (Cl_2)[3][4]	≤ 0.05 ppmvd	USEPA Method 26A, 40CFR60, Appendix A
		≤ 0.05 ppmvd @7% O_2	
		≤ 0.17 lb/hr	
		≤ 0.0006 lb/ton clinker	
	Hydrogen Cyanide (HCN)	3.98 ppmvw	USEPA Method 320, 40CFR63, Appendix A
		3.91 ppmvd @7% O_2	
		5.54 lb/hr	
		0.0182 lb/ton clinker	
	Oxygen (O_2)	4.5 % (dry)	USEPA Method 3A, 40CFR60, Appendix A
	Carbon Dioxide (CO_2)	28.8 % (dry)	USEPA Method 320, 40CFR63, Appendix A
	Moisture (H_2O)	13.7 %	USEPA Method 320, 40CFR63, Appendix A
	Cyclonic Flow Determination	PASS	USEPA Method 1, 40CFR60, Appendix A, Section 11.4
	Three-point O_2 Stratification Determination	< 5 %	USEPA Method 3A, 40CFR60, Appendix A and Method 7E, Section 8.1.2

[3] HF and Cl_2 Method 26A results are reported as the average from Train A and Train B.

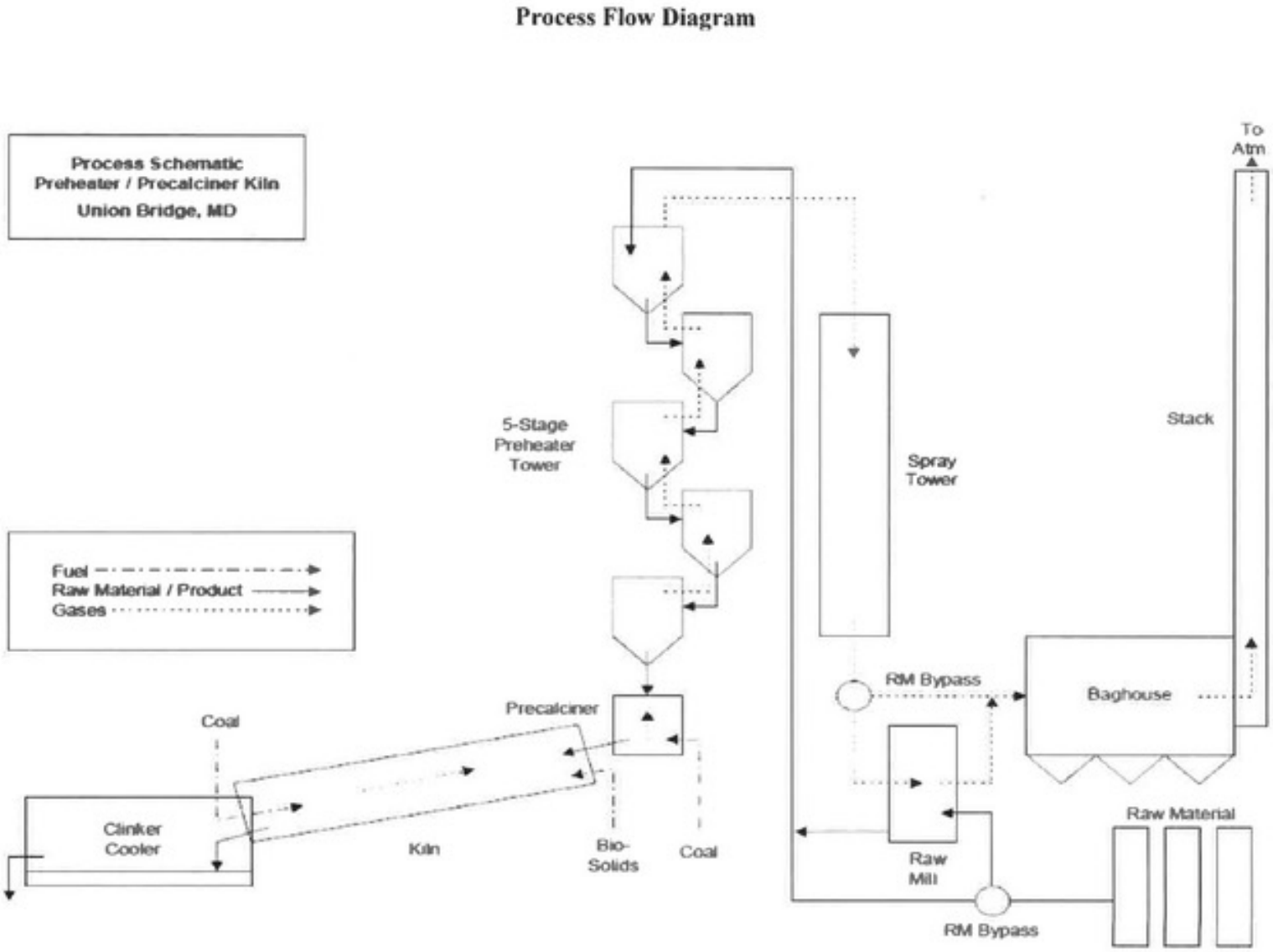
[4] Cl_2 results for train 3A were above detection limit, results are reported but contamination is suspected in this sample train.

3.0 QA SPECIFICATIONS AND PROCESS DIAGRAM

3-1 QA/QC Specifications

Parameter	Method	QA/QC Specification	Acceptance Criteria	Actual Result
HCN	320	Method Detection Limit	0.5 ppm	0.1 ppmvw
		SNR	>2500 at 64 scans	5676 (Run 1 Average)
		S Beam	>0.9	1.072 (Run 1 Average)
		Direct HCN Analysis	±5% of tag value	+1.3%
		Dynamic Spike Analysis	≤10% of total sample volume	<10% for all spikes
			Spike gas ~twice native concentration or 3-4 ppm addition to native concentration	+3.8 ppm
			≤±20% of expected value or ≤±0.5 ppm, whichever is less restrictive	≤±20% of expected value
		Residuals	≤±0.3 ppm, or ≤±5% of measured value, whichever is less restrictive	≤0.3 ppm
HF/Cl_2	26A	Method Detection Limit	300 µg	150 µg
		Paired Train Agreement	≤10% Relative Deviation or ≤0.2 ppm, whichever is less restrictive.	≤0.2 ppm

3-2 Process Flow Diagram



4.0 TEST PROCEDURES

All testing, sampling, analytical, and calibration procedures used for this test program were performed as described in the Title 40, *Code of Federal Regulations*, Part 60, Appendix A (40CFR60), Methods 1, 2, 3A, 4, 26A, and 40CFR63, Appendix A, Method 320; and the latest revisions thereof. Where applicable, the *Quality Assurance Handbook for Air Pollution Measurement Systems*, Volume III, Stationary Source Specific Methods, United States Environmental Protection Agency (USEPA) 600/R-94/038c, September 1994 was used to supplement procedures in addition to the appended "Draft General Test Plan".

4.1 Method 1 Sample and Velocity Traverse Determination

Sample points for testing are determined using USEPA Test Method 1, 40CFR60, Appendix A. The characteristics of the measurement location is summarized below.

Sample Point Selection

Test Location	Stack Diameter	Port Length	Upstream Diameters	Downstream Diameters	Test Parameter	Number of Sampling Points
Main Kiln	13.75 Feet	3.0 Inches	5.0 Diameters	21.4 Diameters	HF/Cl_2 (26A)	12
					O_2 (3A)	3 (stratification)
					$HCN/HF/CO_2$ (320/3A)	1

A cyclonic flow check was performed in accordance with Section 11.4, which demonstrated it meets the criteria of an average value of less than 20° and therefore is considered to be a suitable testing location for flow rate measurements.

4.2 Method 2 Volumetric Flow Rate Determination

The gas velocity and volumetric flowrate were determined using Method 2, 40CFR60, Appendix A, as an integrated part of the HF/Cl_2 sampling system.

Velocity pressures were determined by traversing the duct with wind tunnel calibrated S-type pitot tube. Temperatures were measured using K-type thermocouples with calibrated digital temperature indicators. The molecular weight and moisture content of the gases were also determined to permit the calculation of the volumetric flowrate.

4.3 Method 3A Oxygen (O_2) and Carbon Dioxide (CO_2) Determination

O_2 and CO_2 concentrations were determined in accordance with Method 3A, 40CFR60, Appendix A and Method 320, 40CFR63, Appendix A, respectively. A Servomex analyzer was used to determine O_2 concentrations while the MKS 2030 analyzer was used to determine CO_2 concentrations. The O_2 instrument has a paramagnetic detector and operates in a nominal range of 0-25%.

A list of calibration gases used and the results of all calibration and other required quality assurance checks are found in the appendix of this report. Copies of calibration gas certifications are also appended.

4.4 Method 26A Hydrogen Fluoride (HF) and Chlorine (Cl_2) Determination

HF and Cl_2 concentrations and emission rates were determined in accordance with Method 26A, 40CFR60, Appendix A. Paired sampling trains were used to collect the samples. A total of twelve (12) test points were sampled per run on the main kiln stack. The sample was extracted isokinetically from the gas stream and passed through dilute sulfuric acid (0.1N H_2SO_4). HF was collected in the dilute acid. Cl_2 was collected in the dilute sodium hydroxide (0.1N NaOH) solution. The sample train consisted of a Teflon coated nozzle, a heated borosilicate glass probe liner, a Teflon® filter placed on the outlet of the glass probe liner, and six impingers. The first two impingers contained the 0.1N H_2SO_4, the third remained empty (and was recovered with the first two impingers), the fourth and fifth impingers contained the 0.1N NaOH, while the sixth impinger contained silica gel to absorb any remaining moisture. A de-ionized water rinse was performed on each set of impingers, and samples were stored in Nalgene sample containers for transport. The 0.1N H_2SO_4 impinger catch samples were analyzed for HF while the 0.1N NaOH impinger catch samples were analyzed for Cl_2. The method detection limit (MDL) was determined for both HF and Cl_2 using the “Definition and Procedure for the Determination of the Method Detection Limit, Revision 2”. A value of 150ug was used for both compounds. All equipment used was calibrated in accordance with the specifications of the method. Calibration data is appended.

Method 26A captures water droplets entrained in the stack gas a vaporizes them. Collected water vapor in the impingers is weighed and a % water vapor by volume is calculated. When the stack gas contains water droplets it is super saturated and thus the Method 26A sample train captures more apparent water vapor than is actually in the stack. Therefore, when calculating dry standard cubic foot per minute of stack gas volumetric flow rate, the saturated water vapor volume is used instead of the volume collected by the impinger train.

Hand recorded field data sheets were reviewed and scans are retained on the Mostardi Platt network. Copies of this data is available upon request.

4.5 Method 320 Speciated Flue Gas Concentration Determinations

The sampling procedures for HCN and HF were performed in accordance with USEPA Method 320, 40CFR63, Appendix A. Data was continuously recorded with a data logging system throughout sampling, with brief interruption to properly label reference spectra.

The average gas effluent concentrations were determined from the average gas concentration displayed by the MKS 2030 analyzer. The Method 320 sampling system vaporizes water droplets similar to Method 26A. The difference is that Method 320 is an extractive method that calculates concentration based on compounds continuously flowing through the FTIR gas cell where the Method 26A captures water vapor in an impinger train. Calculating Method 320 concentrations on a dry basis uses the water vapor contained in the FTIR gas cell. In order to calculate lb/hr, the dry FTIR concentration is used in combination with the dry stack gas volumetric flow rate.

All sampling system components were heated to 375^{o}F +/- 25^{o}F, including: stainless steel sample probe, stainless steel calibration tee, in line glass fiber particulate filter, Teflon® sample

line, heated head sample pump, and FTIR detector cell. The sample pump distributes the gas sample to the instrument at a steady sample flow rate (+/- 10%). All components of the sampling system are constructed of stainless steel, glass, or Teflon®.

FTIR technology works on the principle that most gases absorb infrared light. This is true for all compounds except for homonuclear diatomic molecules and noble gases such as: N_2, O_2, H_2, He, Ne, and Ar. Vibrations, stretches, bends, and rotations within the bonds of a molecule determine the infrared absorption distinctiveness. The absorption creates a “fingerprint" which is unique for each given compound. The quantity of infrared light absorbed is proportional to the gas concentration. Most compounds have absorbencies at different infrared frequencies, thus allowing the simultaneous analysis of multiple compounds at one time. The FTIR software compares each sample spectrum to a user-selected list of calibration references and concentration data is generated.

FTIR data was collected using an MKS MultiGas 2030 FTIR spectrometer. Data was generated at 0.5 cm^{-1}. Each Spectra was derived from the coaddition of 62-64 scans with a new data point generated approximately every minute. HCN analyte spiking assured the ability of the FTIR to quantify HCN in the presence of effluent gas. All analyte spikes were introduced using an instrument grade stainless steel rotameter. All QA/QC procedures were within the acceptance criteria allowance of the applicable methodology and the “General Test Plan.”

5.0 TEST RESULTS SUMMARIES

Client: Heidelberg Materials
Facility: Union Bridge Cement Plant
Test Location: Main Kiln Stack (Train A)
Test Method: 26A

Source Condition	**Mill On**		**Mill On**		**Mill On**		
Date	**10/18/23**		**10/18/23**		**10/18/23**		
Start Time	**8:30**		**10:15**		**12:05**		
End Time	**9:45**		**11:29**		**18:03**		
	Run 1A		**Run 2A**		**Run 3A**		**Average**
Stack Conditions							
Average Gas Temperature, °F	256.4		264.5		248.3		256.4
Flue Gas Moisture, percent by volume	11.0%		11.6%		11.1%		11.2%
Average Flue Pressure, in. Hg	29.27		29.27		29.29		29.28
Gas Sample Volume, dscf	41.298		44.944		43.617		43.286
Average Gas Velocity, ft/sec	57.860		62.400		59.516		59.925
Gas Volumetric Flow Rate, acfm	515,500		555,944		530,252		533,899
Gas Volumetric Flow Rate, dscfm	330,813		350,320		344,058		341,730
Gas Volumetric Flow Rate, scfm	371,636		396,321		386,970		384,976
Average %CO_2 by volume, dry basis	24.7		24.4		24.7		24.6
Average %O_2 by volume, dry basis	7.2		7.2		7.1		7.2
Isokinetic Variance	100.1		102.8		101.6		101.5
Hydrogen Fluoride (HF) Emissions								
ug of sample collected	≤	150.00	≤	150.00	≤	150.00	≤	150.00
ppm	≤	0.15	≤	0.14	≤	0.15	≤	0.15
Chlorine (Cl2) Emissions								
ug of sample collected	≤	150.00	≤	150.00	≤	150.00	≤	150.00
ppm	≤	0.04	≤	0.04	≤	0.04	≤	0.04

Client: Heidelberg Materials
Facility: Union Bridge Cement Plant
Test Location: Main Kiln Stack (Train B)
Test Method: 26A

Source Condition	Mill On	Mill On	Mill On	
Date	10/18/23	10/18/23	10/18/23	
Start Time	8:30	10:15	12:05	
End Time	9:45	11:29	18:03	
	Run 1B	Run 2B	Run 3B	Average
Stack Conditions				
Average Gas Temperature, °F	254.1	264.8	249.5	256.1
Flue Gas Moisture, percent by volume	10.7%	10.8%	11.8%	11.1%
Average Flue Pressure, in. Hg	29.26	29.27	29.27	29.27
Gas Sample Volume, dscf	59.577	60.344	60.894	60.272
Average Gas Velocity, ft/sec	58.471	60.448	59.526	59.482
Gas Volumetric Flow Rate, acfm	520,937	538,552	530,334	529,941
Gas Volumetric Flow Rate, dscfm	336,563	342,401	340,402	339,789
Gas Volumetric Flow Rate, scfm	376,688	383,746	386,057	382,164
Average %CO_2 by volume, dry basis	24.7	24.4	24.7	24.6
Average %O_2 by volume, dry basis	7.2	7.2	7.1	7.2
Isokinetic Variance	102.5	102.1	103.6	102.7
Hydrogen Fluoride (HF) Emissions				
ug of sample collected	≤ 150.00	≤ 150.00	≤ 150.00	≤ 150.00
ppm	≤ 0.11	≤ 0.11	≤ 0.10	≤ 0.11
Chlorine (Cl2) Emissions				
ug of sample collected	≤ 150.00	≤ 150.00	≤ 150.00	≤ 150.00
ppm	≤ 0.03	≤ 0.03	≤ 0.03	≤ 0.03

Client: Heidelberg Materials
Facility: Union Bridge Cement Plant
Test Location: Main Kiln Stack
Test Method: 26A - Combined Results

Source Condition		**Mill On**		**Mill On**		**Mill On**		
Date		**10/18/23**		**10/18/23**		**10/18/23**		
Start Time		**8:30**		**10:15**		**12:05**		
End Time		**9:45**		**11:29**		**18:03**		
		Run 1		**Run 2**		**Run 3**		**Average**
Stack Conditions								
Average Gas Velocity, ft/sec		58.166		61.424		59.521		59.704
Gas Volumetric Flow Rate, acfm		518,219		547,248		530,293		531,920
Gas Volumetric Flow Rate, dscfm		333,688		346,361		342,230		340,760
Gas Volumetric Flow Rate, scfm		374,162		390,034		386,514		383,570
Average %CO_2 by volume, dry basis		24.7		24.4		24.7		24.6
Average %O_2 by volume, dry basis		7.2		7.2		7.1		7.2
Clinker Production, ton/hr		311.1		310.9		312.9		311.6
Hydrogen Fluoride (HF) Emissions								
ppm	≤	0.13	≤	0.12	≤	0.13	≤	0.13
ppm@7%O2	≤	0.13	≤	0.12	≤	0.13	≤	0.13
lb/hr	≤	0.48	≤	0.46	≤	0.49	≤	0.48
lb/ton of clinker	≤	0.0015	≤	0.0015	≤	0.0016	≤	0.0015
Chlorine (Cl2) Emissions								
ppm	≤	0.04	≤	0.04	≤	0.04	≤	0.04
ppm@7%O2	≤	0.04	≤	0.04	≤	0.04	≤	0.04
lb/hr	≤	0.04	≤	0.04	≤	0.04	≤	0.04
lb/ton of clinker	≤	0.0001	≤	0.0001	≤	0.0001	≤	0.0001

Heidelberg Materials
Union Bridge Cement Plant
Main Kiln Stack
Mill On
Reference Method Test Data

Test No.	Date	Start Time	End Time	O2 % (dry)	Moisture %	HCN ppmvw	HCN ppmvd @ 7% O2	HF ppmvw	HF ppmvd @ 7% O2
1	10/18/2023	8:30	9:29	7.2	10.9%	3.60	4.09	≤ 0.10	≤ 0.11
2	10/18/2023	10:15	11:14	7.2	11.4%	3.40	3.89	≤ 0.10	≤ 0.11
3	10/18/2023	12:05	17:43	7.1	11.9%	3.17	3.63	≤ 0.10	≤ 0.11
Average				**7.2**	**11.4%**	**3.39**	**3.87**	**≤ 0.10**	**≤ 0.11**

Test No.	Date	Start Time	End Time	Volumetric Flow, DSCFM	Clinker Production, ton/hr	HCN lb/hr	HCN lb/ton	HF lb/hr	HF lb/ton
1	10/18/2023	8:30	9:29	333,688	311.1	5.67	0.0182	≤ 0.12	≤ 0.0004
2	10/18/2023	10:15	11:14	346,361	310.9	5.59	0.0180	≤ 0.12	≤ 0.0004
3	10/18/2023	12:05	17:43	342,230	312.9	5.18	0.0166	≤ 0.12	≤ 0.0004
Average				**340,760**	**311.6**	**5.48**	**0.0176**	**≤ 0.12**	**≤ 0.0004**

Client:	**Heidelberg Materials**
Facility:	**Union Bridge Cement Plant**
Test Location:	**Main Kiln Stack (Train A)**
Test Method:	**26A**

Source Condition		**Mill Off**		**Mill Off**		**Mill Off**		
Date		**10/19/23**		**10/19/23**		**10/19/23**		
Start Time		**8:25**		**10:10**		**11:55**		
End Time		**9:40**		**11:26**		**13:08**		
		Run 1A		**Run 2A**		**Run 3A**		**Average**
Stack Conditions								
Average Gas Temperature, °F		320.2		320.2		318.5		319.6
Flue Gas Moisture, percent by volume		14.5%		15.2%		11.9%		13.9%
Average Flue Pressure, in. Hg		29.27		29.27		29.27		29.27
Gas Sample Volume, dscf		39.542		37.392		37.236		38.057
Average Gas Velocity, ft/sec		58.480		56.822		55.644		56.982
Gas Volumetric Flow Rate, acfm		521,019		506,251		495,753		507,674
Gas Volumetric Flow Rate, dscfm		294,781		284,325		289,755		289,620
Gas Volumetric Flow Rate, scfm		344,922		335,145		328,898		336,322
Average %CO_2 by volume, dry basis		28.6		28.9		29.0		28.8
Average %O_2 by volume, dry basis		4.4		4.5		4.5		4.5
Isokinetic Variance		107.5		105.4		103.0		105.3
Hydrogen Fluoride (HF) Emissions								
ug of sample collected	≤	150.00	≤	150.00	≤	150.00	≤	150.00
ppm	≤	0.16	≤	0.17	≤	0.17	≤	0.17
Chlorine (Cl2) Emissions								
ug of sample collected	≤	150.00	≤	150.00	≤	150.00	≤	150.00
ppm	≤	0.05	≤	0.05	≤	0.05	≤	0.05

Client: Heidelberg Materials
Facility: Union Bridge Cement Plant
Test Location: Main Kiln Stack (Train B)
Test Method: 26A

Source Condition	**Mill Off**		**Mill Off**		**Mill Off**		
Date	**10/19/23**		**10/19/23**		**10/19/23**		
Start Time	**8:25**		**10:10**		**11:55**		
End Time	**9:40**		**11:26**		**13:08**		
	Run 1B		**Run 2B**		**Run 3B**		**Average**
Stack Conditions							
Average Gas Temperature, °F	321.8		321.5		319.3		320.9
Flue Gas Moisture, percent by volume	13.6%		14.0%		14.3%		14.0%
Average Flue Pressure, in. Hg	29.26		29.23		29.23		29.24
Gas Sample Volume, dscf	50.265		49.594		49.103		49.654
Average Gas Velocity, ft/sec	56.347		55.610		55.004		55.654
Gas Volumetric Flow Rate, acfm	502,017		495,450		490,046		495,838
Gas Volumetric Flow Rate, dscfm	286,410		281,212		278,070		281,897
Gas Volumetric Flow Rate, scfm	331,550		326,987		324,320		327,619
Average %CO_2 by volume, dry basis	28.6		28.9		29.0		28.8
Average %O_2 by volume, dry basis	4.4		4.5		4.5		4.5
Isokinetic Variance	101.6		102.1		102.3		102.0
Hydrogen Fluoride (HF) Emissions								
ug of sample collected	≤	150.00	≤	150.00	≤	150.00	≤	150.00
ppm	≤	0.13	≤	0.13	≤	0.13	≤	0.13
Chlorine (Cl2) Emissions								
ug of sample collected	≤	150.00		493.00	≤	150.00	≤	264.33
ppm	≤	0.04		0.12	≤	0.04	≤	0.06

Client:	**Heidelberg Materials**
Facility:	**Union Bridge Cement Plant**
Test Location:	**Main Kiln Stack**
Test Method:	**26A - Combined Results**

Source Condition		**Mill Off**		**Mill Off**		**Mill Off**		
Date		**10/19/23**		**10/19/23**		**10/19/23**		
Start Time		**8:25**		**10:10**		**11:55**		
End Time		**9:40**		**11:26**		**13:08**		
		Run 1		**Run 2**		**Run 3**		**Average**
Stack Conditions								
Average Gas Velocity, ft/sec		57.414		56.216		55.324		56.318
Gas Volumetric Flow Rate, acfm		511,518		500,851		492,900		501,756
Gas Volumetric Flow Rate, dscfm		290,596		282,769		283,913		285,759
Gas Volumetric Flow Rate, scfm		338,236		331,066		326,609		331,970
Average %CO_2 by volume, dry basis		28.6		28.9		29.0		28.8
Average %O_2 by volume, dry basis		4.4		4.5		4.5		4.5
Clinker Production, ton/hr		304.2		303.8		304.0		304.0
Hydrogen Fluoride (HF) Emissions								
ppm	≤	0.14	≤	0.15	≤	0.15	≤	0.15
ppm@7%O2	≤	0.12	≤	0.13	≤	0.13	≤	0.12
lb/hr	≤	0.45	≤	0.47	≤	0.47	≤	0.46
lb/ton of clinker	≤	0.0015	≤	0.0015	≤	0.0015	≤	0.0015
Chlorine (Cl2) Emissions								
ppm	≤	0.04	≤	0.08	≤	0.04	≤	0.05
ppm@7%O2	≤	0.03	≤	0.07	≤	0.03	≤	0.05
lb/hr	≤	0.04	≤	0.07	≤	0.04	≤	0.05
lb/ton of clinker	≤	0.0001	≤	0.0002	≤	0.0001	≤	0.0002

Heidelberg Materials
Union Bridge Cement Plant
Main Kiln Stack
Mill Off
Reference Method Test Data

Test No.	Date	Start Time	End Time	O2 % (dry)	Moisture %	HCN ppmvw	HCN ppmvd @ 7% O2	HF ppmvw	HF ppmvd @ 7% O2
1	10/19/2023	8:25	9:24	4.4	13.5%	3.91	3.82	≤ 0.10	≤ 0.10
2	10/19/2023	10:10	11:09	4.5	13.8%	4.01	3.95	≤ 0.10	≤ 0.10
3	10/19/2023	11:55	12:54	4.5	13.7%	4.02	3.95	≤ 0.10	≤ 0.10
Average				**4.5**	**13.7%**	**3.98**	**3.91**	**≤ 0.10**	**≤ 0.10**

Test No.	Date	Start Time	End Time	Volumetric Flow, DSCFM	Clinker Production, ton/hr	HCN lb/hr	HCN lb/ton	HF lb/hr	HF lb/ton
1	10/19/2023	8:25	9:24	290,596	304.2	5.53	0.0182	≤ 0.10	≤ 0.0003
2	10/19/2023	10:10	11:09	282,769	303.8	5.54	0.0182	≤ 0.10	≤ 0.0003
3	10/19/2023	11:55	12:54	283,913	304.0	5.56	0.0183	≤ 0.10	≤ 0.0003
Average				**285,759**	**304.0**	**5.54**	**0.0182**	**≤ 0.10**	**≤ 0.0003**

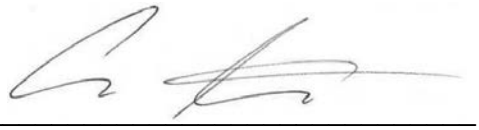
6.0 CERTIFICATION

Mostardi Platt is pleased to have been of service to Heidelberg Materials US Cement, LLC If you have any questions regarding this test report, please do not hesitate to contact us at 630-993-2100.

As project manager, I hereby certify that this test report represents a true and accurate summary of emissions test results and the methodologies employed to obtain those results, and the test program was performed in accordance with the methods specified in this test report.

MOSTARDI PLATT

Eric L. Ehlers — Project Manager



Chet A. Gutwein — Quality Assurance

APPENDICES

Appendix A – Plant Operating Data

Time	BINS
	Clinker ton/hr 1 min
10-18-2023 08:30:00	313.14
10-18-2023 08:31:00	309.28
10-18-2023 08:32:00	310.44
10-18-2023 08:33:00	312.23
10-18-2023 08:34:00	308.33
10-18-2023 08:35:00	307.49
10-18-2023 08:36:00	309.13
10-18-2023 08:37:00	308.98
10-18-2023 08:38:00	311.80
10-18-2023 08:39:00	312.90
10-18-2023 08:40:00	311.17
10-18-2023 08:41:00	311.53
10-18-2023 08:42:00	312.09
10-18-2023 08:43:00	311.33
10-18-2023 08:44:00	312.88
10-18-2023 08:45:00	312.23
10-18-2023 08:46:00	308.41
10-18-2023 08:47:00	311.95
10-18-2023 08:48:00	313.92
10-18-2023 08:49:00	311.86
10-18-2023 08:50:00	310.52
10-18-2023 08:51:00	310.60
10-18-2023 08:52:00	312.80
10-18-2023 08:53:00	311.38
10-18-2023 08:54:00	307.70
10-18-2023 08:55:00	309.26
10-18-2023 08:56:00	312.30
10-18-2023 08:57:00	309.58
10-18-2023 08:58:00	312.02
10-18-2023 08:59:00	311.42
10-18-2023 09:00:00	311.54
10-18-2023 09:01:00	312.85
10-18-2023 09:02:00	313.83
10-18-2023 09:03:00	309.89
10-18-2023 09:04:00	311.54
10-18-2023 09:05:00	312.49
10-18-2023 09:06:00	310.06
10-18-2023 09:07:00	311.14
10-18-2023 09:08:00	309.77
10-18-2023 09:09:00	311.82
10-18-2023 09:10:00	311.47
10-18-2023 09:11:00	312.05
10-18-2023 09:12:00	311.12
10-18-2023 09:13:00	312.28
10-18-2023 09:14:00	309.31
10-18-2023 09:15:00	311.12
10-18-2023 09:16:00	311.30
10-18-2023 09:17:00	310.36
10-18-2023 09:18:00	310.73
10-18-2023 09:19:00	310.22
10-18-2023 09:20:00	311.94
10-18-2023 09:21:00	309.19
10-18-2023 09:22:00	310.43
10-18-2023 09:23:00	312.72
10-18-2023 09:24:00	311.64
10-18-2023 09:25:00	311.56
10-18-2023 09:26:00	311.76
10-18-2023 09:27:00	310.03
10-18-2023 09:28:00	310.33
10-18-2023 09:29:00	313.79
Mill On Run 1 Average	**311.12**
10-18-2023 10:15:00	310.28

Time	BINS
	Clinker ton/hr 1 min
10-18-2023 10:16:00	312.62
10-18-2023 10:17:00	309.97
10-18-2023 10:18:00	310.69
10-18-2023 10:19:00	310.86
10-18-2023 10:20:00	311.67
10-18-2023 10:21:00	313.36
10-18-2023 10:22:00	310.09
10-18-2023 10:23:00	308.99
10-18-2023 10:24:00	310.60
10-18-2023 10:25:00	313.15
10-18-2023 10:26:00	311.37
10-18-2023 10:27:00	310.13
10-18-2023 10:28:00	312.19
10-18-2023 10:29:00	310.37
10-18-2023 10:30:00	311.29
10-18-2023 10:31:00	313.19
10-18-2023 10:32:00	309.17
10-18-2023 10:33:00	310.53
10-18-2023 10:34:00	308.12
10-18-2023 10:35:00	310.54
10-18-2023 10:36:00	311.32
10-18-2023 10:37:00	309.48
10-18-2023 10:38:00	309.42
10-18-2023 10:39:00	310.86
10-18-2023 10:40:00	306.83
10-18-2023 10:41:00	312.39
10-18-2023 10:42:00	309.28
10-18-2023 10:43:00	307.72
10-18-2023 10:44:00	308.91
10-18-2023 10:45:00	309.93
10-18-2023 10:46:00	308.71
10-18-2023 10:47:00	313.69
10-18-2023 10:48:00	311.53
10-18-2023 10:49:00	310.07
10-18-2023 10:50:00	313.97
10-18-2023 10:51:00	313.32
10-18-2023 10:52:00	313.00
10-18-2023 10:53:00	315.80
10-18-2023 10:54:00	312.86
10-18-2023 10:55:00	312.26
10-18-2023 10:56:00	312.72
10-18-2023 10:57:00	312.55
10-18-2023 10:58:00	314.68
10-18-2023 10:59:00	311.45
10-18-2023 11:00:00	312.57
10-18-2023 11:01:00	312.14
10-18-2023 11:02:00	309.11
10-18-2023 11:03:00	314.35
10-18-2023 11:04:00	311.96
10-18-2023 11:05:00	309.25
10-18-2023 11:06:00	312.64
10-18-2023 11:07:00	307.73
10-18-2023 11:08:00	308.81
10-18-2023 11:09:00	307.97
10-18-2023 11:10:00	308.20
10-18-2023 11:11:00	308.89
10-18-2023 11:12:00	311.13
10-18-2023 11:13:00	308.12
10-18-2023 11:14:00	307.80
Mill On Run 2 Average	**310.88**
10-18-2023 12:05:00	308.04
10-18-2023 12:06:00	311.65

Time	BINS
	Clinker ton/hr 1 min
10-18-2023 12:07:00	309.05
10-18-2023 12:08:00	313.76
10-18-2023 12:09:00	311.00
10-18-2023 12:10:00	311.12
10-18-2023 12:11:00	309.99
10-18-2023 12:12:00	313.46
10-18-2023 12:13:00	312.01
10-18-2023 12:14:00	311.21
10-18-2023 12:15:00	310.55
10-18-2023 12:16:00	309.20
10-18-2023 12:17:00	311.20
10-18-2023 12:18:00	311.12
10-18-2023 12:19:00	310.12
10-18-2023 12:20:00	311.69
10-18-2023 12:21:00	311.89
10-18-2023 12:22:00	311.87
10-18-2023 12:23:00	309.71
10-18-2023 12:24:00	312.71
10-18-2023 12:25:00	312.66
10-18-2023 12:26:00	308.24
10-18-2023 12:27:00	311.51
10-18-2023 12:28:00	309.22
10-18-2023 12:29:00	313.69
10-18-2023 12:30:00	312.69
10-18-2023 17:10:00	311.87
10-18-2023 17:11:00	310.19
10-18-2023 17:12:00	311.84
10-18-2023 17:13:00	310.08
10-18-2023 17:14:00	308.69
10-18-2023 17:15:00	311.63
10-18-2023 17:16:00	311.29
10-18-2023 17:17:00	315.42
10-18-2023 17:18:00	313.80
10-18-2023 17:19:00	314.01
10-18-2023 17:20:00	312.99
10-18-2023 17:21:00	314.52
10-18-2023 17:22:00	313.40
10-18-2023 17:23:00	316.00
10-18-2023 17:24:00	315.76
10-18-2023 17:25:00	312.74
10-18-2023 17:26:00	316.14
10-18-2023 17:27:00	315.21
10-18-2023 17:28:00	313.98
10-18-2023 17:29:00	315.07
10-18-2023 17:30:00	313.28
10-18-2023 17:31:00	315.02
10-18-2023 17:32:00	315.11
10-18-2023 17:33:00	314.51
10-18-2023 17:34:00	314.45
10-18-2023 17:35:00	315.29
10-18-2023 17:36:00	314.51
10-18-2023 17:37:00	313.19
10-18-2023 17:38:00	315.66
10-18-2023 17:39:00	314.29
10-18-2023 17:40:00	319.72
10-18-2023 17:41:00	314.95
10-18-2023 17:42:00	318.32
10-18-2023 17:43:00	319.28
Mill On Run 3 Average	**312.86**

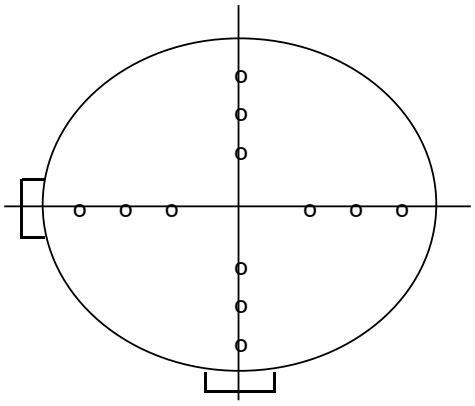
Time	BINS
	Clinker ton/hr 1 min
10-19-2023 08:25:00	305.17
10-19-2023 08:26:00	301.90
10-19-2023 08:27:00	303.75
10-19-2023 08:28:00	303.91
10-19-2023 08:29:00	304.09
10-19-2023 08:30:00	303.71
10-19-2023 08:31:00	304.44
10-19-2023 08:32:00	302.78
10-19-2023 08:33:00	303.78
10-19-2023 08:34:00	305.24
10-19-2023 08:35:00	304.26
10-19-2023 08:36:00	304.88
10-19-2023 08:37:00	304.38
10-19-2023 08:38:00	302.24
10-19-2023 08:39:00	307.04
10-19-2023 08:40:00	305.13
10-19-2023 08:41:00	304.31
10-19-2023 08:42:00	303.49
10-19-2023 08:43:00	306.30
10-19-2023 08:44:00	302.27
10-19-2023 08:45:00	305.06
10-19-2023 08:46:00	301.71
10-19-2023 08:47:00	305.53
10-19-2023 08:48:00	304.38
10-19-2023 08:49:00	304.22
10-19-2023 08:50:00	303.74
10-19-2023 08:51:00	303.53
10-19-2023 08:52:00	306.16
10-19-2023 08:53:00	305.21
10-19-2023 08:54:00	305.46
10-19-2023 08:55:00	303.80
10-19-2023 08:56:00	303.10
10-19-2023 08:57:00	304.21
10-19-2023 08:58:00	305.21
10-19-2023 08:59:00	305.84
10-19-2023 09:00:00	303.64
10-19-2023 09:01:00	304.35
10-19-2023 09:02:00	305.58
10-19-2023 09:03:00	301.85
10-19-2023 09:04:00	302.67
10-19-2023 09:05:00	302.99
10-19-2023 09:06:00	302.02
10-19-2023 09:07:00	305.67
10-19-2023 09:08:00	305.33
10-19-2023 09:09:00	304.35
10-19-2023 09:10:00	302.78
10-19-2023 09:11:00	302.50
10-19-2023 09:12:00	306.85
10-19-2023 09:13:00	304.40
10-19-2023 09:14:00	303.16
10-19-2023 09:15:00	304.36
10-19-2023 09:16:00	302.68
10-19-2023 09:17:00	306.22
10-19-2023 09:18:00	304.39
10-19-2023 09:19:00	306.31
10-19-2023 09:20:00	303.35
10-19-2023 09:21:00	302.88
10-19-2023 09:22:00	302.69
10-19-2023 09:23:00	305.92
10-19-2023 09:24:00	302.16
Mill Off Run 1 Average	**304.16**

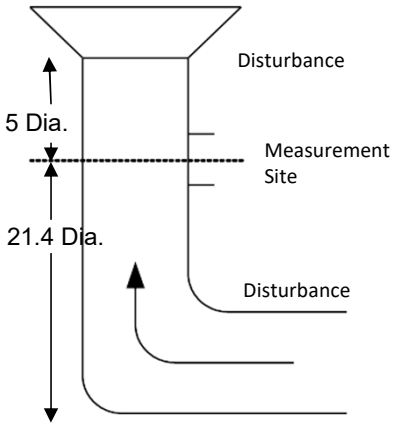
Time	BINS
	Clinker ton/hr 1 min
10-19-2023 10:10:00	304.31
10-19-2023 10:11:00	304.41
10-19-2023 10:12:00	303.46
10-19-2023 10:13:00	302.82
10-19-2023 10:14:00	303.97
10-19-2023 10:15:00	305.06
10-19-2023 10:16:00	303.28
10-19-2023 10:17:00	303.86
10-19-2023 10:18:00	302.83
10-19-2023 10:19:00	302.57
10-19-2023 10:20:00	303.38
10-19-2023 10:21:00	302.65
10-19-2023 10:22:00	305.94
10-19-2023 10:23:00	305.26
10-19-2023 10:24:00	303.73
10-19-2023 10:25:00	303.48
10-19-2023 10:26:00	303.02
10-19-2023 10:27:00	306.67
10-19-2023 10:28:00	301.69
10-19-2023 10:29:00	305.46
10-19-2023 10:30:00	303.91
10-19-2023 10:31:00	303.12
10-19-2023 10:32:00	303.76
10-19-2023 10:33:00	305.46
10-19-2023 10:34:00	301.54
10-19-2023 10:35:00	303.15
10-19-2023 10:36:00	306.46
10-19-2023 10:37:00	303.51
10-19-2023 10:38:00	304.27
10-19-2023 10:39:00	303.42
10-19-2023 10:40:00	302.32
10-19-2023 10:41:00	305.43
10-19-2023 10:42:00	302.90
10-19-2023 10:43:00	302.38
10-19-2023 10:44:00	304.85
10-19-2023 10:45:00	302.96
10-19-2023 10:46:00	304.76
10-19-2023 10:47:00	304.99
10-19-2023 10:48:00	303.18
10-19-2023 10:49:00	305.03
10-19-2023 10:50:00	305.50
10-19-2023 10:51:00	303.60
10-19-2023 10:52:00	303.68
10-19-2023 10:53:00	302.61
10-19-2023 10:54:00	305.07
10-19-2023 10:55:00	300.95
10-19-2023 10:56:00	301.34
10-19-2023 10:57:00	304.84
10-19-2023 10:58:00	306.35
10-19-2023 10:59:00	303.59
10-19-2023 11:00:00	301.94
10-19-2023 11:01:00	303.66
10-19-2023 11:02:00	304.74
10-19-2023 11:03:00	304.41
10-19-2023 11:04:00	303.24
10-19-2023 11:05:00	303.83
10-19-2023 11:06:00	304.43
10-19-2023 11:07:00	302.91
10-19-2023 11:08:00	302.40
10-19-2023 11:09:00	303.93
Mill Off Run 2 Average	**303.80**

Time	BINS
	Clinker ton/hr 1 min
10-19-2023 11:55:00	303.58
10-19-2023 11:56:00	304.71
10-19-2023 11:57:00	304.05
10-19-2023 11:58:00	302.65
10-19-2023 11:59:00	304.66
10-19-2023 12:00:00	303.44
10-19-2023 12:01:00	303.59
10-19-2023 12:02:00	303.76
10-19-2023 12:03:00	302.68
10-19-2023 12:04:00	304.40
10-19-2023 12:05:00	301.24
10-19-2023 12:06:00	301.97
10-19-2023 12:07:00	302.08
10-19-2023 12:08:00	304.98
10-19-2023 12:09:00	305.32
10-19-2023 12:10:00	303.58
10-19-2023 12:11:00	305.91
10-19-2023 12:12:00	304.19
10-19-2023 12:13:00	303.51
10-19-2023 12:14:00	305.22
10-19-2023 12:15:00	302.46
10-19-2023 12:16:00	305.34
10-19-2023 12:17:00	304.38
10-19-2023 12:18:00	305.45
10-19-2023 12:19:00	304.55
10-19-2023 12:20:00	304.60
10-19-2023 12:21:00	302.96
10-19-2023 12:22:00	301.96
10-19-2023 12:23:00	305.25
10-19-2023 12:24:00	303.85
10-19-2023 12:25:00	303.13
10-19-2023 12:26:00	304.78
10-19-2023 12:27:00	304.74
10-19-2023 12:28:00	303.20
10-19-2023 12:29:00	302.70
10-19-2023 12:30:00	303.92
10-19-2023 12:31:00	305.01
10-19-2023 12:32:00	303.92
10-19-2023 12:33:00	305.88
10-19-2023 12:34:00	304.29
10-19-2023 12:35:00	302.29
10-19-2023 12:36:00	301.45
10-19-2023 12:37:00	305.64
10-19-2023 12:38:00	304.94
10-19-2023 12:39:00	305.20
10-19-2023 12:40:00	305.84
10-19-2023 12:41:00	302.21
10-19-2023 12:42:00	304.28
10-19-2023 12:43:00	306.33
10-19-2023 12:44:00	306.17
10-19-2023 12:45:00	305.12
10-19-2023 12:46:00	301.83
10-19-2023 12:47:00	304.20
10-19-2023 12:48:00	304.48
10-19-2023 12:49:00	304.22
10-19-2023 12:50:00	303.41
10-19-2023 12:51:00	303.20
10-19-2023 12:52:00	303.35
10-19-2023 12:53:00	303.98
10-19-2023 12:54:00	305.79
Mill Off Run 3 Average	**304.03**

Appendix B – Test Section Diagrams

EQUAL AREA TRAVERSE FOR ROUND DUCTS





Client: Heidelberg Materials

Facility: Union Bridge Cement Plant

Test Location: Main Kiln Stack

Date: 10/18/23 and 10/19/23

Diameter (Feet): 13.750

Port Length (In): 3.00

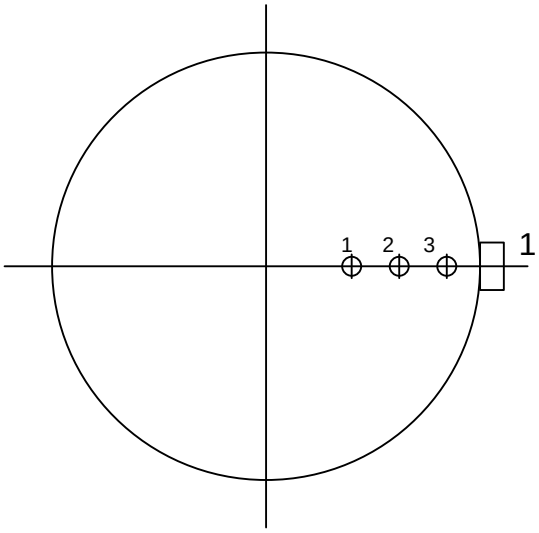
Ports Sampled: 4

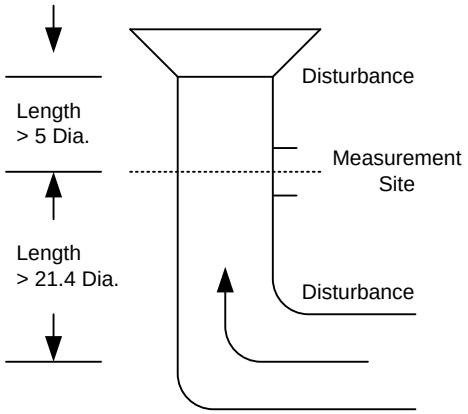
Points/Port: 3

Point Markings

	From inside wall (in.)	% of Diameter
1	7.26	4.40
2	24.09	14.60
3	48.84	29.60

GASEOUS TRAVERSE FOR ROUND DUCTS
(Stratification Test)





Job: Heidelberg Materials
Union Bridge Cement Plant

Date: 10/18/2023

Test Location: Main Kiln Stack

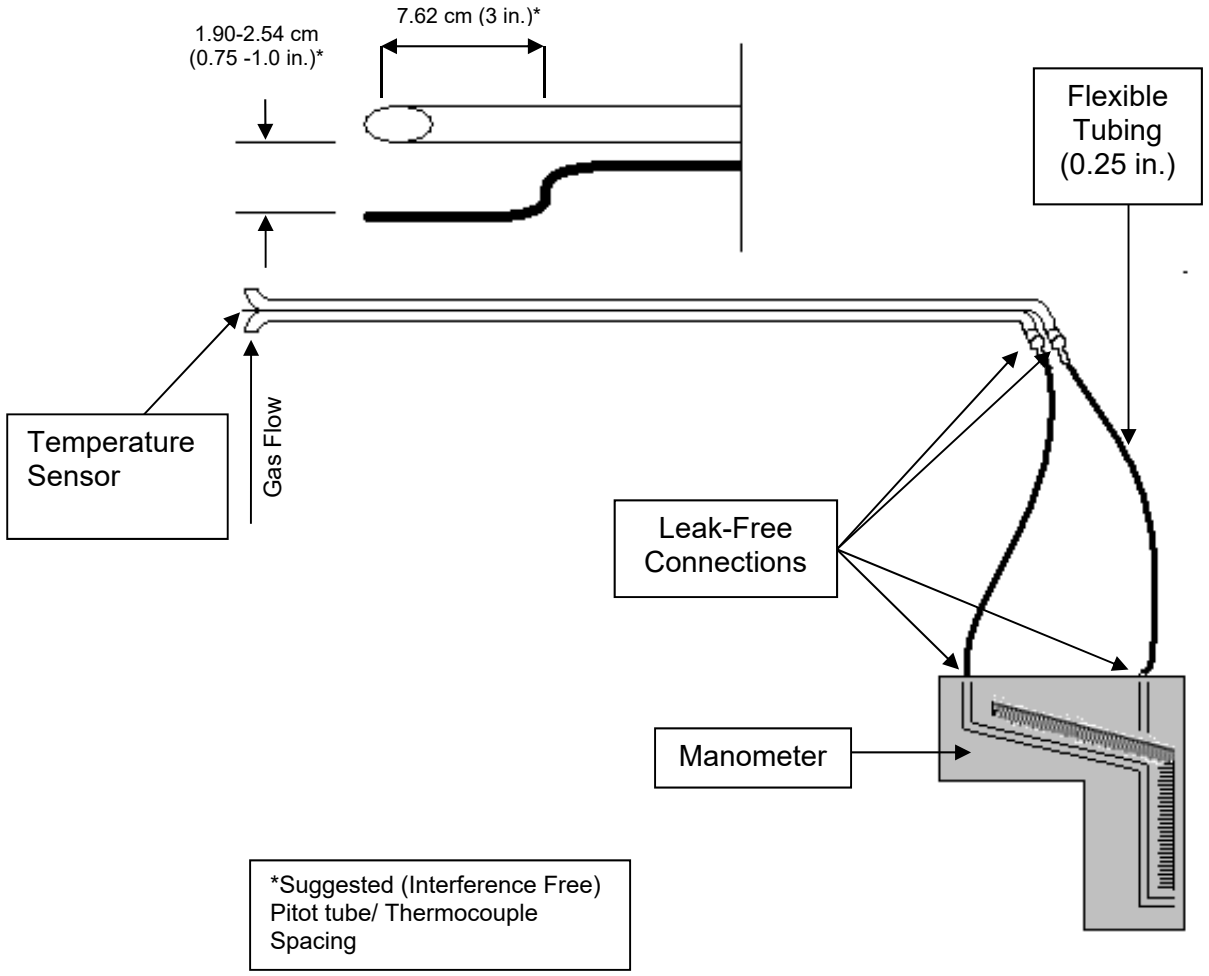
Duct Diameter: 13.75 Feet

Duct Area: 148.49 Square Feet

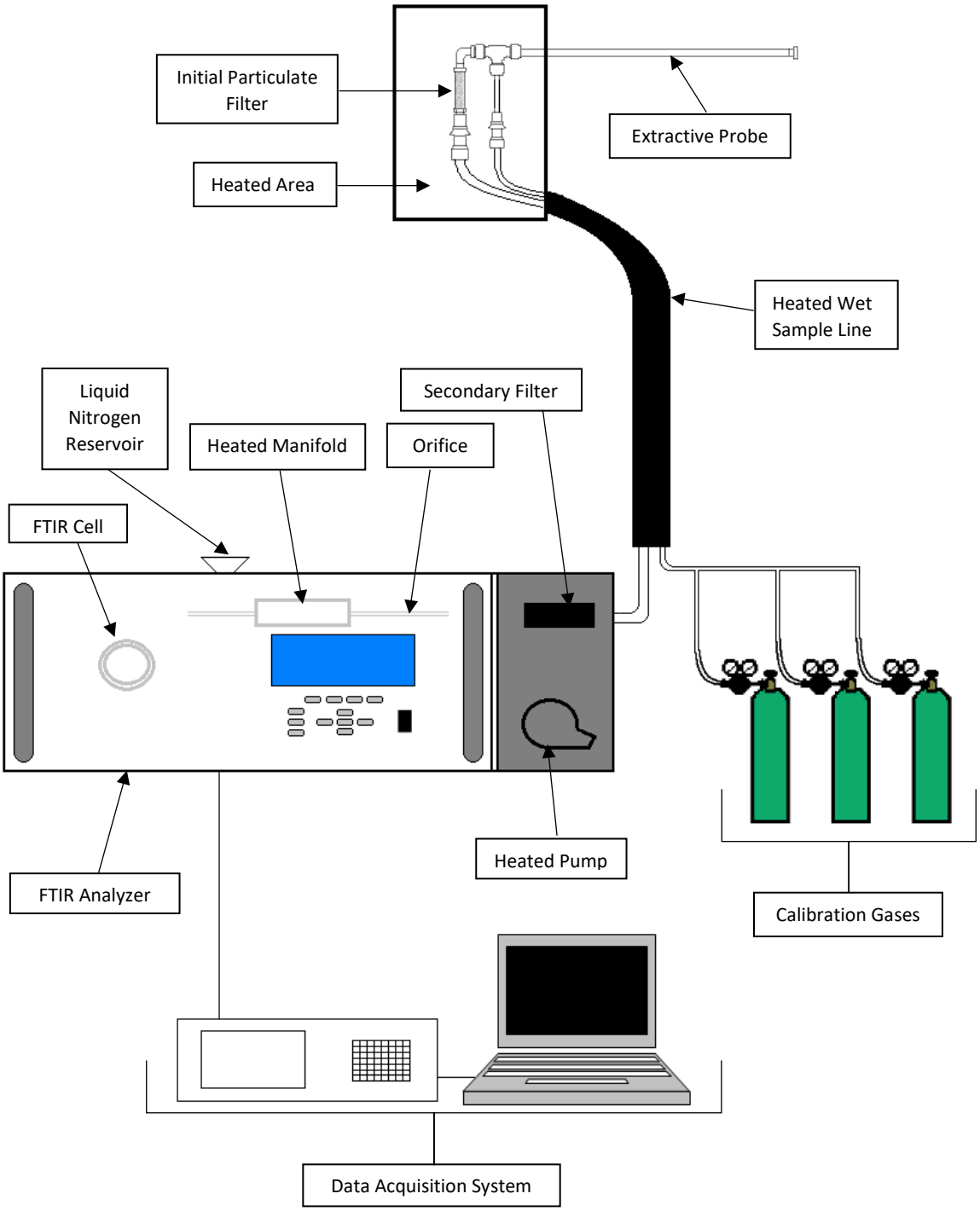
No. Sample Points: 3

Appendix C – Sample Train Diagrams

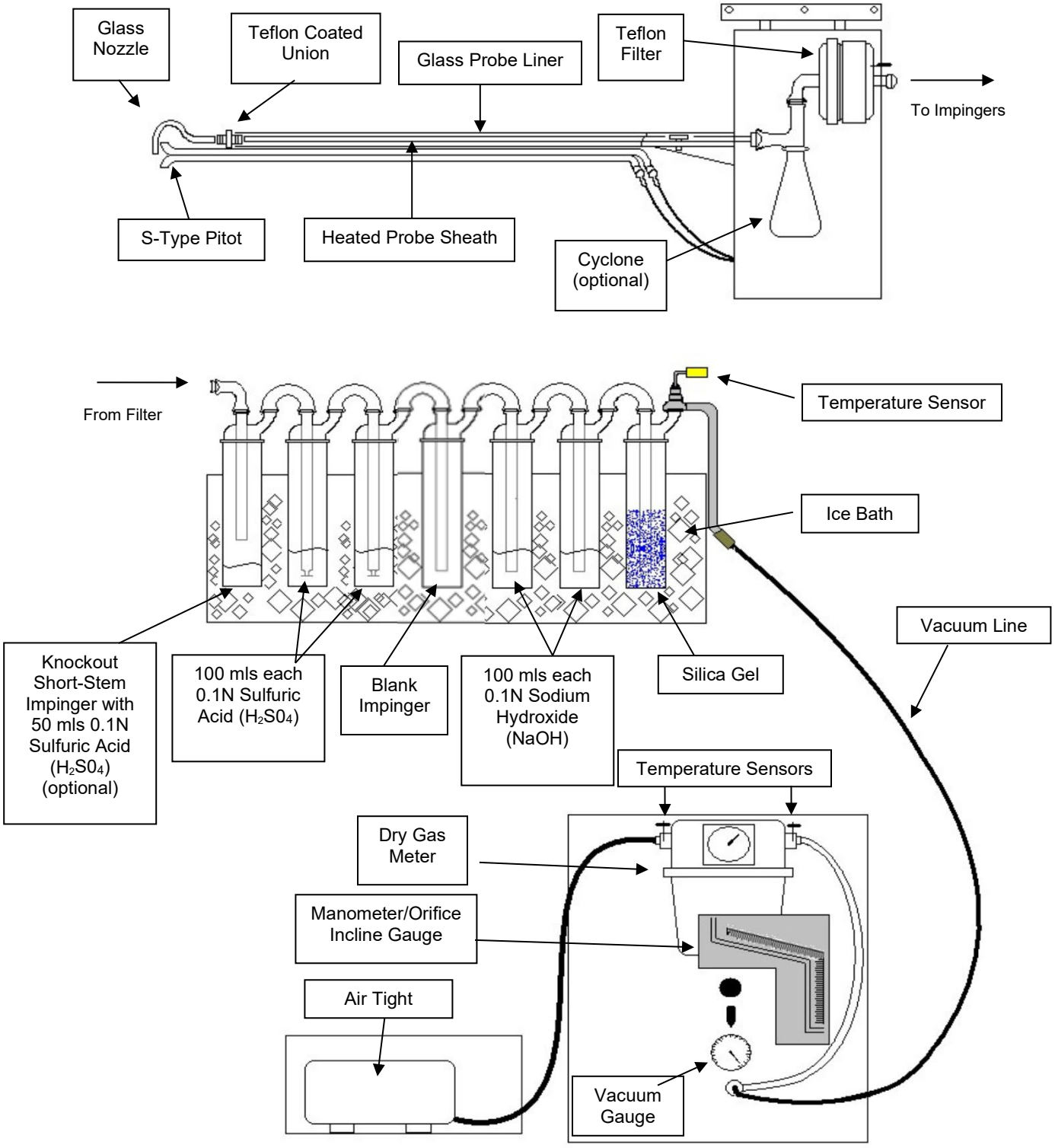
USEPA Method 2 – Type S Pitot Tube Manometer Assembly



USEPA Method 320 – Vapor Phase Organic and Inorganic Emissions by Extractive Fourier Transform Infrared (FTIR) Spectroscopy Sample Train Diagram



USEPA Method 26A – HF and Cl_2 Sample Train Diagram



Appendix D – Calculation Nomenclature and Formulas

Client:	**Heidelberg Materials**
Facility:	**Union Bridge Cement Plant**
Test Location:	**Main Kiln Scrubber Stack**
Run:	**1A**
Date:	**10/18/2023**
Method:	**26A**
Source Condition:	**Mill ON**

Dry Molecular Weight

$$Md = 0.44 \times (\%CO_2) + 0.32 \times (\%O_2) + 0.28 \times \%N_2$$

$\%CO_2$ =	24.7	$\%O_2$ =	7.2	$\%N_2$ =	68.1

Md = 32.236

Wet Molecular Weight

$$Ms = Md \times (1-Bws) + (18.0 \times Bws)$$

Md =	32.236	Bws =	0.110

Ms = 30.672

Meter Volume at Standard Conditions

$$Vm(std) = 17.647 \times Y \times Vm \times \frac{(Pbar + DH/13.6)}{Tm}$$

Y =	0.992	Vm =	43.097	Pbar =	29.3
DH =	1.4	Tm =	76.5		

Vm(std) = 41.298

Volume of Water Vapor Condensed

$$Vw(std) = 0.0471 \times (\text{net } H_2O \text{ gain})$$

Net H_2O = 108.2

Vw(std) = 5.096

Moisture Content

$$Bws = \frac{Vw(std)}{Vw(std) + Vm(std)}$$

Vw(std) =	5.096	Vm(std) =	41.298

Bws = 0.110

Client:	**Heidelberg Materials**
Facility:	**Union Bridge Cement Plant**
Test Location:	**Main Kiln Scrubber Stack**
Run:	**1**
Date:	**10/18/2023**
Method:	**26A**
Source Condition:	**Mill ON**

Average Duct Velocity

$$Vs = 85.49 \times Cp \times \text{Sqrt DP (avg)} \times (Ts\ (avg) + 460 / (Ps \times Ms))^{1/2}$$

Cp =	**0.834**	**Ts (avg) =**	**256.4**	**Sqrt DP (avg):**	**0.908**
Ps =	**29.27**	**Ms =**	**30.672**		

Vs = 57.860

Volumetric Flow Rate (Actual Basis)

Q = Vs x A x 60

Vs =	**57.860**	**A =**	**148.489**

Q = 515,500

Volumetric Flow Rate (Standard Basis)

$$Qstd = 17.647 \times Q \times \frac{Ps}{Ts\ (avg) + 460}$$

Q =	**515,500**	**Ps =**	**29.27**	**Ts (avg) =**	**256.4**

Qstd = 371,636

Volumetric Flow Rate (Standard Dry Basis)

Qstd(dry) = Qstd x (1-Bws)

Qstd =	**371,636**	**Bws =**	**0.110**

Qstd(dry) = 330,813

Isokinetic Variation:

$$\%ISO = \frac{0.0945 \times (Ts + 460) \times Vm(std)}{Vs \times \theta \times An \times Ps \times (1-Bws)}$$

Ts =	**256.4**	**Vm(std) =**	**41.298**	**Vs =**	**57.860**
An =	**0.0003089**	**θ =**	**60**	**Ps =**	**29.27**
Bws =	**0.110**				

%ISO = 100.1

Client:	**Heidelberg Materials**
Facility:	**Union Bridge Cement Plant**
Test Location:	**Main Kiln Scrubber Stack**
Run:	**1**
Date:	**10/18/2023**
Method:	**26A**
Source Condition:	**Mill ON**

Chloride (Cl2) Concentration:

$$mg/m^3 = \frac{\text{mg of Chloride (Cl2)}}{\text{Vm(std) x 0.02832 } m^3/ft^3}$$

mg= 0.15 **Vm(std) =** 41.298

mg/m^3= 0.13

Chloride (Cl2) Emission Rate:

$$\text{lb of Chloride (Cl2)} = \frac{\mu g \text{ of sample x } 10^{-6} \text{ grams}/\mu g}{453.6 \text{ grams/lb}}$$

$$\text{Emission Rate lb/hr} = \frac{\text{lb of Chloride (Cl2)}}{\text{Vm(std)}} \times \text{dscfm} \times 60 \text{ min/hr}$$

lb of Chloride (Cl2) = 3.31E-10 **dscfm =** 330,813

Emission Rate lb/hr = 0.1589

Client: Heidelberg Materials
Facility: Union Bridge Cement Plant
Project #: M234208
Test Location: Main Kiln Stack
Date: 10/18/23

Sample Calculations

$$(7.20\ \% - 0.05\ \%) \times \frac{\textbf{O2 \% (dry)}\ 10.05\ \%}{10.07\ \% - 0.05\ \%} = 7.18\ \%$$

$$C_{gas} = (C - C_o) \times \frac{C_{ma}}{C_m - C_o}$$

where:
C_{gas} = Effluent gas concentration, dry basis, ppm or %
C = Average gas concentration indicated by gas analyzer, dry basis, ppm or %
C_o = Average of initial and final system calibration bias check responses for the zero gas, ppm or %
C_m = Average of inititial and final system calibration bias check responses for the upscale calibration gas, ppm or %
C_{ma} = Actual concentration of the upscale calibration gas, ppm or %

Client: Heidelberg Materials
Facility: Union Bridge Cement Plant
Project #: M234208
Test Location: Main Kiln Stack
Date: 10/18/23

FTIR Sample Calculations

Direct Recovery % of Calibration Transfer Standard

$$DR_{cts} = \frac{D_{cts}}{Cma} \times 100$$

Cma= 100.0 D_{cts} = 99.4

DR_{cts} = 99.4%

Recovery % with Calibration Transfer Standard System Purge

$$R_{cts} = \frac{Sys_{cts}}{D_{cts}} \times 100$$

Sys_{cts} = 98.9 D_{cts} = 99.4

R_{cts} = 100%

Direct Recovery % of Analyte Spike Gas

SF6				HCN			
$DR_{sf6} = \frac{D_{sf6}}{Cma} \times 100$				$DR_{asg} = \frac{D_{asg}}{Cma} \times 100$			
Cma= 5.0	D_{sf6} = 4.9			Cma= 49.7	D_{asg} = 50.3		
DR_{sf6} = 97%				DR_{asg} = 101.3%			

Dilution Factor for Analyte Spiking

$$DF = \frac{Spk_{sf6}}{D_{sf6}}$$

Spk_{sf6} = 0.428 D_{sf6} = 4.874

DF = 0.088

Recovery % for Analyte Spike With HCN

$$R_x = \frac{Spk_x}{(N_x \times (1-DF) + D_{asg} \times DF)}$$

Spk_x = 7.3 N_x = 3.5

DF = 0.088 D_{asg} = 50.3

R_x = 95.1 %

where:

DR_{cts} = Recovery % of the calibration transfer standard directly to the analyzer
Cma = certified concentration of calibration gas, ppm
D_{cts} = Concentration of the calibration transfer standard gas directly to the analyzer, ppm
R_{cts} = Recovery % of the calibration transfer standard through the sampling system
Sys_{cts} = Concentration of the calibration transfer standard gas through the system, ppm
DF = Dilution Factor of analyte spike gas
Spk_{sf6} = SF6 concentration in effluent during spiking
Spk_x = Analyte concentration in effluent during spiking
D_{asg} = Concentration of the analyte spike gas directly to the analyzer, ppm
D_{sf6} = Concentration of the SF6 directly to the analyzer, ppm
R_x = Recovery % of the analyte spike gas
N_x = Native effluent (HCN) concentration prior to analyte spike

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Moisture Calculations

$$V_{wc(std)} = \frac{(V_f - V_i)\rho_w R T_{std}}{P_{std} M_w} = 0.04707(V_f - V_i)$$

$$V_{wsg(std)} = \frac{(W_f - W_i)\rho_w R T_{std}}{P_{std} M_w} = 0.04715(W_f - W_i)$$

$$V_{m(std)} = 17.64\, V_m Y \frac{P_{bar} + \frac{\Delta H}{13.6}}{T_m}$$

$$B_{ws} = \frac{V_{wc(std)} + V_{wsg(std)}}{V_{wc(std)} + V_{wsg(std)} + V_{m(std)}}$$

Where:

B_{ws} = Water vapor in gas stream, proportion by volume
M_w = Molecular weight of water, 18.015 lb/lb-mole
P_{bar} = Barometric pressure at the testing site, in. Hg
P_{std} = Standard absolute pressure, 29.92 in. Hg
R = Ideal gas constant, 0.048137 (in. Hg)(ft^3)/(g-mole)(°R) = [21.8348(in. Hg)(ft^3)/(lb-mole)(°R)]/453.592 g-mole/lb-mole
T_m = Absolute average dry gas meter temperature, °R
T_{std} = Standard absolute temperature, 528 °R
V_f = Final volume of condenser water, ml
V_i = Initial volume of condenser water, ml
V_m = Dry gas volume measured by dry gas meter, dcf
$V_{m(std)}$ = Dry gas volume measured by dry gas meter, corrected to standard conditions, scf
$V_{wc(std)}$ = Volume of condensed water vapor, corrected to standard conditions, scf
$V_{wsg(std)}$ = Volume of water vapor collected in silica gel, corrected to standard conditions, scf
W_f = Final weight of silica gel, g
W_i = Initial weight of silica gel, g
Y = Dry gas meter calibration factor
ΔH = Average pressure exerted on dry gas meter outlet by gas sample bag, in. H_2O
ρ_w = Density of water, 0.9982 g/ml
13.6 = Specific gravity of mercury (Hg)
17.64 = T_{std}/P_{std}
0.04707 = ft^3/ml 0.04715 = ft^3/g

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Volumetric Flow Nomenclature

A =	Cross-sectional area of stack or duct, ft2
Bws =	Water vapor in gas stream, proportion by volume
Cp =	Pitot tube coefficient, dimensionless
Md =	Dry molecular weight of gas, lb/lb-mole
Ms =	Molecular weight of gas, wet basis, lb/lb-mole
Mw =	Molecular weight of water, 18.0 lb/lb-mole
Pbar =	Barometric pressure at testing site, in. Hg
Pg =	Static pressure of gas, in. Hg (in. H2O/13.6)
DH=	Static pressure of gas, in.H2O
Ps =	Absolute pressure of gas, in. Hg = Pbar + Pg
Pstd =	Standard absolute pressure, 29.92 in. Hg
Acfm =	Actual volumetric gas flow rate
Scfm=	Volumetric gas flow rate, corrected to standard conditions
Dscfm =	Standard volumetric flow rate, corrected to dry conditions
R =	Ideal gas constant, 21.85 in. Hg-ft3/°R-lb-mole
Ts =	Average stack gas temperature, °F
Tm =	Average dry gas meter temperature, oF
Tstd =	Standard absolute temperature, 528°R
vs =	Gas velocity, ft/sec
Vm(std)=	Volume of gas sampled, corrected to standard conditions, scf
Vw(std) =	Volume of water vapor in gas sample, corrected to standard conditions, scf
Vlc=	Volume of liquid collected
Y =	Dry gas meter calibration factor
Δp =	Velocity head of gas, in. H2O
K1 =	17.647 °R/in. Hg
%EA =	Percent excess air
%CO2 =	Percent carbon dioxide by volume, dry basis
%O2 =	Percent oxygen by volume, dry basis
%N2 =	Percent nitrogen by volume, dry basis
0.264 =	Ratio of O2 to N2 in air, v/v
0.28 =	Molecular weight of N2 or CO, divided by 100
0.32 =	Molecular weight of O2 divided by 100
0.44 =	Molecular weight of CO2 divided by 100
13.6 =	Specific gravity of mercury (Hg)

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Volumetric Air Flow Calculations

$$Vm\ (std) = 17.647 \times Vm \times \left[\frac{\left(P_{bar} + \left[\frac{DH}{13.6}\right]\right)}{(460 + Tm)}\right] \times Y$$

$$Vw\ (std) = 0.0471 \times Vlc$$

$$Bws = \left[\frac{Vw\ (std)}{Vw\ (std) + Vm\ (std)}\right]$$

$$Md = (0.44 \times \%CO_2) + (0.32 \times \%O_2) + [0.28 \times (100 - \%CO_2 - \%O_2)]$$

$$Ms = Md \times (1 - Bws) + (18 \times Bws)$$

$$Vs = \sqrt{\frac{(Ts + 460)}{Ms \times Ps}} \times \sqrt{DP} \times Cp \times 85.49$$

$$Acfm = Vs \times Area\ (of\ stack\ or\ duct) \times 60$$

$$Scfm = Acfm \times 17.647 \times \left[\frac{Ps}{(460 + Ts)}\right]$$

$$Scfh = Scfm \times 60\frac{min}{hr}$$

$$Dscfm = Scfm \times (1 - Bws)$$

MOSTARDI PLATT

Isokinetic Calculation Formulas

1. $V_{w(std)} = V_{lc}\left(\frac{\rho_w}{M_w}\right)\left(\frac{RT_{std}}{P_{std}}\right) = K_2 V_{lc}$

2. $V_{m(std)} = V_m Y \left(\frac{T_{std}}{T_m}\right)\left(\frac{(P_{bar} + (\frac{\Delta H}{13.6}))}{P_{std}}\right) = K_1\, V_m\, Y \frac{(P_{bar} + (\frac{\Delta H}{13.6}))}{T_m}$

3. $B_{ws} = \frac{V_{w(std)}}{(V_{m(std)} + V_{w(std)})}$

4. $M_d = 0.44(\%CO_2) + 0.32(\%O_2) + 0.28(\%N_2)$

5. $M_s = M_d(1 - B_{ws}) + 18.0(B_{ws})$

6. $C_a = \frac{m_a}{V_a \rho_a}$

7. $W_a = C_a V_{aw} \rho_a$

8. $C_{acf} = 15.43 K_i\left(\frac{m_n P_s}{V_{w(std)} + V_{m(std)}\, T_s}\right)$

9. $C_S = (15.43\ \text{grains/gram})\,(m_n / V_{m(std)})$

10. $v_s = K_p C_p \sqrt{\frac{\Delta P\, T_s}{P_s M_s}}$

11. $Q_{acfm} = v_s A(60_{sec/min})$

12. $Q_{sd} = (3600_{sec/hr})(1 - B_{ws})\, v_s \left(\frac{T_{std} P_s}{T_s P_{std}}\right) A$

13. $E\,(\text{emission rate, lbs/hr}) = Q_{std}\left(C_s / 7000\ \text{grains/lb}\right)$

14. $IKV = \frac{T_s V_{m(std)} P_{std}}{T_{std} v_s \theta A_n P_s 60(1 - B_{ws})} = K_4 \frac{T_s V_{m(std)}}{P_s v_s A_n \theta (1 - B_{ws})}$

15. $\%EA = \left(\frac{\%O_2 - (0.5\,\%CO)}{0.264\,\%N_2 - (\%O_2 - 0.5\,\%CO)}\right) \times 100$

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Isokinetic Nomenclature

A = Cross-sectional area of stack or duct, square feet
A_n = Cross-sectional area of nozzle, square feet
B_{ws} = Water vapor in gas stream, by volume
C_a = Acetone blank residue concentration, g/g
C_{acf} = Concentration of particulate matter in gas stream at actual conditions, gr/acf
C_p = Pitot tube coefficient
C_s = Concentration of particulate matter in gas stream, dry basis, corrected to standard conditions, gr/dscf
IKV = Isokinetic sampling variance, must be 90.0 % ≤ IKV ≤ 110.0%
M_d = Dry molecular weight of gas, lb/lb-mole
M_s = Molecular weight of gas, wet basis, lb/lb-mole
M_w = Molecular weight of water, 18.0 lb/lb-mole
m_a = Mass of residue of acetone after evaporation, grams
P_{bar} = Barometric pressure at testing site, inches mercury
P_g = Static pressure of gas, inches mercury (inches water/13.6)
P_s = Absolute pressure of gas, inches mercury = $P_{bar} + P_g$
P_{std} = Standard absolute pressure, 29.92 inches mercury
Q_{acfm} = Actual volumetric gas flow rate, acfm
Q_{sd} = Dry volumetric gas flow rate corrected to standard conditions, dscfh
R = Ideal gas constant, 21.85 inches mercury cubic foot/°R-lb-mole
T_m = Dry gas meter temperature, °R
T_s = Gas temperature, °R
T_{std} = Absolute temperature, 528°R
V_a = Volume of acetone blank, ml
V_{aw} = Volume of acetone used in wash, ml
W_a = Weight of residue in acetone wash, grams
m_n = Total amount of particulate matter collected, grams
V_{1c} = Total volume of liquid collected in impingers and silica gel, ml
V_m = Volume of gas sample as measured by dry gas meter, dcf
$V_{m(std)}$ = Volume of gas sample measured by dry gas meter, corrected to standard conditions, dscf
v_s = Gas velocity, ft/sec
$V_{w(std)}$ = Volume of water vapor in gas sample, corrected to standard conditions, scf
Y = Dry gas meter calibration factor
ΔH = Average pressure differential across the orifice meter, inches water
Δp = Velocity head of gas, inches water
ρ_a = Density of acetone, 0.7855 g/ml (average)
ρ_w = Density of water, 0.002201 lb/ml
θ = Total sampling time, minutes
K_1 = 17.647 °R/in. Hg
K_2 = 0.04707 ft^3/ml
K_4 = 0.09450/100 = 0.000945
K_p = Pitot tube constant, $85.49 \frac{ft}{sec}\left[\frac{(lb/lb-mole)(in.\ Hg)}{(°R)(in.\ H_2O)}\right]^{1/2}$
%EA = Percent excess air
$\%CO_2$ = Percent carbon dioxide by volume, dry basis
$\%O_2$ = Percent oxygen by volume, dry basis
%CO = Percent carbon monoxide by volume, dry basis
$\%N_2$ = Percent nitrogen by volume, dry basis
0.264 = Ratio of O_2 to N_2 in air, v/v
28 = Molecular weight of N_2 or CO
32 = Molecular weight of O_2
44 = Molecular weight of CO_2
13.6 = Specific gravity of mercury (Hg)

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Calculations for Hydrogen Fluoride By Method 26 or 26A

Concentration

$$\frac{\text{lbs HF}}{\text{dscf}} = \frac{\mu\text{g HF in sample}}{4.536 \times 10^{8} \times \text{dscf}}$$

where:

$4.536 \times 10^{8} = \mu\text{g/lb}$

dscf = Volume of gas sampled

$$\mu g\text{/lb HF} = \mu\text{g F} \times \frac{20.008}{19.000}$$

Parts Per Million

$$\text{ppm HF} = \frac{\text{lbs HF}}{\text{dscf}} \div \frac{20.008}{385 \times 10^{6}}$$

where:

385 = Volume of 1 lb mole of gas at 68°F and 29.92 in. Hg

106 = Conversion of ppm v/v

Emission Rate

lbs HF /dscf × dscfm × 60 min/hr = lbs/hr HF

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Pollutant Concentration Correction 7% for Percent Oxygen

$$C_{adj} = C_d \frac{20.9 - 7\%}{20.9 - \%O_2}$$

where:

C_{adj} = Pollutant concentration corrected to percent O_2

20.9 - 7% = Percent O_2, the defined O_2 correction value, percent

20.9 = Percent O_2 in air

$\%O_2$ = Measured O_2 concentration dry basis, percent

C_d = Pollutant concentration measured, dry basis, ppm.

Appendix E- Laboratory Sample Analysis

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Chain-of-Custody Form

Project Number: M234208	Date Results Required:
Client: Heidelberg Cement Company	TAT Required:
Plant/Test Location: Union Bridge/Main Kiln	Project Supervisor: EE

Sample Number	Sample Date	Sample Point Identification	# of Conts	Sub Lab	Analysis Required	Volume, mls
001	10/18/23	#1A M26A H2SO4 Mill on	1		HF	
002	10/18/23	#1A M26A NaOH Mill on	1		Cl_2	
003	10/18/23	#1B M26A H2SO4 Mill on	1		HF	
004	10/18/23	#1B M26A NaOH Mill on	1		Cl_2	
005	10/18/23	#2A M26A H2SO4 Mill on	1		HF	
006	10/18/23	#2A M26A NaOH Mill on	1		Cl_2	
007	10/18/23	#2B M26A H2SO4 Mill on	1		HF	
008	10/18/23	#2B M26A NaOH Mill on	1		Cl_2	
009	10/18/23	#3A M26A H2SO4 Mill on	1		HF	
010	10/18/23	#3A M26A NaOH Mill on	1		Cl_2	
011	10/18/23	#3B M26A H2SO4 Mill on	1		HF	
012	10/18/23	#3B M26A NaOH Mill on	1		Cl_2	
013	10/18/23	A Train Blank H2SO4 Mill on	1		HF	
014	10/18/23	A Train Blank NaOH Mill on	1		Cl_2	
015	10/19/23	#1A M26A H2SO4 Mill off	1		HF	
016	10/19/23	#1A M26A NaOH Mill off	1		Cl_2	
017	10/19/23	#1B M26A H2SO4 Mill off	1		HF	
018	10/19/23	#1B M26A NaOH Mill off	1		Cl_2	
019	10/19/23	#2A M26A H2SO4 Mill off	1		HF	
020	10/19/23	#2A M26A NaOH Mill off	1		Cl_2	

Delivered to Lab by: Date/Time:	Received by: Date/Time:	Processed by: Date/Time:

Laboratory Notes:

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Chain-of-Custody Form

Project Number: M234208	Date Results Required:
Client: Heidelberg Cement Company	TAT Required:
Plant/Test Location: Union Bridge/Main Kiln	Project Supervisor: EE

Sample Number	Sample Date	Sample Point Identification	# of Conts	Sub Lab	Analysis Required	Volume, mls
021	10/19/23	#2B M26A H2SO4 Mill off	1		HF	
022	10/19/23	#2B M26A NaOH Mill off	1		Cl_2	
023	10/19/23	#3A M26A H2SO4 Mill off	1		HF	
024	10/19/23	#3A M26A NaOH Mill off	1		Cl_2	
025	10/19/23	#3B M26A H2SO4 Mill off	1		HF	
026	10/19/23	#3B M26A NaOH Mill off	1		Cl_2	
027	10/19/23	B Train Blank H2SO4 Mill off	1		HF	
028	10/19/23	B Train Blank NaOH Mill off	1		Cl_2	
029	10/19/23	DI Reagent Blank	1		HF/Cl_2	
030	10/19/23	H2SO4 Reagent Blank	1		HF	
031	10/19/23	NaOH Reagent Blank	1		Cl_2	

Delivered to Lab by: Date/Time:	Received by: Date/Time:	Processed by: Date/Time:

Laboratory Notes:

Kiln-Mill On

Client:	Heidelberg	Analysis Date:	11/6/2023
Facility:	Union Bridge	Analysis Location:	Elmhurst
Test Location:	Kiln-Mill On	Analyst:	JMG
Project Number:	M234208		
Method:	26A		
Date Samples Received:	10/27/2023		

Train A

Sampling Date		10/18/2023	10/18/2023	10/18/2023	10/18/2023		
	UNITS	**M26A DI Blank**	**M26A H2SO4 Blank**	**M26A H2SO4-R1**	**M26A H2SO4-R1 Dup**	**RDL**	**MDL**
Sulfuric Acid Volume	ml	138	181	351	351		
Hydrofluoric Acid	ug	<150	<150	<150	<150	150	15

Sampling Date		10/18/2023	10/18/2023	10/18/2023			
	UNITS	**M26A- H2SO4 R2**	**M26A- H2SO4 R3**	**Train A Train Blank**		**RDL**	**MDL**
Sulfuric Acid Volume	ml	376	357	283			
Hydrofluoric Acid	ug	<150	<150	<150		150	15

Train B

Sampling Date		10/18/2023	10/18/2023	10/18/2023	10/18/2023		
	UNITS	**M26A DI Blank**	**M26A H2SO4 Blank**	**M26A H2SO4-R1**	**M26A H2SO4-R1 Dup**	**RDL**	**MDL**
Sulfuric Acid Volume	ml	138	181	368	368		
Hydrofluoric Acid	ug	<150	<150	<150	<150	150	15

Sampling Date		10/18/2023	10/18/2023	10/18/2023			
	UNITS	**M26A- H2SO4 R2**	**M26A- H2SO4 R3**	**Train B Train Blank**		**RDL**	**MDL**
Sulfuric Acid Volume	ml	368	410	265			
Hydrofluoric Acid	ug	<150	<150	<150		150	15

Client:	Heidelberg	**Analysis Date:**	11/6/2023								
Facility:	Union Bridge	**Analysis Location:**	Elmhurst								
Test Location:	Kiln-Mill On	**Analyst:**	JMG								
Project Number:	M234208										
Method:	26A										
Date Samples Received:	10/27/2023										
Standard ppm HF	**Area**	**Response Factor**	**Calculated Value**	**Slope of Regression Curve**							
1	0.2190	0.2190	**0.95**	**0.2296**							
2	0.4460	0.2230	**1.94**								
5	1.1517	0.2303	**5.02**	**Response Factor Ave**							
8	1.8720	0.2340	**8.15**	**0.2295**							
10	2.4109	0.2411	**10.50**								
Lot Number	Ricca 8209004										
	R²	**0.9994**									
Sample Number	**Sample Date**	**Sample ID**	**Sample Area**	**PPM F**	**PPM X Dilution Factor**	**Dilution Factor**	**Total ml**	**mg F in soln**	**mg HF in soln**	**mg HF in soln avg**	**ug HF in soln**
029	10/18/2023	DI Reagent Blank	0.0069	0.0300	0.0300	1	138	0.0041	0.0044		
029	10/18/2023	DI Reagent Blank	0.0057	0.0248	0.0248	1	138	0.0034	0.0036	**0.0040**	**3.987790235**
030	10/18/2023	H2SO4 Reagent Blank	0.0296	0.1289	0.1289	1	181	0.0233	0.0246		
030	10/18/2023	H2SO4 Reagent Blank	0.0329	0.1433	0.1433	1	181	0.0259	0.0273	**0.0259**	**25.9442587**
001	10/18/2023	Test 1A H2SO4 Imp	0.0281	0.1224	0.1224	1	351	0.0430	0.0452		
001	10/18/2023	Test 1A H2SO4 Imp	0.0295	0.1285	0.1285	1	351	0.0451	0.0475	**0.0464**	**46.36734981**
001	10/18/2023	Test 1A H2SO4 Imp	0.0277	0.1206	0.1206	1	351	0.0423	0.0446		
001	10/18/2023	Test 1A H2SO4 Imp	0.0311	0.1354	0.1354	1	351	0.0475	0.0501	**0.0473**	**47.33333626**
005	10/18/2023	Test 2A H2SO4 Imp	0.0345	0.1502	0.1502	1	376	0.0565	0.0595		
005	10/18/2023	Test 2A H2SO4 Imp	0.0458	0.1995	0.1995	1	376	0.0750	0.0790	**0.0692**	**69.24462445**
009	10/18/2023	Test 3A H2SO4 Imp	0.0337	0.1468	0.1468	1	357	0.0524	0.0552		
009	10/18/2023	Test 3A H2SO4 Imp	0.0329	0.1433	0.1433	1	357	0.0511	0.0539	**0.0545**	**54.5286969**
027	10/18/2023	Train Blank	0.0316	0.1376	0.1376	1	283	0.0389	0.0400		
027	10/18/2023	Train Blank	0.0276	0.1202	0.1202	1	283	0.0340	0.0350	**0.0375**	**37.50877702**
					Expected Value	**% Difference**					
		Run 1 H2SO4 Spike W/ 2ppm	0.2280	0.9929	1.0338						
Lot Number: Thermo 21-191JKS		Run 1 H2SO4 Spike W/ 2ppm	0.2319	1.0099	1.0338	3.14%					
CCV ppm F	**Area**	**PPM F**									
1 ppm ICV	0.2453	1.0682									
5 ppm CCV	1.1274	4.9097									
5 ppm CCV	1.1394	4.9619									
5 ppm CCV	1.1201	4.8779									
Standard ppm F	**Area**	**Difference**									
1	0.2059	3.18%									
2	0.4244	2.54%									
5	1.1246	1.20%									
8	1.8558	0.44%									
10	2.3985	0.26%									

Client:	Heidelberg	**Analysis Date:**	11/6/2023								
Facility:	Union Bridge	**Analysis Location:**	Elmhurst								
Test Location:	Kiln-Mill On	**Analyst:**	JMG								
Project Number:	M234208										
Method:	26A										
Date Samples Received:	10/27/2023										
Standard ppm HF	**Area**	**Response Factor**	**Calculated Value**	**Slope of Regression Curve**							
1	0.2190	0.2190	**0.95**	**0.2296**							
2	0.4460	0.2230	**1.94**								
5	1.1517	0.2303	**5.02**	**Response Factor Ave**							
8	1.8720	0.2340	**8.15**	**0.2295**							
10	2.4109	0.2411	**10.50**								
Lot Number	Ricca 8209004										
	R^2	**0.9994**									
Sample Number	**Sample Date**	**Sample ID**	**Sample Area**	**PPM F**	**PPM X Dilution Factor**	**Dilution Factor**	**Total ml**	**mg F in soln**	**mg HF in soln**	**mg HF in soln avg**	**ug HF in soln**
029	10/18/2023	DI Reagent Blank	0.0069	0.0300	0.0300	1	138	0.0041	0.0044		
029	10/18/2023	DI Reagent Blank	0.0057	0.0248	0.0248	1	138	0.0034	0.0036	**0.0040**	**3.987790235**
030	10/18/2023	H2SO4 Reagent Blank	0.0296	0.1289	0.1289	1	181	0.0233	0.0246		
030	10/18/2023	H2SO4 Reagent Blank	0.0329	0.1433	0.1433	1	181	0.0259	0.0273	**0.0259**	**25.9442587**
003	10/18/2023	Test 1B H2SO4 Imp	0.0555	0.2417	0.2417	1	368	0.0889	0.0937		
003	10/18/2023	Test 1B H2SO4 Imp	0.0619	0.2696	0.2696	1	368	0.0992	0.1045	**0.0991**	**99.08287271**
003	10/18/2023	Test 1B H2SO4 Imp	0.0572	0.2491	0.2491	1	368	0.0917	0.0966		
003	10/18/2023	Test 1B H2SO4 Imp	0.0532	0.2317	0.2317	1	368	0.0853	0.0898	**0.0932**	**93.17503532**
007	10/18/2023	Test 2B H2SO4 Imp	0.0394	0.1716	0.1716	1	368	0.0631	0.0665		
007	10/18/2023	Test 2B H2SO4 Imp	0.0421	0.1833	0.1833	1	368	0.0675	0.0711	**0.0688**	**68.78410669**
011	10/18/2023	Test 3B H2SO4 Imp	0.0054	0.0235	0.0235	1	410	0.0096	0.0102		
011	10/18/2023	Test 3B H2SO4 Imp	0.0042	0.0183	0.0183	1	410	0.0075	0.0079	**0.0090**	**9.026881967**
027	10/18/2023	Train B Train Blank	0.0169	0.0736	0.0736	1	265	0.0195	0.0205		
027	10/18/2023	Train B Train Blank	0.0181	0.0788	0.0788	1	265	0.0209	0.0220	**0.0213**	**21.27142537**
CCV ppm F	**Area**	**PPM F**									
1 ppm ICV	0.2453	1.0682									
5 ppm CCV	1.1274	4.9097									
5 ppm CCV	1.1394	4.9619									
5 ppm CCV	0.1201	0.5230									
Standard ppm F	**Area**	**Difference**									
1	0.2059	3.18%									
2	0.4244	2.54%									
5	1.1246	1.20%									
8	1.8558	0.44%									
10	2.3985	0.26%									

Kiln-Mill On

Client:	Heidelberg	Analysis Date:	11/6/2023
Facility:	Union Bridge	Analysis Location:	Elmhurst
Test Location:	Kiln-Mill On	Analyst:	JMG
Project Number:	M234208		
Method:	26A		
Date Samples Received:	10/27/2023		

Train A

Sampling Date		10/18/2023	10/18/2023	10/18/2023	10/18/2023		
	UNITS	**M26A DI Blank**	**M26A NaOH Blank**	**M26A NaOH-R1**	**M26A NaOH-R1 Dup**	**RDL**	**MDL**
Sodium Hydroxide Volume	ml	138	172	224	224		
Chlorine	ug	<150	<150	<150	<150	150	15

Sampling Date		10/18/2023	10/18/2023	10/18/2023			
	UNITS	**M26A- NaOH R2**	**M26A- NaOH R3**	**M26A- NaOH Train Blank**		**RDL**	**MDL**
Sodium Hydroxide Volume	ml	227	165	256			
Chlorine	ug	<150	<150	<150		150	15

Train B

Sampling Date		10/18/2023	10/18/2023	10/18/2023	10/18/2023		
	UNITS	**M26A DI Blank**	**M26A NaOH Blank**	**M26A NaOH-R1**	**M26A NaOH-R1 Dup**	**RDL**	**MDL**
Sodium Hydroxide Volume	ml	138	172	240	240		
Chlorine	ug	<150	<150	<150	<150	150	15

Sampling Date		10/18/2023	10/18/2023				
	UNITS	**M26A- NaOH R2**	**M26A- NaOH R3**			**RDL**	**MDL**
Sodium Hydroxide Volume	ml	234	216				
Chlorine	ug	161	<150			150	15

Client:	Heidelberg	**Analysis Date:**	11/6/2023							
Facility:	Union Bridge	**Analysis Location:**	Elmhurst Lab							
Test Location:	Kiln-Mill On	**Analyst:**	JMG							
Project Number:	M234208									
Method:	26A									
Date Samples Received:	10/27/2023									
Standard ppm Cl	**Area**	**Response Factor**	**Calculated Value**	**Slope of Regression Curve**						
1	0.1521	0.1521	**1.00**	**0.1527**						
2	0.2976	0.1488	**1.95**							
5	0.7590	0.1518	**4.97**	**Response Factor Ave**						
8	1.2301	0.1538	**8.06**	**0.1526**						
10	1.5672	0.1567	**10.26**							
Lot Number	Ricca 8209004									
	R^2	**0.9997**								
Sample Number	**Sample Date**	**Sample ID**	**Sample Area**	**PPM Cl**	**PPM X Dilution Factor**	**Dilution Factor**	**Total ml**	**mg Cl in soln**	**ug Cl2 in soln**	**ug Cl2 in soln**
029	10/18/2023	DI Reagent Blank	0.0061	0.0400	0.0400	1	138	0.0055		
029	10/18/2023	DI Reagent Blank	0.0012	0.0079	0.0079	1	138	0.0011	**0.0033**	**3.298876686**
031	10/18/2023	NaOH Reagent Blank	0.0162	0.1061	0.1061	1	172	0.0182		
031	10/18/2023	NaOH Reagent Blank	0.0149	0.0976	0.0976	1	172	0.0168	**0.0175**	**17.51672739**
002	10/18/2023	Test 1A NaOH Imp	0.0001	0.0007	0.0007	1	224	0.0001		
002	10/18/2023	Test 1A NaOH Imp	0.0011	0.0072	0.0072	1	224	0.0016	**0.0009**	**0.880224393**
002	10/18/2023	Test 1A NaOH Imp	0.0010	0.0065	0.0065	1	224	0.0015		
002	10/18/2023	Test 1A NaOH Imp	0.0004	0.0026	0.0026	1	224	0.0006	**0.0010**	**1.026928458**
006	10/18/2023	Test 2A NaOH Imp	0.0016	0.0105	0.0105	1	227	0.0024		
006	10/18/2023	Test 2A NaOH Imp	0.0002	0.0013	0.0013	1	227	0.0003	**0.0013**	**1.338019669**
010	10/18/2023	Test 3A NaOH Imp	0.0363	0.2377	0.2377	1	165	0.0392		
010	10/18/2023	Test 3A NaOH Imp	0.0370	0.2423	0.2423	1	165	0.0400	**0.0396**	**39.60518571**
028	10/18/2023	Train Blank	0.0152	0.0995	0.0995	1	256	0.0255		
028	10/18/2023	Train Blank	0.0140	0.0917	0.0917	1	256	0.0235	**0.0245**	**24.47862121**
					Expected Value	**% Difference**				
		Run 1 H2SO4 Spike W/ 2ppm	0.1407	0.9215	0.9765					
		Run 1 H2SO4 Spike W/ 2ppm	0.1400	0.9169	0.9765	5.87%				
CCV ppm Cl	**Area**	**PPM Cl**								
5 ppm ICV	0.7457	4.8838								
5 ppm CCV	0.7531	4.9323								
5 ppm CCV	0.7878	5.1595								
Standard ppm Cl	**Area**	**Difference**								
1	0.1597	2.38%								
2	0.2978	0.03%								
5	0.7638	0.31%								
8	1.2043	1.07%								
10	1.5462	0.68%								

Client:	Heidelberg	**Analysis Date:**	11/6/2023							
Facility:	Union Bridge	**Analysis Location:**	Elmhurst Lab							
Test Location:	Kiln-Mill On	**Analyst:**	JMG							
Project Number:	M234208									
Method:	26A									
Date Samples Received:	10/27/2023									
Standard ppm Cl	**Area**	**Response Factor**	**Calculated Value**	**Slope of Regression Curve**						
1	0.1521	0.1521	**1.00**	**0.1527**						
2	0.2976	0.1488	**1.95**							
5	0.7590	0.1518	**4.97**	**Response Factor Ave**						
8	1.2301	0.1538	**8.06**	**0.1526**						
10	1.5672	0.1567	**10.26**							
Lot Number	Ricca 8209004									
	R^2	**0.9997**								
Sample Number	**Sample Date**	**Sample ID**	**Sample Area**	**PPM Cl**	**PPM X Dilution Factor**	**Dilution Factor**	**Total ml**	**mg Cl in soln**	**mg Cl2 in soln avg**	**ug Cl2 in soln**
029	10/18/2023	DI Reagent Blank	0.0061	0.0400	0.0400	1	138	0.0055		
029	10/18/2023	DI Reagent Blank	0.0012	0.0079	0.0079	1	138	0.0011	**0.0033**	**3.298876686**
031	10/18/2023	NaOH Reagent Blank	0.0162	0.1061	0.1061	1	172	0.0182		
031	10/18/2023	NaOH Reagent Blank	0.0149	0.0976	0.0976	1	172	0.0168	**0.0175**	**17.51672739**
004	10/18/2023	Test 1B NaOH Imp	0.0254	0.1664	0.1664	1	240	0.0399		
004	10/18/2023	Test 1B NaOH Imp	0.0275	0.1801	0.1801	1	240	0.0432	**0.0416**	**41.57488427**
004	10/18/2023	Test 1B NaOH Imp	0.0240	0.1572	0.1572	1	240	0.0377		
004	10/18/2023	Test 1B NaOH Imp	0.0250	0.1637	0.1637	1	240	0.0393	**0.0385**	**38.50981718**
008	10/18/2023	Test 2B NaOH Imp	0.0986	0.6458	0.6458	1	234	0.1511		
008	10/18/2023	Test 2B NaOH Imp	0.1114	0.7296	0.7296	1	234	0.1707	**0.1609**	**160.9160218**
012	10/18/2023	Test 3B NaOH Imp	0.0245	0.1605	0.1605	1	216	0.0347		
012	10/18/2023	Test 3B NaOH Imp	0.0337	0.2207	0.2207	1	216	0.0477	**0.0412**	**41.16620866**
CCV ppm Cl	**Area**	**PPM Cl**								
5 ppm ICV	0.7457	4.8838								
5 ppm CCV	0.7531	4.9323								
5 ppm CCV	0.7878	5.1595								
Standard ppm Cl	**Area**	**Difference**								
1	0.1597	2.38%								
2	0.2978	0.03%								
5	0.7638	0.31%								
8	1.2043	1.07%								
10	1.5462	0.68%								

Kiln-Mill Off

Client:	Heidelberg	Analysis Date:	11/6/23-11/7/23
Facility:	Union Bridge	Analysis Location:	Elmhurst
Test Location:	Kiln-Mill Off	Analyst:	JMG
Project Number:	M234208		
Method:	26A		
Date Samples Received:	10/27/2023		

Train A

Sampling Date		10/18/2023	10/18/2023	10/19/2023	10/19/2023		
	UNITS	**M26A DI Blank**	**M26A H2SO4 Blank**	**M26A H2SO4-R1**	**M26A H2SO4-R1 Dup**	**RDL**	**MDL**
Sulfuric Acid Volume	ml	138	181	355	355		
Hydrofluoric Acid	ug	<150	<150	<150	<150	150	15

Sampling Date		10/19/2023	10/19/2023	10/18/2023			
	UNITS	**M26A- H2SO4 R2**	**M26A- H2SO4 R3**	**Train A Train Blank**		**RDL**	**MDL**
Sulfuric Acid Volume	ml	337	332	283			
Hydrofluoric Acid	ug	<150	<150	<150		150	15

Train B

Sampling Date		10/18/2023	10/18/2023	10/18/2023	10/19/2023		
	UNITS	**M26A DI Blank**	**M26A H2SO4 Blank**	**M26A H2SO4-R1**	**M26A H2SO4-R1 Dup**	**RDL**	**MDL**
Sulfuric Acid Volume	ml	138	181	402	402		
Hydrofluoric Acid	ug	<150	<150	<150	<150	150	15

Sampling Date		10/19/2023	10/19/2023	10/18/2023			
	UNITS	**M26A- H2SO4 R2**	**M26A- H2SO4 R3**	**Train B Train Blank**		**RDL**	**MDL**
Sulfuric Acid Volume	ml	411	380	265			
Hydrofluoric Acid	ug	<150	<150	<150		150	15

Client:	Heidelberg	**Analysis Date:**	11/6/23-11/7/23								
Facility:	Union Bridge	**Analysis Location:**	Elmhurst								
Test Location:	Kiln-Mill Off	**Analyst:**	JMG								
Project Number:	M234208										
Method:	26A										
Date Samples Received:	10/27/2023										
Standard ppm HF	**Area**	**Response Factor**	**Calculated Value**	**Slope of Regression Curve**							
1	0.2190	0.2190	**0.95**	**0.2296**							
2	0.4460	0.2230	**1.94**								
5	1.1517	0.2303	**5.02**	**Response Factor Ave**							
8	1.8720	0.2340	**8.15**	**0.2295**							
10	2.4109	0.2411	**10.50**								
Lot Number	Ricca 8209004										
	R^2	**0.9994**									
Sample Number	**Sample Date**	**Sample ID**	**Sample Area**	**PPM F**	**PPM X Dilution Factor**	**Dilution Factor**	**Total ml**	**mg F in soln**	**mg HF in soln**	**mg HF in soln avg**	**ug HF in soln**
029	10/18/2023	DI Reagent Blank	0.0069	0.0300	0.0300	1	138	0.0041	0.0044		
029	10/18/2023	DI Reagent Blank	0.0057	0.0248	0.0248	1	138	0.0034	0.0036	**0.0040**	**3.987790235**
030	10/18/2023	H2SO4 Reagent Blank	0.0296	0.1289	0.1289	1	181	0.0233	0.0246		
030	10/18/2023	H2SO4 Reagent Blank	0.0329	0.1433	0.1433	1	181	0.0259	0.0273	**0.0259**	**25.9442587**
015	10/19/2023	Test 1A H2SO4 Imp	0.0539	0.2347	0.2347	1	355	0.0833	0.0878		
015	10/19/2023	Test 1A H2SO4 Imp	0.0466	0.2029	0.2029	1	355	0.0720	0.0759	**0.0818**	**81.82331844**
015	10/19/2023	Test 1A H2SO4 Imp	0.0441	0.1920	0.1920	1	355	0.0682	0.0718		
015	10/19/2023	Test 1A H2SO4 Imp	0.0496	0.2160	0.2160	1	355	0.0767	0.0808	**0.0763**	**76.2870143**
019	10/19/2023	Test 2A H2SO4 Imp	0.0262	0.1141	0.1141	1	337	0.0385	0.0405		
019	10/19/2023	Test 2A H2SO4 Imp	0.0247	0.1076	0.1076	1	337	0.0362	0.0382	**0.0393**	**39.33963781**
023	10/19/2023	Test 3A H2SO4 Imp	0.0475	0.2069	0.2069	1	332	0.0687	0.0723		
023	10/19/2023	Test 3A H2SO4 Imp	0.0487	0.2121	0.2121	1	332	0.0704	0.0742	**0.0732**	**73.24800991**
026	10/18/2023	Train Blank	0.0140	0.0610	0.0610	1	283	0.0173	0.0177		
026	10/18/2023	Train Blank	0.0123	0.0536	0.0536	1	283	0.0152	0.0156	**0.0167**	**16.66352763**
					Expected Value	**% Difference**					
		Run 1 H2SO4 Spike W/ 2ppm	0.2594	1.1296	1.0805						
Lot Number: Thermo 21-191JKS		Run 1 H2SO4 Spike W/ 2ppm	0.2644	1.1514	1.0805	5.55%					
CCV ppm F	**Area**	**PPM F**									
1 ppm ICV	0.2453	1.0682									
5 ppm CCV	1.1274	4.9097									
5 ppm CCV	1.1394	4.9619									
5 ppm CCV	1.1233	4.8918									
Standard ppm F	**Area**	**Difference**									
1	0.2059	3.18%									
2	0.4244	2.54%									
5	1.1246	1.20%									
8	1.8558	0.44%									
10	2.3985	0.26%									

Client:	Heidelberg	**Analysis Date:**	11/6/23-11/7/23								
Facility:	Union Bridge	**Analysis Location:**	Elmhurst								
Test Location:	Kiln-Mill Off	**Analyst:**	JMG								
Project Number:	M234208										
Method:	26A										
Date Samples Received:	10/27/2023										

Standard ppm HF	**Area**	**Response Factor**	**Calculated Value**	**Slope of Regression Curve**
1	0.2190	0.2190	**0.95**	**0.2296**
2	0.4460	0.2230	**1.94**	
5	1.1517	0.2303	**5.02**	**Response Factor Ave**
8	1.8720	0.2340	**8.15**	**0.2295**
10	2.4109	0.2411	**10.50**	
Lot Number	Ricca 8209004			
	R^2	**0.9994**		

Sample Number	**Sample Date**	**Sample ID**	**Sample Area**	**PPM F**	**PPM X Dilution Factor**	**Dilution Factor**	**Total ml**	**mg F in soln**	**mg HF in soln**	**mg HF in soln avg**	**ug HF in soln**
029	10/18/2023	DI Reagent Blank	0.0069	0.0300	0.0300	1	138	0.0041	0.0044		
029	10/18/2023	DI Reagent Blank	0.0057	0.0248	0.0248	1	138	0.0034	0.0036	**0.0040**	**3.987790235**
030	10/18/2023	H2SO4 Reagent Blank	0.0296	0.1289	0.1289	1	181	0.0233	0.0246		
030	10/18/2023	H2SO4 Reagent Blank	0.0329	0.1433	0.1433	1	181	0.0259	0.0273	**0.0259**	**25.9442587**
017	10/19/2023	Test 1B H2SO4 Imp	0.0264	0.1150	0.1150	1	402	0.0462	0.0487		
017	10/19/2023	Test 1B H2SO4 Imp	0.0188	0.0819	0.0819	1	402	0.0329	0.0347	**0.0417**	**41.67227035**
017	10/19/2023	Test 1B H2SO4 Imp	0.0222	0.0967	0.0967	1	402	0.0389	0.0409		
017	10/19/2023	Test 1B H2SO4 Imp	0.0165	0.0719	0.0719	1	402	0.0289	0.0304	**0.0357**	**35.6795766**
021	10/19/2023	Test 2B H2SO4 Imp	0.0295	0.1285	0.1285	1	411	0.0528	0.0556		
021	10/19/2023	Test 2B H2SO4 Imp	0.0289	0.1259	0.1259	1	411	0.0517	0.0545	**0.0550**	**55.04746741**
025	10/19/2023	Test 3B H2SO4 Imp	0.0362	0.1576	0.1576	1	380	0.0599	0.0631		
025	10/19/2023	Test 3B H2SO4 Imp	0.0358	0.1559	0.1559	1	380	0.0592	0.0624	**0.0627**	**62.74783806**
026	10/18/2023	Train B Train Blank	0.0161	0.0701	0.0701	1	265	0.0186	0.0196		
026	10/18/2023	Train B Train Blank	0.0138	0.0601	0.0601	1	265	0.0159	0.0168	**0.0182**	**18.17187481**

CCV ppm F	**Area**	**PPM F**
1 ppm ICV	0.2453	1.0682
5 ppm CCV	1.1274	4.9097
5 ppm CCV	1.1394	4.9619
5 ppm CCV	1.1233	4.8918

Standard ppm F	**Area**	**Difference**
1	0.2059	3.18%
2	0.4244	2.54%
5	1.1246	1.20%
8	1.8558	0.44%
10	2.3985	0.26%

Kiln-Mill Off

Client:	Heidelberg	Analysis Date:	11/6/23-11/7/23
Facility:	Union Bridge	Analysis Location:	Elmhurst
Test Location:	Kiln-Mill Off	Analyst:	JMG
Project Number:	M234208		
Method:	26A		
Date Samples Received:	10/27/2023		

Train A

Sampling Date		10/18/2023	10/18/2023	10/19/2023	10/19/2023		
	UNITS	**M26A DI Blank**	**M26A NaOH Blank**	**M26A NaOH-R1**	**M26A NaOH-R1 Dup**	**RDL**	**MDL**
Sodium Hydroxide Volume	ml	138	172	216	216		
Chlorine	ug	<150	<150	<150	<150	150	15

Sampling Date		10/19/2023	10/19/2023				
	UNITS	**M26A- NaOH R2**	**M26A- NaOH R3**			**RDL**	**MDL**
Sodium Hydroxide Volume	ml	204	242				
Chlorine	ug	<150	<150			150	15

Train B

Sampling Date		10/19/2023	10/18/2023	10/19/2023	10/19/2023		
	UNITS	**M26A DI Blank**	**M26A NaOH Blank**	**M26A NaOH-R1**	**M26A NaOH-R1 Dup**	**RDL**	**MDL**
Sodium Hydroxide Volume	ml	138	172	204	204		
Chlorine	ug	<150	<150	<150	<150	150	15

Sampling Date		10/19/2023	10/19/2023				
	UNITS	**M26A- NaOH R2**	**M26A- NaOH R3**			**RDL**	**MDL**
Sodium Hydroxide Volume	ml	231	228				
Chlorine	ug	493	<150			150	15

Client:	Heidelberg	**Analysis Date:**	11/7/2023							
Facility:	Union Bridge	**Analysis Location:**	Elmhurst Lab							
Test Location:	Kiln-Mill Off	**Analyst:**	JMG							
Project Number:	M234208									
Method:	26A									
Date Samples Received:	10/27/2023									
Standard ppm Cl	**Area**	**Response Factor**	**Calculated Value**	**Slope of Regression Curve**						
1	0.1521	0.1521	**1.00**	**0.1527**						
2	0.2976	0.1488	**1.95**							
5	0.7590	0.1518	**4.97**	**Response Factor Ave**						
8	1.2301	0.1538	**8.06**	**0.1526**						
10	1.5672	0.1567	**10.26**							
Lot Number	Ricca 8209004									
	R^2	**0.9997**								
Sample Number	**Sample Date**	**Sample ID**	**Sample Area**	**PPM Cl**	**PPM X Dilution Factor**	**Dilution Factor**	**Total ml**	**mg Cl in soln**	**ug Cl2 in soln**	**ug Cl2 in soln**
029	10/18/2023	DI Reagent Blank	0.0061	0.0400	0.0400	1	138	0.0055		
029	10/18/2023	DI Reagent Blank	0.0012	0.0079	0.0079	1	138	0.0011	**0.0033**	**3.298876686**
031	10/18/2023	NaOH Reagent Blank	0.0162	0.1061	0.1061	1	172	0.0182		
031	10/18/2023	NaOH Reagent Blank	0.0149	0.0976	0.0976	1	172	0.0168	**0.0175**	**17.51672739**
016	10/19/2023	Test 1A NaOH Imp	0.0248	0.1624	0.1624	1	216	0.0351		
016	10/19/2023	Test 1A NaOH Imp	0.0204	0.1336	0.1336	1	216	0.0289	**0.0320**	**31.97100741**
016	10/19/2023	Test 1A NaOH Imp	0.0190	0.1244	0.1244	1	216	0.0269		
016	10/19/2023	Test 1A NaOH Imp	0.0329	0.2155	0.2155	1	216	0.0465	**0.0367**	**36.71007267**
020	10/19/2023	Test 2A NaOH Imp	0.1419	0.9293	0.9293	1	204	0.1896		
020	10/19/2023	Test 2A NaOH Imp	0.0782	0.5122	0.5122	1	204	0.1045	**0.1470**	**147.0328398**
024	10/19/2023	Test 3A NaOH Imp	0.0415	0.2718	0.2718	1	242	0.0658		
024	10/19/2023	Test 3A NaOH Imp	0.0355	0.2325	0.2325	1	242	0.0563	**0.0610**	**61.01972223**
027	10/18/2023	Train Blank	0.0093	0.0609	0.0609	1	256	0.0156		
027	10/18/2023	Train Blank	0.0089	0.0583	0.0583	1	256	0.0149	**0.0153**	**15.25722281**
					Expected Value	**% Difference**				
		Run 1 H2SO4 Spike W/ 2ppm	0.1591	1.0420	1.0485					
		Run 1 H2SO4 Spike W/ 2ppm	0.1617	1.0590	1.0485	0.19%				
CCV ppm Cl	**Area**	**PPM Cl**								
5 ppm ICV	0.7457	4.8838								
5 ppm CCV	0.7531	4.9323								
5 ppm CCV	0.7878	5.1595								
Standard ppm Cl	**Area**	**Difference**								
1	0.1597	2.38%								
2	0.2978	0.03%								
5	0.7638	0.31%								
8	1.2043	1.07%								
10	1.5462	0.68%								

Client:	Heidelberg	**Analysis Date:**	11/7/2023							
Facility:	Union Bridge	**Analysis Location:**	Elmhurst Lab							
Test Location:	Kiln-Mill Off	**Analyst:**	JMG							
Project Number:	M234208									
Method:	26A									
Date Samples Received:	10/27/2023									
Standard ppm Cl	**Area**	**Response Factor**	**Calculated Value**	**Slope of Regression Curve**						
1	0.1521	0.1521	**1.00**	**0.1527**						
2	0.2976	0.1488	**1.95**							
5	0.7590	0.1518	**4.97**	**Response Factor Ave**						
8	1.2301	0.1538	**8.06**	**0.1526**						
10	1.5672	0.1567	**10.26**							
Lot Number	Ricca 8209004									
	R^2	**0.9997**								
Sample Number	**Sample Date**	**Sample ID**	**Sample Area**	**PPM Cl**	**PPM X Dilution Factor**	**Dilution Factor**	**Total ml**	**mg Cl in soln**	**mg Cl2 in soln avg**	**ug Cl2 in soln**
029	10/18/2023	DI Reagent Blank	0.0061	0.0400	0.0400	1	138	0.0055		
029	10/18/2023	DI Reagent Blank	0.0012	0.0079	0.0079	1	138	0.0011	**0.0033**	**3.298876686**
031	10/18/2023	NaOH Reagent Blank	0.0162	0.1061	0.1061	1	172	0.0182		
031	10/18/2023	NaOH Reagent Blank	0.0149	0.0976	0.0976	1	172	0.0168	**0.0175**	**17.51672739**
018	10/19/2023	Test 1B NaOH Imp	0.0392	0.2567	0.2567	1	204	0.0524		
018	10/19/2023	Test 1B NaOH Imp	0.0242	0.1585	0.1585	1	204	0.0323	**0.0424**	**42.35293976**
018	10/19/2023	Test 1B NaOH Imp	0.0177	0.1159	0.1159	1	204	0.0236		
018	10/19/2023	Test 1B NaOH Imp	0.0151	0.0989	0.0989	1	204	0.0202	**0.0219**	**21.91130006**
022	10/19/2023	Test 2B NaOH Imp	0.3280	2.1482	2.1482	1	231	0.4962		
022	10/19/2023	Test 2B NaOH Imp	0.3237	2.1200	2.1200	1	231	0.4897	**0.4930**	**492.9737972**
026	10/19/2023	Test 3B NaOH Imp	0.0968	0.6340	0.6340	1	228	0.1445		
026	10/19/2023	Test 3B NaOH Imp		0.0000	0.0000	1	228	0.0000	**0.0723**	**72.27270997**
CCV ppm Cl	**Area**	**PPM Cl**								
5 ppm ICV	0.7457	4.8838								
5 ppm CCV	0.7531	4.9323								
5 ppm CCV	0.7878	5.1595								
5 ppm CCV	0.7598	4.9761								
Standard ppm Cl	**Area**	**Difference**								
1	0.1597	2.38%								
2	0.2978	0.03%								
5	0.7638	0.31%								
8	1.2043	1.07%								
10	1.5462	0.68%								

Appendix F - Reference Method Test Data

Client:	Heidelberg Materials		
Facility:	Union Bridge Cement Plant		
Test Location:	Main Kiln Scrubber Stack		
Project #:	M234208		
Test Method:	26A		
Test Engineer:	PPP		
Test Technician:	WJD		
	Run 1A	**Run 2A**	**Run 3A**
Temp ID:	CM27	CM27	CM27
Meter ID:	CM27	CM27	CM27
Pitot ID:	S8-058-A	S8-058-A	S8-058-A
Nozzle Diameter (Inches):	0.238	0.238	0.238
Meter Calibration Date:	10/6/2023	10/6/2023	10/6/2023
Meter Calibration Factor (Y):	0.992	0.992	0.992
Meter Orifice Setting (Delta H):	1.589	1.589	1.589
Nozzle Kit ID Number and Material:	Glass #1	Glass #1	Glass #1
Pitot Tube Coefficient:	0.834		
Probe Length (Feet):	6.0		
Probe Liner Material:	Glass		
Sample Plane:	Horizontal		
Port Length (Inches):	3.00		
Port Size (Diameter, Inches):	6.50		
Port Type:	Nipple		
Duct Shape:	Circular		
Diameter (Feet):	13.75		
Duct Area (Square Feet):	148.489		
Upstream Diameters:	5.0		
Downstream Diameters:	21.4		
Number of Ports Sampled:	4		
Number of Points per Port:	3		
Minutes per Point:	5.0		
Minutes per Reading:	5.0		
Total Number of Traverse Points:	12		
Test Length (Minutes):	60		
Train Type:	Anderson Box		
Source Condition:	Mill ON		
Diluent Model/Serial Number:	Servomex 1440D1/3934		
Moisture Balance ID:	S10-31		
# of Runs	3		

Run 1A - Method 26A

Client: Heidelberg Materials | **Date: 10/18/23**
Facility: Union Bridge Cement Plant | **Start Time: 8:30**
Test Location: Main Kiln Scrubber Stack | **End Time: 9:45**
Source Condition: Mill ON

DRY GAS METER CONDITIONS			STACK CONDITIONS		
ΔH:	1.43	in. H_2O	Static Pressure	0.10	in. H_2O
Meter Temperature, Tm:	76.5	°F	Flue Pressure (Ps):	29.27	in. Hg. abs.
Sqrt ΔP:	0.908	in. H_2O	Carbon Dioxide:	24.68	%
Stack Temperature, Ts:	256.4	°F	Oxygen:	7.18	%
Meter Volume, Vm:	43.097	ft^3	Nitrogen:	68.14	%
Meter Volume, Vmstd:	41.298	dscf	Gas Weight dry, Md:	32.236	lb/lb mole
Meter Volume, Vwstd:	5.096	wscf	Gas Weight wet, Ms:	30.672	lb/lb mole
Isokinetic Variance:	100.1	%I	Excess Air:	66.426	%
			Gas Velocity, Vs:	57.860	fps
Test Length:	60.00	in mins.	Volumetric Flow:	515,500	acfm
Nozzle Diameter:	0.238	in inches	Volumetric Flow:	330,813	dscfm
Barometric Pressure:	29.26	in Hg	Volumetric Flow:	371,636	scfm

MOISTURE DETERMINATION

Initial Impinger Content:	3374.4	ml	Silica Initial Wt.	882.8	grams
Final Impinger Content:	3476.1	ml	Silica Final Wt.	889.3	grams
Impinger Difference:	101.7	ml	Silica Difference:	6.5	grams
Total Water Gain:	108.2		Moisture, Bws:	0.110	

Port-Point No.	Clock Time	Velocity Head Δp in. H2O	Orifice ΔH in. H2O	Actual Meter Vol. ft^3	Stack Temp °F	Meter Temp Inlet °F	Meter Temp Outlet °F	Probe Temp °F	Filter Exit Temp °F	Impinger Exit Temp °F	
1-1	8:30:00	1.00	1.80	740.992	246	73	73	260	260	59	
1-2	8:35:00	0.83	1.50	745.170	245	73	73	259	261	51	
1-3	8:40:00	0.64	1.10	748.920	244	74	73	260	256	52	
	8:45:00			751.952							
2-1	8:51:00	0.97	1.70	751.952	246	75	73	261	261	47	
2-2	8:56:00	0.85	1.50	755.210	250	77	74	260	262	46	
2-3	9:01:00	0.65	1.10	759.120	255	80	75	260	261	47	
	9:06:00			762.935							
3-1	9:10:00	0.94	1.60	762.935	258	80	76	260	260	50	
3-2	9:15:00	0.82	1.40	766.930	263	82	76	260	258	51	
3-3	9:20:00	0.71	1.20	770.510	263	82	76	260	260	50	
	9:25:00			773.009							
4-1	9:30:00	1.00	1.70	773.009	265	80	76	260	261	55	
4-2	9:35:00	0.84	1.40	777.320	270	81	76	260	260	51	
4-3	9:40:00	0.71	1.20	780.860	272	81	76	260	258	55	
	9:45:00			784.089							
Total	1:00:00			43.097		78.2	74.8				
Average		0.83	1.43		256.4	76.5					
Min			1.10		244.0	73.0					
Max			1.80		272.0	82.0					

Impinger Weight Sheet - Run 1A

Client:	**Heidelberg Materials**
Facility:	**Union Bridge Cement Plant**
Test Location:	**Main Kiln Scrubber Stack**
Project #:	**M234208**
Date:	**10/18/2023**
Test Method:	**26A**
Weighed/Measured By:	**ELE**
Balance ID:	**S10-31**

Scale Calibration Check Date: **10/18/2023**

Scale Calibration Check (see QS-6.05C for procedure)

must be within ± 0.5g of certified mass

Certified Weight, grams	Result, grams
250	250.0
500	500.0
750	750.0

IMPINGER CONTENTS	FINAL MLS / GRAMS	INITIAL MLS / GRAMS	GAIN MLS / GRAMS
0.1N H2SO4	762.8	703.3	59.5
0.1N H2SO4	745.7	713.0	32.7
Empty	610.3	604.3	6.0
0.1N NaOH	633.4	631.4	2.0
0.1N NaOH	723.9	722.4	1.5
Silica Gel	889.3	882.8	6.5
	3,476.1 Liquid Final	3,374.4 Liquid Initial	101.7 Liquid Gain
	889.3 Silica Final	882.8 Silica Initial	6.5 Silica Gain

Run 2A - Method 26A

Client: Heidelberg Materials | **Date: 10/18/23**

Facility: Union Bridge Cement Plant | **Start Time: 10:15**

Test Location: Main Kiln Scrubber Stack | **End Time: 11:29**

Source Condition: Mill ON

DRY GAS METER CONDITIONS			STACK CONDITIONS		
ΔH:	1.64	In. H_2O	Static Pressure	0.10	in. H_2O
Meter Temperature, Tm:	75.4	°F	Flue Pressure (Ps):	29.27	in. Hg. abs.
Sqrt ΔP:	0.972	In. H_2O	Carbon Dioxide:	24.38	%
Stack Temperature, Ts:	264.5	°F	Oxygen:	7.21	%
Meter Volume, Vm:	46.786	ft^3	Nitrogen:	68.4	%
Meter Volume, Vmstd:	44.944	dscf	Gas Weight dry, Md:	32.189	lb/lb mole
Meter Volume, Vwstd:	5.902	wscf	Gas Weight wet, Ms:	30.542	lb/lb mole
Isokinetic Variance:	102.8	%I	Excess Air:	66.450	%
			Gas Velocity, Vs:	62.400	fps
Test Length:	60.00	in mins.	Volumetric Flow:	555,944	acfm
Nozzle Diameter:	0.238	in inches	Volumetric Flow:	350,320	dscfm
Barometric Pressure:	29.26	in Hg	Volumetric Flow:	396,321	scfm

MOISTURE DETERMINATION

Initial Impinger Content:	3571.6	ml	Silica Initial Wt.	850.1	grams
Final Impinger Content:	3683.2	ml	Silica Final Wt.	863.8	grams
Impinger Difference:	111.6	ml	Silica Difference:	13.7	grams
Total Water Gain:	125.3		Moisture, Bws:	0.116	

Port-Point No.	Clock Time	Velocity Head Δp in. H2O	Orifice ΔH in. H2O	Actual Meter Vol. ft^3	Stack Temp °F	Meter Temp Inlet °F	Meter Temp Outlet °F	Probe Temp °F	Filter Exit Temp °F	Impinger Exit Temp °F
1-1	10:15:00	1.10	1.80	785.489	274	77	75	260	259	64
1-2	10:20:00	0.94	1.60	789.670	273	79	75	261	261	58
1-3	10:25:00	0.75	1.30	793.410	272	80	75	259	259	60
	10:30:00			797.004						
2-1	10:34:00	1.00	1.70	797.004	270	78	74	260	262	62
2-2	10:39:00	0.97	1.70	801.120	267	81	75	260	260	59
2-3	10:44:00	0.73	1.30	804.990	265	81	75	260	258	59
	10:49:00			808.450						
3-1	10:54:00	1.20	2.10	808.450	262	77	74	260	260	65
3-2	10:59:00	1.00	1.70	812.650	260	78	73	260	261	57
3-3	11:04:00	0.74	1.30	816.410	259	77	73	260	261	55
	11:09:00			820.324						
4-1	11:14:00	1.20	2.10	820.324	258	73	71	260	261	62
4-2	11:19:00	0.96	1.70	824.530	257	74	71	260	260	56
4-3	11:24:00	0.83	1.40	828.580	257	74	70	260	261	58
	11:29:00			832.275						
Total	1:00:00			46.786		77.4	73.4			
Average			1.64		264.5	75.4				
Min			1.30		257.0	70.0				
Max			2.10		274.0	81.0				

Impinger Weight Sheet - Run 2A

Client:	**Heidelberg Materials**
Facility:	**Union Bridge Cement Plant**
Test Location:	**Main Kiln Scrubber Stack**
Project #:	**M234208**
Date:	**10/18/2023**
Test Method:	**26A**
Weighed/Measured By:	**ELE**
Balance ID:	**S10-31**

Scale Calibration Check Date: **10/18/2023**

Scale Calibration Check (see QS-6.05C for procedure)

must be within ± 0.5g of certified mass

Certified Weight, grams	Result, grams
250	250.0
500	500.0
750	750.0

IMPINGER CONTENTS	FINAL MLS / GRAMS	INITIAL MLS / GRAMS	GAIN MLS / GRAMS
0.1N H2SO4	839.9	769.6	70.3
0.1N H2SO4	732.5	702.0	30.5
Empty	672.0	663.3	8.7
0.1N NaOH	694.2	694.5	-0.3
0.1N NaOH	744.6	742.2	2.4
Silica Gel	863.8	850.1	13.7
	3,683.2	3,571.6	111.6
	Liquid Final	**Liquid Initial**	**Liquid Gain**
	863.8	850.1	13.7
	Silica Final	**Silica Initial**	**Silica Gain**

Run 3A - Method 26A

Client: Heidelberg Materials | **Date: 10/18/23**

Facility: Union Bridge Cement Plant | **Start Time: 12:05**

Test Location: Main Kiln Scrubber Stack | **End Time: 18:03**

Source Condition: Mill ON

DRY GAS METER CONDITIONS			STACK CONDITIONS		
ΔH:	1.57	In. H_2O	Static Pressure	0.40	in. H_2O
Meter Temperature, Tm:	69.5	°F	Flue Pressure (Ps):	29.29	in. Hg. abs.
Sqrt ΔP:	0.940	In. H_2O	Carbon Dioxide:	24.66	%
Stack Temperature, Ts:	248.3	°F	Oxygen:	7.13	%
Meter Volume, Vm:	44.907	ft^3	Nitrogen:	68.21	%
Meter Volume, Vmstd:	43.617	dscf	Gas Weight dry, Md:	32.231	lb/lb mole
Meter Volume, Vwstd:	5.440	wscf	Gas Weight wet, Ms:	30.653	lb/lb mole
Isokinetic Variance:	101.6	%I	Excess Air:	65.549	%
			Gas Velocity, Vs:	59.516	fps
Test Length:	60.00	in mins.	Volumetric Flow:	530,252	acfm
Nozzle Diameter:	0.238	in inches	Volumetric Flow:	344,058	dscfm
Barometric Pressure:	29.26	in Hg	Volumetric Flow:	386,970	scfm

MOISTURE DETERMINATION

Initial Impinger Content:	3338.5	ml	Silica Initial Wt.	856.0	grams
Final Impinger Content:	3438.9	ml	Silica Final Wt.	871.1	grams
Impinger Difference:	100.4	ml	Silica Difference:	15.1	grams
Total Water Gain:	115.5		Moisture, Bws:	0.111	

Port-Point No.	Clock Time	Velocity Head Δp in. H2O	Orifice ΔH in. H2O	Actual Meter Vol. ft^3	Stack Temp °F	Meter Temp Inlet °F	Meter Temp Outlet °F	Probe Temp °F	Filter Exit Temp °F	Impinger Exit Temp °F
1-1	12:05:00	1.20	2.00	835.156	263	67	66	261	260	66
1-2	12:10:00	0.94	1.60	839.520	262	68	66	261	260	48
1-3	12:15:00	0.64	1.10	843.250	261	69	66	260	260	48
	12:20:00			846.473						
2-1	12:25:00	1.10	1.90	846.473	259	67	65	259	259	51
	12:30:00			850.330						
2-2	17:11:00	0.95	1.70	853.102	243	67	67	260	261	56
2-3	17:16:00	0.79	1.40	856.210	242	69	67	260	259	46
	17:21:00			860.573						
3-1	17:28:00	1.10	2.00	860.573	236	71	67	261	260	52
3-2	17:33:00	0.88	1.60	864.430	241	75	69	260	260	46
3-3	17:38:00	0.54	0.96	868.460	242	77	69	260	257	49
	17:43:00			871.595						
4-1	17:48:00	1.20	2.10	871.595	243	73	70	260	255	58
4-2	17:53:00	0.85	1.50	875.980	244	76	70	260	260	50
4-3	17:58:00	0.58	1.00	879.450	243	76	70	260	261	52
	18:03:00			882.835						
Total	1:00:00			44.907		71.3	67.7			
Average			1.57		248.3	69.5				
Min			0.96		236.0	65.0				
Max			2.10		263.0	77.0				

Impinger Weight Sheet - Run 3A

Client:	**Heidelberg Materials**
Facility:	**Union Bridge Cement Plant**
Test Location:	**Main Kiln Scrubber Stack**
Project #:	**M234208**
Date:	**10/18/2023**
Test Method:	**26A**
Weighed/Measured By:	**ELE**
Balance ID:	**S10-31**

Scale Calibration Check Date: **10/18/2023**

Scale Calibration Check (see QS-6.05C for procedure)

must be within ± 0.5g of certified mass

Certified Weight, grams	Result, grams
250	250.0
500	500.0
750	750.0

IMPINGER CONTENTS	FINAL MLS / GRAMS	INITIAL MLS / GRAMS	GAIN MLS / GRAMS
0.1N H2SO4	842.9	684.9	158.0
0.1N H2SO4	695.5	701.9	-6.4
Empty	608.2	604.6	3.6
0.1N NaOH	595.4	641.1	-45.7
0.1N NaOH	696.9	706.0	-9.1
Silica Gel	871.1	856.0	15.1

Liquid Final	Liquid Initial	Liquid Gain
3,438.9	3,338.5	100.4

Silica Final	Silica Initial	Silica Gain
871.1	856.0	15.1

Client:	Heidelberg Materials		
Facility:	Union Bridge Cement Plant		
Test Location:	Main Kiln Scrubber Stack		
Project #:	M234208		
Test Method:	26A		
Test Engineer:	JVC		
Test Technician:	WJD		
	Run 1B	**Run 2B**	**Run 3B**
Temp ID:	CM25	CM25	CM25
Meter ID:	CM25	CM25	CM25
Pitot ID:	S8-058	S8-058	S8-058
Nozzle Diameter (Inches):	0.280	0.280	0.280
Meter Calibration Date:	10/5/2023	10/5/2023	10/5/2023
Meter Calibration Factor (Y):	0.982	0.982	0.982
Meter Orifice Setting (Delta H):	1.984	1.984	1.984
Nozzle Kit ID Number and Material:	Glass #1	Glass #1	Glass #1
Pitot Tube Coefficient:	0.839		
Probe Length (Feet):	6.0		
Probe Liner Material:	Glass		
Sample Plane:	Horizontal		
Port Length (Inches):	3.00		
Port Size (Diameter, Inches):	6.50		
Port Type:	Nipple		
Duct Shape:	Circular		
Diameter (Feet):	13.75		
Duct Area (Square Feet):	148.489		
Upstream Diameters:	5.0		
Downstream Diameters:	21.4		
Number of Ports Sampled:	4		
Number of Points per Port:	3		
Minutes per Point:	5.0		
Minutes per Reading:	5.0		
Total Number of Traverse Points:	12		
Test Length (Minutes):	60		
Train Type:	Anderson Box		
Source Condition:	Mill ON		
Diluent Model/Serial Number:	Servomex 1440D1/3934		
Moisture Balance ID:	S10-31		
# of Runs	3		

Run 1B - Method 26A

Client: Heidelberg Materials | **Date: 10/18/23**
Facility: Union Bridge Cement Plant | **Start Time: 8:30**
Test Location: Main Kiln Scrubber Stack | **End Time: 9:45**
Source Condition: Mill ON

DRY GAS METER CONDITIONS			STACK CONDITIONS		
ΔH:	3.53	in. H_2O	Static Pressure	0.10	in. H_2O
Meter Temperature, Tm:	76.3	°F	Flue Pressure (Ps):	29.26	in. Hg. abs.
Sqrt ΔP:	0.915	in. H_2O	Carbon Dioxide:	24.68	%
Stack Temperature, Ts:	254.1	°F	Oxygen:	7.18	%
Meter Volume, Vm:	62.462	ft^3	Nitrogen:	68.14	%
Meter Volume, Vmstd:	59.577	dscf	Gas Weight dry, Md:	32.236	lb/lb mole
Meter Volume, Vwstd:	7.103	wscf	Gas Weight wet, Ms:	30.720	lb/lb mole
Isokinetic Variance:	102.5	%I	Excess Air:	66.426	%
			Gas Velocity, Vs:	58.471	fps
Test Length:	60.00	in mins.	Volumetric Flow:	520,937	acfm
Nozzle Diameter:	0.280	in inches	Volumetric Flow:	336,563	dscfm
Barometric Pressure:	29.26	in Hg	Volumetric Flow:	376,688	scfm

MOISTURE DETERMINATION

Initial Impinger Content:	3716.7	ml	Silica Initial Wt.	850.7	grams
Final Impinger Content:	3849.2	ml	Silica Final Wt.	869.0	grams
Impinger Difference:	132.5	ml	Silica Difference:	18.3	grams
Total Water Gain:	150.8		Moisture, Bws:	0.107	

Port-Point No.	Clock Time	Velocity Head Δp in. H2O	Orifice ΔH in. H2O	Actual Meter Vol. ft^3	Stack Temp °F	Meter Temp Inlet °F	Meter Temp Outlet °F	Probe Temp °F	Filter Exit Temp °F	Impinger Exit Temp °F	
1-1	8:30:00	0.92	3.90	18.632	245	71	72	259	260	61	
1-2	8:35:00	0.83	3.50	24.130	244	72	72	259	260	61	
1-3	8:40:00	0.85	3.60	29.180	246	73	74	260	260	62	
	8:45:00			34.549							
2-1	8:51:00	0.91	3.90	34.549	247	76	75	261	259	61	
2-2	8:56:00	0.84	3.60	39.920	248	78	76	258	260	62	
2-3	9:01:00	0.75	3.20	45.290	249	80	77	259	260	62	
	9:06:00			50.236							
3-1	9:10:00	0.95	4.00	50.236	252	80	78	263	259	63	
3-2	9:15:00	0.85	3.60	55.890	253	81	78	258	261	63	
3-3	9:20:00	0.72	3.00	61.150	257	81	78	260	259	64	
	9:25:00			65.843							
4-1	9:30:00	0.93	3.90	65.843	265	77	79	263	264	64	
4-2	9:35:00	0.80	3.30	70.830	271	76	77	256	260	64	
4-3	9:40:00	0.71	2.90	76.380	272	75	76	259	261	65	
	9:45:00			81.094							
Total	1:00:00			62.462		76.7	76.0				
Average			3.53		254.1	76.3					
Min			2.90		244.0	71.0					
Max			4.00		272.0	81.0					

Impinger Weight Sheet - Run 1B

Client:	**Heidelberg Materials**
Facility:	**Union Bridge Cement Plant**
Test Location:	**Main Kiln Scrubber Stack**
Project #:	**M234208**
Date:	**10/18/2023**
Test Method:	**26A**
Weighed/Measured By:	**ELE**
Balance ID:	**S10-31**

Scale Calibration Check Date: **10/18/2023**

Scale Calibration Check (see QS-6.05C for procedure)

must be within ± 0.5g of certified mass

Certified Weight, grams	Result, grams
250	250.0
500	500.0
750	750.0

IMPINGER CONTENTS	FINAL MLS / GRAMS	INITIAL MLS / GRAMS	GAIN MLS / GRAMS
0.1N H2SO4	790.9	761.8	29.1
0.1N H2SO4	819.5	757.7	61.8
Empty	673.6	650.6	23.0
0.1N NaOH	794.0	779.5	14.5
0.1N NaOH	771.2	767.1	4.1
Silica Gel	869.0	850.7	18.3

3,849.2	3,716.7	132.5
Liquid Final	**Liquid Initial**	**Liquid Gain**
869.0	850.7	18.3
Silica Final	**Silica Initial**	**Silica Gain**

Run 2B - Method 26A

Client: Heidelberg Materials | **Date: 10/18/23**

Facility: Union Bridge Cement Plant | **Start Time: 10:15**

Test Location: Main Kiln Scrubber Stack | **End Time: 11:29**

Source Condition: Mill ON

DRY GAS METER CONDITIONS			STACK CONDITIONS		
ΔH:	3.63	In. H_2O	Static Pressure	0.10	in. H_2O
Meter Temperature, Tm:	66.8	°F	Flue Pressure (Ps):	29.27	in. Hg. abs.
Sqrt ΔP:	0.938	In. H_2O	Carbon Dioxide:	24.38	%
Stack Temperature, Ts:	264.8	°F	Oxygen:	7.21	%
Meter Volume, Vm:	62.125	ft^3	Nitrogen:	68.4	%
Meter Volume, Vmstd:	60.344	dscf	Gas Weight dry, Md:	32.189	lb/lb mole
Meter Volume, Vwstd:	7.286	wscf	Gas Weight wet, Ms:	30.660	lb/lb mole
Isokinetic Variance:	102.1	%I	Excess Air:	66.450	%
			Gas Velocity, Vs:	60.448	fps
Test Length:	60.00	in mins.	Volumetric Flow:	538,552	acfm
Nozzle Diameter:	0.280	in inches	Volumetric Flow:	342,401	dscfm
Barometric Pressure:	29.26	in Hg	Volumetric Flow:	383,746	scfm

MOISTURE DETERMINATION

Initial Impinger Content:	3535.1	ml	Silica Initial Wt.	891.7	grams
Final Impinger Content:	3679.2	ml	Silica Final Wt.	902.3	grams
Impinger Difference:	144.1	ml	Silica Difference:	10.6	grams
Total Water Gain:	154.7		Moisture, Bws:	0.108	

Port-Point No.	Clock Time	Velocity Head Δp in. H2O	Orifice ΔH in. H2O	Actual Meter Vol. ft^3	Stack Temp °F	Meter Temp Inlet °F	Meter Temp Outlet °F	Probe Temp °F	Filter Exit Temp °F	Impinger Exit Temp °F
1-1	10:15:00	0.97	4.00	82.119	274	68	70	253	268	61
1-2	10:20:00	0.90	3.70	87.630	273	68	70	250	263	60
1-3	10:25:00	0.75	3.10	92.760	273	69	72	258	261	61
	10:30:00			97.426						
2-1	10:34:00	0.98	4.00	97.426	270	70	68	257	260	62
2-2	10:39:00	0.87	3.60	102.810	266	70	67	260	260	61
2-3	10:44:00	0.73	3.00	108.050	264	68	66	261	259	61
	10:49:00			112.920						
3-1	10:54:00	1.00	4.10	112.920	262	66	66	262	260	62
3-2	10:59:00	0.92	3.80	118.370	261	66	65	260	260	62
3-3	11:04:00	0.80	3.30	123.790	260	67	65	259	261	62
	11:09:00			128.671						
4-1	11:14:00	0.98	4.00	128.671	259	64	63	261	261	62
4-2	11:19:00	0.89	3.70	134.220	258	65	63	259	260	62
4-3	11:24:00	0.79	3.30	139.260	258	64	63	259	260	63
	11:29:00			144.244						
Total	1:00:00			62.125		67.1	66.5			
Average			3.63		264.8	66.8				
Min			3.00		258.0	63.0				
Max			4.10		274.0	72.0				

Impinger Weight Sheet - Run 2B

Client:	**Heidelberg Materials**
Facility:	**Union Bridge Cement Plant**
Test Location:	**Main Kiln Scrubber Stack**
Project #:	**M234208**
Date:	**10/18/2023**
Test Method:	**26A**
Weighed/Measured By:	**ELE**
Balance ID:	**S10-31**

Scale Calibration Check Date: **10/18/2023**

Scale Calibration Check (see QS-6.05C for procedure)

must be within ± 0.5g of certified mass

Certified Weight, grams	Result, grams
250	250.0
500	500.0
750	750.0

IMPINGER CONTENTS	FINAL MLS / GRAMS	INITIAL MLS / GRAMS	GAIN MLS / GRAMS
0.1N H2SO4	727.7	690.6	37.1
0.1N H2SO4	785.6	726.2	59.4
Empty	691.1	665.6	25.5
0.1N NaOH	740.5	723.7	16.8
0.1N NaOH	734.3	729.0	5.3
Silica Gel	902.3	891.7	10.6
	3,679.2 Liquid Final	3,535.1 Liquid Initial	144.1 Liquid Gain
	902.3 Silica Final	891.7 Silica Initial	10.6 Silica Gain

Run 3B - Method 26A

Client: Heidelberg Materials | **Date: 10/18/23**

Facility: Union Bridge Cement Plant | **Start Time: 12:05**

Test Location: Main Kiln Scrubber Stack | **End Time: 18:03**

Source Condition: Mill ON

DRY GAS METER CONDITIONS			STACK CONDITIONS		
ΔH:	3.78	In. H_2O	Static Pressure	0.10	in. H_2O
Meter Temperature, Tm:	67.8	°F	Flue Pressure (Ps):	29.27	in. Hg. abs.
Sqrt ΔP:	0.932	In. H_2O	Carbon Dioxide:	24.66	%
Stack Temperature, Ts:	249.5	°F	Oxygen:	7.13	%
Meter Volume, Vm:	62.788	ft^3	Nitrogen:	68.21	%
Meter Volume, Vmstd:	60.894	dscf	Gas Weight dry, Md:	32.231	lb/lb mole
Meter Volume, Vwstd:	8.167	wscf	Gas Weight wet, Ms:	30.548	lb/lb mole
Isokinetic Variance:	103.6	%I	Excess Air:	65.549	%
			Gas Velocity, Vs:	59.526	fps
Test Length:	60.00	in mins.	Volumetric Flow:	530,334	acfm
Nozzle Diameter:	0.280	in inches	Volumetric Flow:	340,402	dscfm
Barometric Pressure:	29.26	in Hg	Volumetric Flow:	386,057	scfm

MOISTURE DETERMINATION

Initial Impinger Content:	3700.8	ml	Silica Initial Wt.	842.9	grams
Final Impinger Content:	3854.2	ml	Silica Final Wt.	862.9	grams
Impinger Difference:	153.4	ml	Silica Difference:	20.0	grams
Total Water Gain:	173.4		Moisture, Bws:	0.118	

Port-Point No.	Clock Time	Velocity Head Δp in. H2O	Orifice ΔH in. H2O	Actual Meter Vol. ft^3	Stack Temp °F	Meter Temp Inlet °F	Meter Temp Outlet °F	Probe Temp °F	Filter Exit Temp °F	Impinger Exit Temp °F
1-1	12:05:00	0.99	4.10	45.091	264	62	63	251	261	59
1-2	12:10:00	0.89	3.60	50.470	264	65	62	259	260	60
1-3	12:15:00	0.79	3.20	55.690	262	66	62	260	260	60
	12:20:00			60.753						
2-1	12:25:00	0.99	4.10	60.753	261	64	62	259	260	61
	12:30:00			66.130						
2,2	17:11:00	0.88	3.70	66.130	243	67	67	262	260	63
2,3	17:16:00	0.76	3.20	71.330	243	70	67	258	260	63
	17:21:00			76.438						
3,1	17:28:00	0.97	4.20	76.438	241	71	68	260	260	64
3,2	17:33:00	0.91	3.90	82.130	242	73	69	260	261	63
3,3	17:38:00	0.70	4.30	87.340	243	75	70	260	260	64
	17:43:00			92.285						
4,1	17:48:00	0.96	4.10	92.285	244	71	70	262	260	64
4,2	17:53:00	0.89	3.80	97.700	244	72	69	259	259	65
4,3	17:58:00	0.72	3.10	103.220	243	72	70	260	260	65
	18:03:00			107.879						
Total	1:00:00			62.788		69.0	66.6			
Average			3.78		249.5	67.8				
Min			3.10		241.0	62.0				
Max			4.30		264.0	75.0				

Impinger Weight Sheet - Run 3B

Client:	**Heidelberg Materials**
Facility:	**Union Bridge Cement Plant**
Test Location:	**Main Kiln Scrubber Stack**
Project #:	**M234208**
Date:	**10/18/2023**
Test Method:	**26A**
Weighed/Measured By:	**ELE**
Balance ID:	**S10-31**

Scale Calibration Check Date: **10/18/2023**

Scale Calibration Check (see QS-6.05C for procedure)

must be within ± 0.5g of certified mass

Certified Weight, grams	Result, grams
250	250.0
500	500.0
750	750.0

IMPINGER CONTENTS	FINAL MLS / GRAMS	INITIAL MLS / GRAMS	GAIN MLS / GRAMS
0.1N H2SO4	844.9	751.0	93.9
0.1N H2SO4	804.4	759.6	44.8
Empty	664.3	656.5	7.8
0.1N NaOH	771.5	767.7	3.8
0.1N NaOH	769.1	766.0	3.1
Silica Gel	862.9	842.9	20.0
	3,854.2 Liquid Final	3,700.8 Liquid Initial	153.4 Liquid Gain
	862.9 Silica Final	842.9 Silica Initial	20.0 Silica Gain

Client: Heidelberg Materials
Facility: Union Bridge Cement Plant
Project #: M234208
Test Location: Main Kiln Stack
Date: 10/18/23

Run 1

		FTIR Data						Analyzer Data
Spectrum	Time	H2O %	CO2 % (wet)	HCN ppmvw	HF ppmvw	Cell Temp	Pressure	O2 % (dry)
RUN 1_007862.LAB	8:30	11.80	21.46	3.49	0.10	191.06	0.98	7.19
RUN 1_007863.LAB	8:31	11.95	21.54	3.42	0.10	190.99	0.98	7.20
RUN 1_007864.LAB	8:32	12.00	21.63	3.66	0.10	190.94	0.98	7.15
RUN 1_007865.LAB	8:33	11.94	21.55	3.63	0.10	191.00	0.98	7.17
RUN 1_007866.LAB	8:34	11.85	21.51	3.72	0.10	190.97	0.98	7.18
RUN 1_007867.LAB	8:35	11.78	21.62	3.73	0.10	191.05	0.98	7.27
RUN 1_007868.LAB	8:36	11.70	21.72	3.51	0.10	190.95	0.98	7.16
RUN 1_007869.LAB	8:37	11.64	21.64	3.44	0.10	190.94	0.98	7.07
RUN 1_007870.LAB	8:38	11.58	21.98	3.41	0.10	190.98	0.98	7.11
RUN 1_007871.LAB	8:39	11.66	21.75	3.47	0.10	191.05	0.98	7.08
RUN 1_007872.LAB	8:40	11.66	21.55	3.44	0.10	191.13	0.98	7.16
RUN 1_007873.LAB	8:41	11.82	21.46	3.46	0.10	191.15	0.98	7.26
RUN 1_007874.LAB	8:42	11.79	21.32	3.45	0.10	191.11	0.98	7.26
RUN 1_007875.LAB	8:43	11.69	21.37	3.38	0.10	190.95	0.98	7.31
RUN 1_007876.LAB	8:44	11.56	21.42	3.41	0.10	190.94	0.98	7.31
RUN 1_007877.LAB	8:45	11.34	21.63	3.49	0.10	190.94	0.98	7.30
RUN 1_007878.LAB	8:46	11.17	21.45	3.59	0.10	190.94	0.98	7.36
RUN 1_007879.LAB	8:47	10.94	21.95	3.65	0.10	190.94	0.98	7.33
RUN 1_007880.LAB	8:48	10.89	22.00	3.68	0.10	190.97	0.98	7.38
RUN 1_007881.LAB	8:49	10.91	22.06	3.64	0.10	191.06	0.98	7.21
RUN 1_007882.LAB	8:50	10.84	22.01	3.66	0.10	191.10	0.98	7.21
RUN 1_007883.LAB	8:51	10.86	22.22	3.63	0.10	191.01	0.98	7.13
RUN 1_007884.LAB	8:52	10.69	22.16	3.60	0.10	191.03	0.98	7.15
RUN 1_007885.LAB	8:53	10.59	22.01	3.68	0.10	190.99	0.98	7.14
RUN 1_007886.LAB	8:54	10.73	21.91	3.64	0.10	191.03	0.98	7.51
RUN 1_007887.LAB	8:55	10.75	21.91	3.70	0.10	190.98	0.98	7.66
RUN 1_007888.LAB	8:56	10.65	21.94	3.66	0.10	191.01	0.98	7.48
RUN 1_007889.LAB	8:57	10.74	22.06	3.66	0.10	190.94	0.98	7.19
RUN 1_007890.LAB	8:58	10.80	22.07	3.66	0.10	190.94	0.98	7.20
RUN 1_007891.LAB	8:59	10.70	22.00	3.69	0.10	191.00	0.98	7.16
RUN 1_007892.LAB	9:00	10.72	22.00	3.66	0.10	191.00	0.98	7.16
RUN 1_007893.LAB	9:01	10.60	22.00	3.68	0.10	191.02	0.98	7.11
RUN 1_007894.LAB	9:02	10.68	21.99	3.70	0.10	191.00	0.98	7.17
RUN 1_007895.LAB	9:03	10.65	22.14	3.70	0.10	191.02	0.98	7.20
RUN 1_007896.LAB	9:04	10.69	22.14	3.66	0.10	191.05	0.98	7.17
RUN 1_007897.LAB	9:05	10.73	21.97	3.54	0.10	191.05	0.98	7.11
RUN 1_007898.LAB	9:06	10.68	21.99	3.53	0.10	190.97	0.98	7.15
RUN 1_007899.LAB	9:07	10.73	22.02	3.54	0.10	191.02	0.98	7.21
RUN 1_007900.LAB	9:08	10.66	21.95	3.55	0.10	191.05	0.98	7.16
RUN 1_007901.LAB	9:09	10.60	22.02	3.67	0.10	191.05	0.98	7.20
RUN 1_007902.LAB	9:10	10.65	22.03	3.62	0.10	190.97	0.98	7.23
RUN 1_007903.LAB	9:11	10.59	22.03	3.60	0.10	190.94	0.98	7.21
RUN 1_007904.LAB	9:12	10.60	22.11	3.57	0.10	190.94	0.98	7.19
RUN 1_007905.LAB	9:13	10.61	22.24	3.61	0.10	190.99	0.98	7.17
RUN 1_007906.LAB	9:14	10.62	22.25	3.64	0.10	191.01	0.98	7.17
RUN 1_007907.LAB	9:15	10.64	22.10	3.55	0.10	190.97	0.98	7.16
RUN 1_007908.LAB	9:16	10.62	22.15	3.61	0.10	191.02	0.98	7.18
RUN 1_007909.LAB	9:17	10.62	22.05	3.62	0.10	191.05	0.98	7.10
RUN 1_007910.LAB	9:18	10.62	22.05	3.54	0.10	191.05	0.98	7.07
RUN 1_007911.LAB	9:19	10.63	22.06	3.58	0.10	190.99	0.98	7.08
RUN 1_007912.LAB	9:20	10.50	22.21	3.61	0.10	190.94	0.98	7.17
RUN 1_007913.LAB	9:21	10.45	22.23	3.66	0.10	190.91	0.98	7.15
RUN 1_007914.LAB	9:22	10.45	22.27	3.66	0.10	190.93	0.98	7.17
RUN 1_007915.LAB	9:23	10.42	22.53	3.66	0.10	191.02	0.98	7.21
RUN 1_007916.LAB	9:24	10.45	22.62	3.54	0.10	191.01	0.98	7.20
RUN 1_007917.LAB	9:25	10.40	22.66	3.64	0.10	191.07	0.98	7.18
RUN 1_007918.LAB	9:26	10.23	22.66	3.65	0.10	190.99	0.98	7.13
RUN 1_007919.LAB	9:27	10.15	22.55	3.61	0.10	191.05	0.98	7.19
RUN 1_007920.LAB	9:28	10.14	22.53	3.58	0.10	191.06	0.98	7.10
RUN 1_007921.LAB	9:29	10.08	22.52	3.68	0.10	191.05	0.98	7.00
Average		**10.92**	**21.98**	**3.60**	**0.10**	**191.01**	**0.98**	**7.20**

Client: Heidelberg Materials
Facility: Union Bridge Cement Plant
Project #: M234208
Test Location: Main Kiln Stack
Date: 10/18/23

Run 2

		FTIR Data						Analyzer Data
Spectrum	Time	H2O %	CO2 % (wet)	HCN ppmvw	HF ppmvw	Cell Temp	Pressure	O2 % (dry)
RUN 2_008046.LAB	10:15	10.74	22.2	3.48	0.10	191.0	0.97	7.05
RUN 2_008047.LAB	10:16	10.68	22.1	3.49	0.10	191.0	0.97	7.15
RUN 2_008048.LAB	10:17	16.87	20.1	3.71	0.10	191.0	0.97	7.12
RUN 2_008049.LAB	10:18	11.17	21.8	3.36	0.10	191.0	0.97	7.21
RUN 2_008050.LAB	10:19	10.82	21.8	3.45	0.10	191.0	0.97	7.23
RUN 2_008051.LAB	10:20	10.86	21.7	3.40	0.10	191.0	0.97	7.23
RUN 2_008052.LAB	10:21	10.91	21.6	3.44	0.10	191.0	0.97	7.29
RUN 2_008053.LAB	10:22	10.90	21.6	3.40	0.10	191.0	0.97	7.22
RUN 2_008054.LAB	10:23	10.93	21.7	3.47	0.10	191.0	0.97	7.19
RUN 2_008055.LAB	10:24	11.00	21.6	3.48	0.10	191.0	0.97	7.21
RUN 2_008056.LAB	10:25	11.06	21.8	3.36	0.10	191.0	0.97	7.16
RUN 2_008057.LAB	10:26	11.17	21.7	3.45	0.10	191.0	0.97	7.18
RUN 2_008058.LAB	10:27	13.95	21.0	3.44	0.10	191.0	0.97	7.19
RUN 2_008059.LAB	10:28	11.20	21.8	3.40	0.10	190.9	0.97	7.18
RUN 2_008060.LAB	10:29	11.24	21.7	3.41	0.10	190.8	0.97	7.24
RUN 2_008061.LAB	10:30	11.18	21.5	3.42	0.10	191.0	0.97	7.31
RUN 2_008062.LAB	10:31	11.15	21.6	3.43	0.10	191.0	0.97	7.29
RUN 2_008063.LAB	10:32	11.11	21.6	3.43	0.10	191.0	0.97	7.26
RUN 2_008064.LAB	10:33	11.11	21.5	3.38	0.10	191.0	0.97	7.29
RUN 2_008065.LAB	10:34	11.12	21.7	3.34	0.10	191.0	0.97	7.26
RUN 2_008066.LAB	10:35	11.19	21.6	3.33	0.10	191.0	0.97	7.28
RUN 2_008067.LAB	10:36	11.34	21.7	3.30	0.10	191.0	0.97	7.15
RUN 2_008068.LAB	10:37	11.38	21.8	3.31	0.10	191.0	0.97	7.16
RUN 2_008069.LAB	10:38	11.41	22.1	3.36	0.10	191.0	0.97	7.16
RUN 2_008070.LAB	10:39	11.43	22.0	3.37	0.10	191.0	0.97	7.14
RUN 2_008071.LAB	10:40	11.38	21.7	3.39	0.10	191.0	0.97	7.18
RUN 2_008072.LAB	10:41	11.36	21.6	3.34	0.10	191.0	0.97	7.22
RUN 2_008073.LAB	10:42	11.33	21.5	3.35	0.10	191.0	0.97	7.22
RUN 2_008074.LAB	10:43	11.22	21.5	3.36	0.10	191.0	0.97	7.30
RUN 2_008075.LAB	10:44	11.18	21.6	3.37	0.10	191.0	0.97	7.32
RUN 2_008076.LAB	10:45	11.10	21.7	3.38	0.10	191.0	0.97	7.35
RUN 2_008077.LAB	10:46	11.19	21.5	3.38	0.10	191.0	0.97	7.34
RUN 2_008078.LAB	10:47	11.27	21.5	3.32	0.10	191.0	0.97	7.37
RUN 2_008079.LAB	10:48	11.28	21.5	3.45	0.10	191.0	0.97	7.38
RUN 2_008080.LAB	10:49	11.31	21.6	3.44	0.10	191.0	0.97	7.34
RUN 2_008081.LAB	10:50	11.34	21.6	3.32	0.10	191.0	0.97	7.27
RUN 2_008082.LAB	10:51	11.48	22.1	3.25	0.10	191.0	0.97	7.24
RUN 2_008083.LAB	10:52	11.51	22.0	3.31	0.10	190.9	0.97	7.15
RUN 2_008084.LAB	10:53	13.46	21.2	3.42	0.10	190.9	0.97	7.12
RUN 2_008085.LAB	10:54	11.46	21.6	3.30	0.10	190.9	0.97	7.10
RUN 2_008086.LAB	10:55	11.38	21.6	3.26	0.10	191.0	0.97	7.18
RUN 2_008087.LAB	10:56	11.42	21.5	3.37	0.10	191.0	0.97	7.26
RUN 2_008088.LAB	10:57	11.42	21.5	3.32	0.10	191.0	0.97	7.26
RUN 2_008089.LAB	10:58	11.36	21.6	3.29	0.10	191.0	0.97	7.24
RUN 2_008090.LAB	10:59	11.28	21.7	3.40	0.10	191.0	0.97	7.33
RUN 2_008091.LAB	11:00	11.22	21.7	3.30	0.10	191.0	0.97	7.35
RUN 2_008092.LAB	11:01	11.20	21.5	3.32	0.10	191.0	0.97	7.22
RUN 2_008093.LAB	11:02	11.25	21.6	3.44	0.10	191.0	0.97	7.26
RUN 2_008094.LAB	11:03	11.27	21.6	3.52	0.10	191.0	0.97	7.33
RUN 2_008095.LAB	11:04	11.26	21.7	3.52	0.10	191.0	0.97	7.32
RUN 2_008096.LAB	11:05	11.23	21.6	3.44	0.10	191.0	0.97	7.31
RUN 2_008097.LAB	11:06	11.16	21.5	3.49	0.10	191.0	0.97	7.31
RUN 2_008098.LAB	11:07	11.15	21.7	3.51	0.10	191.0	0.97	7.40
RUN 2_008099.LAB	11:08	11.19	21.5	3.47	0.10	191.0	0.97	7.37
RUN 2_008100.LAB	11:09	11.20	21.5	3.46	0.10	191.0	0.97	7.41
RUN 2_008101.LAB	11:10	11.24	21.5	3.43	0.10	191.0	0.97	7.34
RUN 2_008102.LAB	11:11	11.22	21.5	3.39	0.10	191.0	0.97	7.36
RUN 2_008103.LAB	11:12	11.20	21.4	3.41	0.10	190.9	0.97	7.42
RUN 2_008104.LAB	11:13	11.18	21.5	3.42	0.10	190.9	0.97	7.46
RUN 2_008105.LAB	11:14	11.19	21.6	3.39	0.10	190.9	0.97	7.49
Average		**11.38**	**21.61**	**3.40**	**0.10**	**191.01**	**0.97**	**7.26**

Client: Heidelberg Materials
Facility: Union Bridge Cement Plant
Project #: M234208
Test Location: Main Kiln Stack
Date: 10/18/23

Run 3

		FTIR Data						Analyzer Data
Spectrum	Time	H2O %	CO2 % (wet)	HCN ppmvw	HF ppmvw	Cell Temp	Pressure	O2 % (dry)
RUN 3 MILL ON_008718.LAB	12:05	11.40	22.0	3.3	0.10	191.0	0.97	7.43
RUN 3 MILL ON_008719.LAB	12:06	11.17	22.0	3.4	0.10	191.0	0.97	7.48
RUN 3 MILL ON_008720.LAB	12:07	11.12	21.8	3.4	0.10	191.0	0.97	7.47
RUN 3 MILL ON_008721.LAB	12:08	11.21	21.5	3.3	0.10	191.0	0.97	7.43
RUN 3 MILL ON_008722.LAB	12:09	11.51	21.4	3.3	0.10	191.0	0.97	7.43
RUN 3 MILL ON_008723.LAB	12:10	11.60	21.6	3.2	0.10	191.0	0.97	7.33
RUN 3 MILL ON_008724.LAB	12:11	11.73	21.7	3.0	0.10	191.0	0.97	7.31
RUN 3 MILL ON_008725.LAB	12:12	11.69	21.6	3.0	0.10	191.0	0.97	7.32
RUN 3 MILL ON_008726.LAB	12:13	11.70	21.5	3.0	0.10	191.0	0.97	7.24
RUN 3 MILL ON_008727.LAB	12:14	11.71	21.5	3.0	0.10	191.0	0.97	7.31
RUN 3 MILL ON_008728.LAB	12:15	11.73	21.4	3.0	0.10	191.0	0.97	7.31
RUN 3 MILL ON_008729.LAB	12:16	11.77	21.4	3.1	0.10	191.0	0.97	7.31
RUN 3 MILL ON_008730.LAB	12:17	11.73	21.6	3.1	0.10	191.0	0.97	7.32
RUN 3 MILL ON_008731.LAB	12:18	11.72	21.6	3.1	0.10	191.0	0.97	7.41
RUN 3 MILL ON_008732.LAB	12:19	11.68	21.7	3.1	0.10	191.0	0.97	7.39
RUN 3 MILL ON_008733.LAB	12:20	11.81	21.6	3.1	0.10	190.9	0.97	7.35
RUN 3 MILL ON_008734.LAB	12:21	12.05	21.7	3.1	0.10	190.9	0.97	7.41
RUN 3 MILL ON_008735.LAB	12:22	11.97	21.7	3.3	0.10	190.9	0.97	7.36
RUN 3 MILL ON_008736.LAB	12:23	11.97	21.6	3.1	0.10	190.9	0.97	7.33
RUN 3 MILL ON_008737.LAB	12:24	12.03	21.8	3.3	0.10	190.9	0.97	7.31
RUN 3 MILL ON_008738.LAB	12:25	12.03	21.4	3.2	0.10	191.0	0.97	7.31
RUN 3 MILL ON_008739.LAB	12:26	11.85	21.3	3.1	0.10	191.0	0.97	7.28
RUN 3 MILL ON_008740.LAB	12:27	11.95	21.4	3.0	0.10	191.0	0.97	7.26
RUN 3 MILL ON_008741.LAB	12:28	12.08	21.5	3.2	0.10	191.0	0.97	7.17
RUN 3 MILL ON_008742.LAB	12:29	12.11	21.5	3.2	0.10	191.0	0.97	6.99
RUN 3 MILL ON_008743.LAB	12:30	12.12	21.7	3.2	0.10	190.9	0.97	7.00
RUN 3 MILL ON_008744.LAB	17:10	12.12	22.0	3.2	0.10	190.9	0.97	7.18
RUN 3 MILL ON_008745.LAB	17:11	12.26	22.0	3.2	0.10	190.8	0.97	7.18
RUN 3 MILL ON_008746.LAB	17:12	12.36	22.1	3.2	0.10	190.9	0.97	7.27
RUN 3 MILL ON_008747.LAB	17:13	12.31	22.2	3.1	0.10	191.0	0.97	7.30
RUN 3 MILL ON_008748.LAB	17:14	12.36	22.1	3.1	0.10	191.2	0.97	7.28
RUN 3 MILL ON_008749.LAB	17:15	12.21	22.1	3.1	0.10	191.1	0.97	7.22
RUN 3 MILL ON_008750.LAB	17:16	12.04	22.1	3.1	0.10	191.0	0.97	7.19
RUN 3 MILL ON_008751.LAB	17:17	11.98	22.0	3.2	0.10	191.0	0.97	7.11
RUN 3 MILL ON_008752.LAB	17:18	11.97	21.8	3.1	0.10	191.0	0.97	7.03
RUN 3 MILL ON_008753.LAB	17:19	11.74	21.4	3.1	0.10	191.0	0.97	7.03
RUN 3 MILL ON_008754.LAB	17:20	11.79	21.4	3.0	0.10	190.9	0.97	6.87
RUN 3 MILL ON_008755.LAB	17:21	11.93	21.5	3.1	0.10	191.0	0.97	6.81
RUN 3 MILL ON_008756.LAB	17:22	11.99	21.8	3.2	0.10	191.0	0.97	6.79
RUN 3 MILL ON_008757.LAB	17:23	11.86	22.1	3.2	0.10	191.0	0.97	6.81
RUN 3 MILL ON_008758.LAB	17:24	11.82	21.9	3.0	0.10	191.0	0.97	6.86
RUN 3 MILL ON_008759.LAB	17:25	11.88	21.9	2.9	0.10	190.9	0.97	6.96
RUN 3 MILL ON_008760.LAB	17:26	11.92	22.1	3.2	0.10	191.0	0.97	7.33
RUN 3 MILL ON_008761.LAB	17:27	12.11	21.9	3.1	0.10	191.1	0.97	7.12
RUN 3 MILL ON_008762.LAB	17:28	12.07	21.9	3.2	0.10	191.1	0.97	7.70
RUN 3 MILL ON_008763.LAB	17:29	12.13	21.9	3.2	0.10	191.0	0.97	7.28
RUN 3 MILL ON_008764.LAB	17:30	12.23	22.0	3.2	0.10	191.0	0.97	7.18
RUN 3 MILL ON_008765.LAB	17:31	12.12	21.8	3.2	0.10	191.0	0.97	7.04
RUN 3 MILL ON_008766.LAB	17:32	12.04	21.6	3.2	0.10	191.0	0.97	7.09
RUN 3 MILL ON_008767.LAB	17:33	12.02	21.6	3.2	0.10	190.9	0.97	7.59
RUN 3 MILL ON_008768.LAB	17:34	12.11	21.6	3.2	0.10	191.0	0.97	7.01
RUN 3 MILL ON_008769.LAB	17:35	12.05	21.6	3.2	0.10	191.0	0.97	6.95
RUN 3 MILL ON_008770.LAB	17:36	12.12	21.6	3.3	0.10	191.0	0.97	6.93
RUN 3 MILL ON_008771.LAB	17:37	11.99	21.7	3.2	0.10	191.0	0.97	6.96
RUN 3 MILL ON_008772.LAB	17:38	12.11	21.7	3.2	0.10	191.0	0.97	7.09
RUN 3 MILL ON_008773.LAB	17:39	12.23	21.6	3.3	0.10	191.0	0.97	7.02
RUN 3 MILL ON_008774.LAB	17:40	12.18	21.6	3.3	0.10	191.0	0.97	7.02
RUN 3 MILL ON_008775.LAB	17:41	12.04	21.5	3.3	0.10	191.0	0.97	7.20
RUN 3 MILL ON_008776.LAB	17:42	12.09	21.6	3.4	0.10	191.0	0.97	7.24
RUN 3 MILL ON_008777.LAB	17:43	12.04	21.5	3.3	0.10	191.0	0.97	7.29
Average		**11.93**	**21.72**	**3.17**	**0.10**	**191.01**	**0.97**	**7.20**

Client:	Heidelberg Materials		
Facility:	Union Bridge Cement Plant		
Test Location:	Main Kiln Scrubber Stack		
Project #:	M234208		
Test Method:	26A		
Test Engineer:	PPP		
Test Technician:	WJD		
	Run 1A	**Run 2A**	**Run 3A**
Temp ID:	CM27	CM27	CM27
Meter ID:	CM27	CM27	CM27
Pitot ID:	S8-058-A	S8-058-A	S8-058-A
Nozzle Diameter (Inches):	0.238	0.238	0.238
Meter Calibration Date:	10/6/2023	10/6/2023	10/6/2023
Meter Calibration Factor (Y):	0.992	0.992	0.992
Meter Orifice Setting (Delta H):	1.589	1.589	1.589
Nozzle Kit ID Number and Material:	Glass #1	Glass #1	Glass #1
Pitot Tube Coefficient:	0.834		
Probe Length (Feet):	6.0		
Probe Liner Material:	Glass		
Sample Plane:	Horizontal		
Port Length (Inches):	3.00		
Port Size (Diameter, Inches):	6.50		
Port Type:	Nipple		
Duct Shape:	Circular		
Diameter (Feet):	13.75		
Duct Area (Square Feet):	148.489		
Upstream Diameters:	5.0		
Downstream Diameters:	21.4		
Number of Ports Sampled:	4		
Number of Points per Port:	3		
Minutes per Point:	5.0		
Minutes per Reading:	5.0		
Total Number of Traverse Points:	12		
Test Length (Minutes):	60		
Train Type:	Anderson Box		
Source Condition:	Mill OFF		
Diluent Model/Serial Number:	Servomex 1440D1/3934		
Moisture Balance ID:	S10-31		
# of Runs	3		

Run 1A - Method 26A

Client: Heidelberg Materials | **Date: 10/19/23**
Facility: Union Bridge Cement Plant | **Start Time: 8:25**
Test Location: Main Kiln Scrubber Stack | **End Time: 9:40**
Source Condition: Mill OFF

DRY GAS METER CONDITIONS			STACK CONDITIONS		
ΔH:	1.20	in. H_2O	Static Pressure	0.10	in. H_2O
Meter Temperature, Tm:	63.6	°F	Flue Pressure (Ps):	29.27	in. Hg. abs.
Sqrt ΔP:	0.879	in. H_2O	Carbon Dioxide:	28.59	%
Stack Temperature, Ts:	320.2	°F	Oxygen:	4.44	%
Meter Volume, Vm:	40.298	ft^3	Nitrogen:	66.97	%
Meter Volume, Vmstd:	39.542	dscf	Gas Weight dry, Md:	32.752	lb/lb mole
Meter Volume, Vwstd:	6.726	wscf	Gas Weight wet, Ms:	30.608	lb/lb mole
Isokinetic Variance:	107.5	%I	Excess Air:	33.535	%
			Gas Velocity, Vs:	58.480	fps
Test Length:	60.00	in mins.	Volumetric Flow:	521,019	acfm
Nozzle Diameter:	0.238	in inches	Volumetric Flow:	294,781	dscfm
Barometric Pressure:	29.26	in Hg	Volumetric Flow:	344,922	scfm

MOISTURE DETERMINATION

Initial Impinger Content:	3520.9	ml	Silica Initial Wt.	863.8	grams
Final Impinger Content:	3653.7	ml	Silica Final Wt.	873.8	grams
Impinger Difference:	132.8	ml	Silica Difference:	10.0	grams
Total Water Gain:	142.8		Moisture, Bws:	0.145	

Port-Point No.	Clock Time	Velocity Head Δp in. H2O	Orifice ΔH in. H2O	Actual Meter Vol. ft^3	Stack Temp °F	Meter Temp Inlet °F	Meter Temp Outlet °F	Probe Temp °F	Filter Exit Temp °F	Impinger Exit Temp °F	
1-1	8:25:00	0.95	1.70	884.318	314	56	55	260	260	50	
1-2	8:30:00	0.74	1.50	888.260	316	57	56	260	260	51	
1-3	8:35:00	0.61	0.89	891.820	316	59	56	259	256	55	
	8:40:00			894.990							
2-1	8:45:00	0.94	1.40	894.990	318	60	57	259	261	56	
2-2	8:50:00	0.79	1.10	898.120	320	66	59	261	260	50	
2-3	8:55:00	0.57	0.80	901.740	321	67	59	259	257	49	
	9:00:00			904.990							
3-1	9:06:00	0.94	1.40	904.990	323	68	62	260	260	54	
3-2	9:11:00	0.83	1.20	908.630	323	71	63	260	257	50	
3-3	9:16:00	0.63	0.92	911.710	322	72	63	260	260	51	
	9:21:00			914.922							
4-1	9:25:00	0.94	1.40	914.922	322	71	65	260	258	58	
4-2	9:30:00	0.82	1.20	918.230	324	74	66	261	262	52	
4-3	9:35:00	0.59	0.87	921.780	323	77	67	259	259	52	
	9:40:00			924.616							
Total	1:00:00			40.298		66.5	60.7				
Average		0.78	1.20		320.2	63.6					
Min			0.80		314.0	55.0					
Max			1.70		324.0	77.0					

Impinger Weight Sheet - Run 1A

Client:	**Heidelberg Materials**
Facility:	**Union Bridge Cement Plant**
Test Location:	**Main Kiln Scrubber Stack**
Project #:	**M234208**
Date:	**10/19/2023**
Test Method:	**26A**
Weighed/Measured By:	**ELE**
Balance ID:	**S10-31**

Scale Calibration Check Date: **10/19/2023**

Scale Calibration Check (see QS-6.05C for procedure)

must be within ± 0.5g of certified mass

Certified Weight, grams	Result, grams
250	250.0
500	500.0
750	750.0

IMPINGER CONTENTS	FINAL MLS / GRAMS	INITIAL MLS / GRAMS	GAIN MLS / GRAMS
0.1N H2SO4	854.6	757.3	97.3
0.1N H2SO4	705.8	682.3	23.5
Empty	672.8	667.7	5.1
0.1N NaOH	700.9	697.4	3.5
0.1N NaOH	719.6	716.2	3.4
Silica Gel	873.8	863.8	10.0
	3,653.7	3,520.9	132.8
	Liquid Final	**Liquid Initial**	**Liquid Gain**
	873.8	863.8	10.0
	Silica Final	**Silica Initial**	**Silica Gain**

Run 2A - Method 26A

Client: Heidelberg Materials | **Date: 10/19/23**

Facility: Union Bridge Cement Plant | **Start Time: 10:10**

Test Location: Main Kiln Scrubber Stack | **End Time: 11:26**

Source Condition: Mill OFF

DRY GAS METER CONDITIONS			STACK CONDITIONS		
ΔH:	1.08	In. H_2O	Static Pressure	0.10	in. H_2O
Meter Temperature, Tm:	72.7	°F	Flue Pressure (Ps):	29.27	in. Hg. abs.
Sqrt ΔP:	0.853	In. H_2O	Carbon Dioxide:	28.91	%
Stack Temperature, Ts:	320.2	°F	Oxygen:	4.50	%
Meter Volume, Vm:	38.782	ft^3	Nitrogen:	66.6	%
Meter Volume, Vmstd:	37.392	dscf	Gas Weight dry, Md:	32.806	lb/lb mole
Meter Volume, Vwstd:	6.683	wscf	Gas Weight wet, Ms:	30.561	lb/lb mole
Isokinetic Variance:	105.4	%I	Excess Air:	34.404	%
			Gas Velocity, Vs:	56.822	fps
Test Length:	60.00	in mins.	Volumetric Flow:	506,251	acfm
Nozzle Diameter:	0.238	in inches	Volumetric Flow:	284,325	dscfm
Barometric Pressure:	29.26	in Hg	Volumetric Flow:	335,145	scfm

MOISTURE DETERMINATION

Initial Impinger Content:	3356.1	ml	Silica Initial Wt.	871.1	grams
Final Impinger Content:	3488.3	ml	Silica Final Wt.	880.8	grams
Impinger Difference:	132.2	ml	Silica Difference:	9.7	grams
Total Water Gain:	141.9		Moisture, Bws:	0.152	

Port-Point No.	Clock Time	Velocity Head Δp in. H2O	Orifice ΔH in. H2O	Actual Meter Vol. ft^3	Stack Temp °F	Meter Temp Inlet °F	Meter Temp Outlet °F	Probe Temp °F	Filter Exit Temp °F	Impinger Exit Temp °F
1-1	10:10:00	0.95	1.40	925.365	323	69	68	260	260	60
1-2	10:15:00	0.78	1.10	929.570	324	73	68	260	259	49
1-3	10:20:00	0.66	0.97	932.350	324	74	68	260	262	51
	10:25:00			935.155						
2-1	10:29:00	0.94	1.40	935.155	322	74	69	261	260	54
2-2	10:34:00	0.78	1.20	938.830	321	78	69	262	260	49
2-3	10:39:00	0.63	0.93	942.010	320	77	70	260	260	52
	10:44:00			944.926						
3-1	10:52:00	0.89	1.30	944.926	318	72	70	260	260	61
3-2	10:57:00	0.70	1.00	948.430	319	76	70	260	260	50
3-3	11:02:00	0.43	0.64	951.830	316	78	75	260	260	51
	11:07:00			954.416						
4-1	11:11:00	0.90	1.30	954.416	319	77	71	259	262	54
4-2	11:16:00	0.68	1.00	958.830	318	78	71	261	261	53
4-3	11:21:00	0.51	0.76	961.570	318	79	71	260	260	54
	11:26:00			964.147						
Total	1:00:00			38.782		75.4	70.0			
Average			1.08		320.2	72.7				
Min			0.64		316.0	68.0				
Max			1.40		324.0	79.0				

Impinger Weight Sheet - Run 2A

Client:	**Heidelberg Materials**
Facility:	**Union Bridge Cement Plant**
Test Location:	**Main Kiln Scrubber Stack**
Project #:	**M234208**
Date:	**10/19/2023**
Test Method:	**26A**
Weighed/Measured By:	**ELE**
Balance ID:	**S10-31**

Scale Calibration Check Date: **10/19/2023**

Scale Calibration Check (see QS-6.05C for procedure)

must be within ± 0.5g of certified mass

Certified Weight, grams	Result, grams
250	250.0
500	500.0
750	750.0

IMPINGER CONTENTS	FINAL MLS / GRAMS	INITIAL MLS / GRAMS	GAIN MLS / GRAMS
0.1N H2SO4	785.0	684.5	100.5
0.1N H2SO4	726.4	707.9	18.5
Empty	610.2	605.1	5.1
0.1N NaOH	649.2	641.3	7.9
0.1N NaOH	717.5	717.3	0.2
Silica Gel	880.8	871.1	9.7
	3,488.3	3,356.1	132.2
	Liquid Final	**Liquid Initial**	**Liquid Gain**
	880.8	871.1	9.7
	Silica Final	**Silica Initial**	**Silica Gain**

Run 3A - Method 26A

Client: Heidelberg Materials | **Date: 10/19/23**

Facility: Union Bridge Cement Plant | **Start Time: 11:55**

Test Location: Main Kiln Scrubber Stack | **End Time: 13:08**

Source Condition: Mill OFF

DRY GAS METER CONDITIONS			STACK CONDITIONS		
ΔH:	1.07	In. H_2O	Static Pressure	0.10	in. H_2O
Meter Temperature, Tm:	75.1	°F	Flue Pressure (Ps):	29.27	in. Hg. abs.
Sqrt ΔP:	0.843	In. H_2O	Carbon Dioxide:	29.03	%
Stack Temperature, Ts:	318.5	°F	Oxygen:	4.54	%
Meter Volume, Vm:	38.797	ft^3	Nitrogen:	66.43	%
Meter Volume, Vmstd:	37.236	dscf	Gas Weight dry, Md:	32.826	lb/lb mole
Meter Volume, Vwstd:	5.030	wscf	Gas Weight wet, Ms:	31.062	lb/lb mole
Isokinetic Variance:	103.0	%I	Excess Air:	34.930	%
			Gas Velocity, Vs:	55.644	fps
Test Length:	60.00	in mins.	Volumetric Flow:	495,753	acfm
Nozzle Diameter:	0.238	in inches	Volumetric Flow:	289,755	dscfm
Barometric Pressure:	29.26	in Hg	Volumetric Flow:	328,898	scfm

MOISTURE DETERMINATION

Initial Impinger Content:	3496.9	ml	Silica Initial Wt.	873.8	grams
Final Impinger Content:	3597.3	ml	Silica Final Wt.	880.2	grams
Impinger Difference:	100.4	ml	Silica Difference:	6.4	grams
Total Water Gain:	106.8		Moisture, Bws:	0.119	

Port-Point No.	Clock Time	Velocity Head Δp in. H2O	Orifice ΔH in. H2O	Actual Meter Vol. ft^3	Stack Temp °F	Meter Temp Inlet °F	Meter Temp Outlet °F	Probe Temp °F	Filter Exit Temp °F	Impinger Exit Temp °F
1-1	11:55:00	0.89	1.30	967.660	318	71	70	260	258	59
1-2	12:00:00	0.65	0.96	971.520	320	76	73	260	260	46
1-3	12:05:00	0.45	0.67	975.460	319	79	72	260	260	47
	12:10:00			977.620						
2-1	12:14:00	0.90	1.30	977.620	320	76	72	259	261	51
2-2	12:19:00	0.65	0.97	981.250	319	79	72	262	260	48
2-3	12:24:00	0.47	0.70	984.410	319	80	72	259	260	49
	12:29:00			986.679						
3-1	12:34:00	0.93	1.40	986.679	320	76	72	260	260	56
3-2	12:39:00	0.77	1.10	990.391	319	80	72	261	260	52
3-3	12:44:00	0.62	0.93	993.820	318	81	73	260	261	53
	12:49:00			996.659						
4-1	12:53:00	0.91	1.40	996.659	317	77	72	261	260	55
4-2	12:58:00	0.79	1.20	1000.150	317	80	73	260	259	54
4-3	13:03:00	0.62	0.93	1003.620	316	82	73	260	260	56
	13:08:00			1006.457						
Total	1:00:00			38.797		78.1	72.2			
Average			1.07		318.5	75.1				
Min			0.67		316.0	70.0				
Max			1.40		320.0	82.0				

Impinger Weight Sheet - Run 3A

Client:	**Heidelberg Materials**
Facility:	**Union Bridge Cement Plant**
Test Location:	**Main Kiln Scrubber Stack**
Project #:	**M234208**
Date:	**10/19/2023**
Test Method:	**26A**
Weighed/Measured By:	**ELE**
Balance ID:	**S10-31**

Scale Calibration Check Date: **10/19/2023**

Scale Calibration Check (see QS-6.05C for procedure)

must be within ± 0.5g of certified mass

Certified Weight, grams	Result, grams
250	250.0
500	500.0
750	750.0

IMPINGER CONTENTS	FINAL MLS / GRAMS	INITIAL MLS / GRAMS	GAIN MLS / GRAMS
0.1N H2SO4	821.2	736.9	84.3
0.1N H2SO4	693.3	678.9	14.4
Empty	669.9	668.6	1.3
0.1N NaOH	684.0	685.0	-1.0
0.1N NaOH	728.9	727.5	1.4
Silica Gel	880.2	873.8	6.4
	3,597.3	3,496.9	100.4
	Liquid Final	**Liquid Initial**	**Liquid Gain**
	880.2	873.8	6.4
	Silica Final	**Silica Initial**	**Silica Gain**

Client:	Heidelberg Materials		
Facility:	Union Bridge Cement Plant		
Test Location:	Main Kiln Scrubber Stack		
Project #:	M234208		
Test Method:	26A		
Test Engineer:	JVC		
Test Technician:	WJD		
	Run 1B	**Run 2B**	**Run 3B**
Temp ID:	CM25	CM25	CM25
Meter ID:	CM25	CM25	CM25
Pitot ID:	S8-058	S8-058	S8-058
Nozzle Diameter (Inches):	0.280	0.280	0.280
Meter Calibration Date:	10/5/2023	10/5/2023	10/5/2023
Meter Calibration Factor (Y):	0.982	0.982	0.982
Meter Orifice Setting (Delta H):	1.984	1.984	1.984
Nozzle Kit ID Number and Material:	Glass #1	Glass #1	Glass #1
Pitot Tube Coefficient:	0.839		
Probe Length (Feet):	6.0		
Probe Liner Material:	Glass		
Sample Plane:	Horizontal		
Port Length (Inches):	3.00		
Port Size (Diameter, Inches):	6.50		
Port Type:	Nipple		
Duct Shape:	Circular		
Diameter (Feet):	13.75		
Duct Area (Square Feet):	148.489		
Upstream Diameters:	5.0		
Downstream Diameters:	21.4		
Number of Ports Sampled:	4		
Number of Points per Port:	3		
Minutes per Point:	5.0		
Minutes per Reading:	5.0		
Total Number of Traverse Points:	12		
Test Length (Minutes):	60		
Train Type:	Anderson Box		
Source Condition:	Mill OFF		
Diluent Model/Serial Number:	Servomex 1440D1/3934		
Moisture Balance ID:	S10-31		
# of Runs	3		

Run 1B - Method 26A

Client: Heidelberg Materials | **Date: 10/19/23**
Facility: Union Bridge Cement Plant | **Start Time: 8:25**
Test Location: Main Kiln Scrubber Stack | **End Time: 9:40**
Source Condition: Mill OFF

DRY GAS METER CONDITIONS			STACK CONDITIONS		
ΔH:	2.51	in. H_2O	Static Pressure	0.10	in. H_2O
Meter Temperature, Tm:	64.9	°F	Flue Pressure (Ps):	29.26	in. Hg. abs.
Sqrt ΔP:	0.843	in. H_2O	Carbon Dioxide:	28.59	%
Stack Temperature, Ts:	321.8	°F	Oxygen:	4.44	%
Meter Volume, Vm:	51.776	ft^3	Nitrogen:	66.97	%
Meter Volume, Vmstd:	50.265	dscf	Gas Weight dry, Md:	32.752	lb/lb mole
Meter Volume, Vwstd:	7.922	wscf	Gas Weight wet, Ms:	30.744	lb/lb mole
Isokinetic Variance:	101.6	%I	Excess Air:	33.535	%
			Gas Velocity, Vs:	56.347	fps
Test Length:	60.00	in mins.	Volumetric Flow:	502,017	acfm
Nozzle Diameter:	0.280	in inches	Volumetric Flow:	286,410	dscfm
Barometric Pressure:	29.22	in Hg	Volumetric Flow:	331,550	scfm

MOISTURE DETERMINATION

Initial Impinger Content:	3525.4	ml	Silica Initial Wt.	857.2	grams
Final Impinger Content:	3679.4	ml	Silica Final Wt.	871.4	grams
Impinger Difference:	154.0	ml	Silica Difference:	14.2	grams
Total Water Gain:	168.2		Moisture, Bws:	0.136	

Port-Point No.	Clock Time	Velocity Head Δp in. H2O	Orifice ΔH in. H2O	Actual Meter Vol. ft^3	Stack Temp °F	Meter Temp Inlet °F	Meter Temp Outlet °F	Probe Temp °F	Filter Exit Temp °F	Impinger Exit Temp °F	
1-1	8:25:00	0.80	2.80	9.015	317	58	59	260	260	58	
1-2	8:30:00	0.74	2.60	13.610	319	60	59	261	260	60	
1-3	8:35:00	0.56	2.00	17.840	318	64	59	260	260	60	
	8:40:00			21.828							
2-1	8:45:00	0.81	2.80	21.828	321	64	61	259	260	61	
2-2	8:50:00	0.74	2.60	26.480	322	66	61	258	260	60	
2-3	8:55:00	0.58	2.00	30.770	321	69	62	261	260	55	
	9:00:00			34.764							
3-1	9:06:00	0.83	2.90	34.764	320	65	63	261	259	50	
3-2	9:11:00	0.75	2.60	39.500	325	70	64	258	260	50	
3-3	9:16:00	0.60	2.10	43.790	323	71	64	259	260	51	
	9:21:00			47.773							
4-1	9:25:00	0.81	2.90	47.773	325	72	66	261	260	55	
4-2	9:30:00	0.73	2.60	52.480	326	73	66	260	260	53	
4-3	9:35:00	0.61	2.20	56.870	325	74	67	258	259	54	
	9:40:00			60.791							
Total	1:00:00			51.776		67.2	62.6				
Average			2.51		321.8	64.9					
Min			2.00		317.0	58.0					
Max			2.90		326.0	74.0					

Impinger Weight Sheet - Run 1B

Client:	**Heidelberg Materials**
Facility:	**Union Bridge Cement Plant**
Test Location:	**Main Kiln Scrubber Stack**
Project #:	**M234208**
Date:	**10/19/2023**
Test Method:	**26A**
Weighed/Measured By:	**ELE**
Balance ID:	**S10-31**

Scale Calibration Check Date: **10/19/2023**

Scale Calibration Check (see QS-6.05C for procedure)

must be within ± 0.5g of certified mass

Certified Weight, grams	Result, grams
250	250.0
500	500.0
750	750.0

IMPINGER CONTENTS	FINAL MLS / GRAMS	INITIAL MLS / GRAMS	GAIN MLS / GRAMS
0.1N H2SO4	806.4	698.8	107.6
0.1N H2SO4	757.5	720.0	37.5
Empty	673.6	667.7	5.9
0.1N NaOH	716.6	713.8	2.8
0.1N NaOH	725.3	725.1	0.2
Silica Gel	871.4	857.2	14.2
	3,679.4	3,525.4	154.0
	Liquid Final	**Liquid Initial**	**Liquid Gain**
	871.4	857.2	14.2
	Silica Final	**Silica Initial**	**Silica Gain**

Run 2B - Method 26A

Client: Heidelberg Materials | **Date: 10/19/23**

Facility: Union Bridge Cement Plant | **Start Time: 10:10**

Test Location: Main Kiln Scrubber Stack | **End Time: 11:26**

Source Condition: Mill OFF

DRY GAS METER CONDITIONS			STACK CONDITIONS		
ΔH:	2.48	In. H_2O	Static Pressure	0.10	in. H_2O
Meter Temperature, Tm:	70.7	°F	Flue Pressure (Ps):	29.23	in. Hg. abs.
Sqrt ΔP:	0.831	In. H_2O	Carbon Dioxide:	28.91	%
Stack Temperature, Ts:	321.5	°F	Oxygen:	4.50	%
Meter Volume, Vm:	51.652	ft^3	Nitrogen:	66.6	%
Meter Volume, Vmstd:	49.594	dscf	Gas Weight dry, Md:	32.806	lb/lb mole
Meter Volume, Vwstd:	8.073	wscf	Gas Weight wet, Ms:	30.733	lb/lb mole
Isokinetic Variance:	102.1	%I	Excess Air:	34.404	%
			Gas Velocity, Vs:	55.610	fps
Test Length:	60.00	in mins.	Volumetric Flow:	495,450	acfm
Nozzle Diameter:	0.280	in inches	Volumetric Flow:	281,212	dscfm
Barometric Pressure:	29.22	in Hg	Volumetric Flow:	326,987	scfm

MOISTURE DETERMINATION

Initial Impinger Content:	3699.9	ml	Silica Initial Wt.	862.9	grams
Final Impinger Content:	3862.4	ml	Silica Final Wt.	871.8	grams
Impinger Difference:	162.5	ml	Silica Difference:	8.9	grams
Total Water Gain:	171.4		Moisture, Bws:	0.140	

Port-Point No.	Clock Time	Velocity Head Δp in. H2O	Orifice ΔH in. H2O	Actual Meter Vol. ft^3	Stack Temp °F	Meter Temp Inlet °F	Meter Temp Outlet °F	Probe Temp °F	Filter Exit Temp °F	Impinger Exit Temp °F
1-1	10:10:00	0.81	2.80	63.661	325	64	65	250	264	52
1-2	10:15:00	0.72	2.50	68.290	326	70	66	257	261	50
1-3	10:20:00	0.65	2.30	72.540	325	73	65	260	261	48
	10:25:00			76.682						
2-1	10:29:00	0.79	2.80	76.682	324	71	67	261	260	54
2-2	10:34:00	0.71	2.50	81.350	323	73	67	258	260	50
2-3	10:39:00	0.56	2.00	85.530	321	78	69	259	260	51
	10:44:00			89.594						
3-1	10:52:00	0.76	2.70	89.594	320	72	70	262	260	53
3-2	10:57:00	0.71	2.50	94.240	319	74	70	261	260	50
3-3	11:02:00	0.57	2.00	98.440	318	76	69	260	258	52
	11:07:00			102.526						
4-1	11:11:00	0.76	2.70	102.526	319	72	70	259	260	56
4-2	11:16:00	0.69	2.50	107.110	320	76	70	259	258	54
4-3	11:21:00	0.59	2,1	111.420	318	79	70	261	259	55
	11:26:00			115.313						
Total	1:00:00			51.652		73.2	68.2			
Average			2.48		321.5	70.7				
Min			2.00		318.0	64.0				
Max			2.80		326.0	79.0				

Impinger Weight Sheet - Run 2B

Client:	**Heidelberg Materials**
Facility:	**Union Bridge Cement Plant**
Test Location:	**Main Kiln Scrubber Stack**
Project #:	**M234208**
Date:	**10/19/2023**
Test Method:	**26A**
Weighed/Measured By:	**ELE**
Balance ID:	**S10-31**

Scale Calibration Check Date: **10/19/2023**

Scale Calibration Check (see QS-6.05C for procedure)

must be within ± 0.5g of certified mass

Certified Weight, grams	Result, grams
250	250.0
500	500.0
750	750.0

IMPINGER CONTENTS	FINAL MLS / GRAMS	INITIAL MLS / GRAMS	GAIN MLS / GRAMS
0.1N H2SO4	875.4	757.7	117.7
0.1N H2SO4	791.8	756.9	34.9
Empty	662.0	658.1	3.9
0.1N NaOH	762.2	759.8	2.4
0.1N NaOH	771.0	767.4	3.6
Silica Gel	871.8	862.9	8.9
	3,862.4	3,699.9	162.5
	Liquid Final	**Liquid Initial**	**Liquid Gain**
	871.8	862.9	8.9
	Silica Final	**Silica Initial**	**Silica Gain**

Run 3B - Method 26A

Client: Heidelberg Materials | **Date: 10/19/23**

Facility: Union Bridge Cement Plant | **Start Time: 11:55**

Test Location: Main Kiln Scrubber Stack | **End Time: 13:08**

Source Condition: Mill OFF

DRY GAS METER CONDITIONS			STACK CONDITIONS		
ΔH:	2.46	In. H_2O	Static Pressure	0.10	in. H_2O
Meter Temperature, Tm:	72.0	°F	Flue Pressure (Ps):	29.23	in. Hg. abs.
Sqrt ΔP:	0.823	In. H_2O	Carbon Dioxide:	29.03	%
Stack Temperature, Ts:	319.3	°F	Oxygen:	4.54	%
Meter Volume, Vm:	51.267	ft^3	Nitrogen:	66.43	%
Meter Volume, Vmstd:	49.103	dscf	Gas Weight dry, Md:	32.826	lb/lb mole
Meter Volume, Vwstd:	8.167	wscf	Gas Weight wet, Ms:	30.712	lb/lb mole
Isokinetic Variance:	102.3	%I	Excess Air:	34.930	%
			Gas Velocity, Vs:	55.004	fps
Test Length:	60.00	in mins.	Volumetric Flow:	490,046	acfm
Nozzle Diameter:	0.280	in inches	Volumetric Flow:	278,070	dscfm
Barometric Pressure:	29.22	in Hg	Volumetric Flow:	324,320	scfm

MOISTURE DETERMINATION

Initial Impinger Content:	3700.8	ml	Silica Initial Wt.	842.9	grams
Final Impinger Content:	3854.2	ml	Silica Final Wt.	862.9	grams
Impinger Difference:	153.4	ml	Silica Difference:	20.0	grams
Total Water Gain:	173.4		Moisture, Bws:	0.143	

Port-Point No.	Clock Time	Velocity Head Δp in. H2O	Orifice ΔH in. H2O	Actual Meter Vol. ft^3	Stack Temp °F	Meter Temp Inlet °F	Meter Temp Outlet °F	Probe Temp °F	Filter Exit Temp °F	Impinger Exit Temp °F
1-1	11:55:00	0.75	2.70	15.872	319	68	70	261	262	55
1-2	12:00:00	0.71	2.50	20.390	320	73	69	257	260	52
1-3	12:05:00	0.62	2.20	24.760	320	74	70	260	261	53
	12:10:00			28.734						
2-1	12:14:00	0.75	2.70	28.734	321	73	69	263	261	58
2-2	12:19:00	0.69	2.50	33.170	321	75	70	258	260	58
2-3	12:24:00	0.54	1.90	37.460	319	76	70	260	260	59
	12:29:00			41.295						
3-1	12:34:00	0.77	2.80	41.295	320	73	70	256	259	61
3-2	12:39:00	0.70	2.50	45.770	320	75	70	256	260	59
3-3	12:44:00	0.59		50.100	318	76	70	261	260	59
	12:49:00			54.238						
4-1	12:53:00	0.74	2.70	54.238	318	74	70	258	260	61
4-2	12:58:00	0.67	2.40	58.650	318	75	71	259	259	60
4-3	13:03:00	0.62	2.20	63.080	318	75	71	259	260	61
	13:08:00			67.139						
Total	1:00:00			51.267		73.9	70.0			
Average			2.46		319.3	72.0				
Min			1.90		318.0	68.0				
Max			2.80		321.0	76.0				

Impinger Weight Sheet - Run 3B

Client:	**Heidelberg Materials**
Facility:	**Union Bridge Cement Plant**
Test Location:	**Main Kiln Scrubber Stack**
Project #:	**M234208**
Date:	**10/19/2023**
Test Method:	**26A**
Weighed/Measured By:	**ELE**
Balance ID:	**S10-31**

Scale Calibration Check Date: **10/19/2023**

Scale Calibration Check (see QS-6.05C for procedure)

must be within ± 0.5g of certified mass

Certified Weight, grams	Result, grams
250	250.0
500	500.0
750	750.0

IMPINGER CONTENTS	FINAL MLS / GRAMS	INITIAL MLS / GRAMS	GAIN MLS / GRAMS
0.1N H2SO4	844.9	751.0	93.9
0.1N H2SO4	804.4	759.6	44.8
Empty	664.3	656.5	7.8
0.1N NaOH	771.5	767.7	3.8
0.1N NaOH	769.1	766.0	3.1
Silica Gel	862.9	842.9	20.0
	3,854.2 Liquid Final	3,700.8 Liquid Initial	153.4 Liquid Gain
	862.9 Silica Final	842.9 Silica Initial	20.0 Silica Gain

Client: Heidelberg Materials
Facility: Union Bridge Cement Plant
Project #: M234208
Test Location: Main Kiln Stack
Date: 10/19/23

Run 1

		FTIR Data						Analyzer Data
Spectrum	Time	H2O %	CO2 % (wet)	HCN ppmvw	HF ppmvw	Cell Temp	Pressure	O2 % (dry)
RUN 1_009302.LAB	8:25	13.33	24.94	3.96	0.10	190.94	0.97	4.44
RUN 1_009303.LAB	8:26	13.50	24.91	3.93	0.10	190.94	0.97	4.53
RUN 1_009304.LAB	8:27	13.42	24.96	3.86	0.10	191.01	0.97	4.44
RUN 1_009305.LAB	8:28	13.56	24.82	3.89	0.10	191.05	0.97	4.55
RUN 1_009306.LAB	8:29	13.37	24.79	3.86	0.10	191.05	0.97	4.57
RUN 1_009307.LAB	8:30	13.47	24.82	3.91	0.10	190.94	0.97	4.52
RUN 1_009308.LAB	8:31	13.51	24.84	3.82	0.10	190.94	0.97	4.55
RUN 1_009309.LAB	8:32	13.35	24.55	3.78	0.10	190.94	0.97	4.59
RUN 1_009310.LAB	8:33	13.47	24.59	3.92	0.10	190.94	0.97	4.57
RUN 1_009311.LAB	8:34	13.41	24.62	3.85	0.10	190.98	0.97	4.67
RUN 1_009312.LAB	8:35	13.48	24.66	3.89	0.10	191.05	0.97	4.64
RUN 1_009313.LAB	8:36	13.37	24.65	3.96	0.10	191.05	0.97	4.63
RUN 1_009314.LAB	8:37	13.39	24.67	3.90	0.10	191.03	0.97	4.57
RUN 1_009315.LAB	8:38	13.35	24.86	4.09	0.10	190.94	0.97	4.61
RUN 1_009316.LAB	8:39	13.30	24.84	4.02	0.10	191.04	0.97	4.51
RUN 1_009317.LAB	8:40	13.34	24.82	3.93	0.10	190.95	0.97	4.51
RUN 1_009318.LAB	8:41	13.36	24.75	3.86	0.10	190.99	0.97	4.46
RUN 1_009319.LAB	8:42	13.53	24.87	3.95	0.10	191.05	0.97	4.38
RUN 1_009320.LAB	8:43	13.45	24.79	3.95	0.10	191.04	0.97	4.43
RUN 1_009321.LAB	8:44	13.53	24.97	3.88	0.10	191.04	0.97	4.43
RUN 1_009322.LAB	8:45	13.43	24.99	3.94	0.10	190.94	0.97	4.48
RUN 1_009323.LAB	8:46	13.58	24.83	3.92	0.10	190.94	0.97	4.53
RUN 1_009324.LAB	8:47	13.33	24.78	3.92	0.10	190.94	0.97	4.60
RUN 1_009325.LAB	8:48	13.37	24.74	3.88	0.10	190.94	0.97	4.55
RUN 1_009326.LAB	8:49	13.35	24.54	3.90	0.10	190.94	0.97	4.56
RUN 1_009327.LAB	8:50	13.28	24.80	3.97	0.10	190.97	0.97	4.73
RUN 1_009328.LAB	8:51	13.25	24.84	3.90	0.10	191.14	0.97	4.68
RUN 1_009329.LAB	8:52	13.16	24.54	3.91	0.10	191.15	0.97	4.70
RUN 1_009330.LAB	8:53	13.28	24.61	3.87	0.10	191.05	0.97	4.78
RUN 1_009331.LAB	8:54	13.28	24.50	3.90	0.10	190.98	0.97	4.67
RUN 1_009332.LAB	8:55	13.36	24.38	3.92	0.10	190.98	0.97	4.69
RUN 1_009333.LAB	8:56	13.40	24.48	3.87	0.10	191.00	0.97	4.68
RUN 1_009334.LAB	8:57	13.47	24.59	3.93	0.10	190.94	0.97	4.53
RUN 1_009335.LAB	8:58	13.39	24.65	3.93	0.10	191.05	0.97	4.52
RUN 1_009336.LAB	8:59	13.54	24.82	3.99	0.10	191.05	0.97	4.57
RUN 1_009337.LAB	9:00	13.41	24.85	3.98	0.10	191.07	0.97	4.59
RUN 1_009338.LAB	9:01	13.49	24.59	3.82	0.10	190.99	0.97	4.51
RUN 1_009339.LAB	9:02	13.39	24.84	3.98	0.10	190.94	0.97	4.57
RUN 1_009340.LAB	9:03	13.51	24.76	3.85	0.10	190.98	0.97	4.43
RUN 1_009341.LAB	9:04	13.55	24.95	3.90	0.10	191.04	0.97	4.41
RUN 1_009342.LAB	9:05	13.56	24.92	3.92	0.10	190.98	0.97	4.43
RUN 1_009343.LAB	9:06	13.53	24.89	3.93	0.10	191.04	0.97	4.52
RUN 1_009344.LAB	9:07	13.57	24.59	3.85	0.10	190.94	0.97	4.50
RUN 1_009345.LAB	9:08	13.47	24.84	3.88	0.10	190.94	0.97	4.49
RUN 1_009346.LAB	9:09	13.52	24.84	3.90	0.10	191.01	0.97	4.52
RUN 1_009347.LAB	9:10	13.51	24.85	3.95	0.10	191.04	0.97	4.55
RUN 1_009348.LAB	9:11	13.50	24.73	3.93	0.10	190.94	0.97	4.54
RUN 1_009349.LAB	9:12	13.55	24.84	3.90	0.10	190.94	0.97	4.56
RUN 1_009350.LAB	9:13	13.54	24.55	3.87	0.10	190.95	0.97	4.64
RUN 1_009351.LAB	9:14	13.63	24.51	3.92	0.10	191.05	0.97	4.63
RUN 1_009352.LAB	9:15	13.58	24.62	3.97	0.10	191.02	0.97	4.54
RUN 1_009353.LAB	9:16	13.58	24.91	3.89	0.10	190.98	0.97	4.36
RUN 1_009354.LAB	9:17	13.60	24.83	3.92	0.10	191.02	0.97	4.54
RUN 1_009355.LAB	9:18	13.57	24.72	3.97	0.10	190.96	0.97	4.57
RUN 1_009356.LAB	9:19	13.58	24.47	3.92	0.10	191.04	0.97	4.64
RUN 1_009357.LAB	9:20	13.62	24.66	3.88	0.10	191.00	0.97	4.58
RUN 1_009358.LAB	9:21	13.58	24.67	3.85	0.10	191.04	0.97	4.50
RUN 1_009359.LAB	9:22	13.71	24.60	3.88	0.10	190.99	0.97	4.53
RUN 1_009360.LAB	9:23	13.76	24.61	3.93	0.10	191.01	0.97	4.51
RUN 1_009361.LAB	9:24	13.66	24.81	4.02	0.10	190.98	0.97	4.45
Average		**13.47**	**24.74**	**3.91**	**0.10**	**191.00**	**0.97**	**4.55**

Client: Heidelberg Materials
Facility: Union Bridge Cement Plant
Project #: M234208
Test Location: Main Kiln Stack
Date: 10/19/23

Run 2

		FTIR Data						Analyzer Data
Spectrum	Time	H2O %	CO2 % (wet)	HCN ppmvw	HF ppmvw	Cell Temp	Pressure	O2 % (dry)
RUN 2_009474.LAB	10:10	13.58	25.0	4.07	0.10	190.9	0.97	4.83
RUN 2_009475.LAB	10:11	13.58	24.9	4.06	0.10	190.9	0.97	4.79
RUN 2_009476.LAB	10:12	13.64	24.9	3.92	0.10	190.9	0.97	4.91
RUN 2_009477.LAB	10:13	13.66	24.9	4.09	0.10	190.9	0.97	4.79
RUN 2_009478.LAB	10:14	13.75	24.9	4.04	0.10	190.9	0.97	4.92
RUN 2_009479.LAB	10:15	13.79	24.6	3.99	0.10	191.0	0.97	4.89
RUN 2_009480.LAB	10:16	13.80	24.6	3.96	0.10	191.0	0.97	4.94
RUN 2_009481.LAB	10:17	13.79	24.6	3.98	0.10	191.0	0.97	4.93
RUN 2_009482.LAB	10:18	13.79	24.8	4.19	0.10	191.0	0.97	4.85
RUN 2_009483.LAB	10:19	13.72	24.8	4.15	0.10	191.0	0.97	4.87
RUN 2_009484.LAB	10:20	13.80	24.9	4.13	0.10	190.9	0.97	4.81
RUN 2_009485.LAB	10:21	13.71	25.1	4.10	0.10	190.9	0.97	4.75
RUN 2_009486.LAB	10:22	13.78	25.0	4.09	0.10	190.9	0.97	4.50
RUN 2_009487.LAB	10:23	13.73	25.0	4.06	0.10	191.0	0.97	4.35
RUN 2_009488.LAB	10:24	13.71	25.0	4.06	0.10	191.0	0.97	4.51
RUN 2_009489.LAB	10:25	13.75	25.0	4.05	0.10	191.0	0.97	4.37
RUN 2_009490.LAB	10:26	13.89	25.3	3.98	0.10	191.0	0.97	4.28
RUN 2_009491.LAB	10:27	13.98	25.2	4.02	0.10	191.1	0.97	4.27
RUN 2_009492.LAB	10:28	14.13	25.3	4.05	0.10	191.0	0.97	4.16
RUN 2_009493.LAB	10:29	14.12	25.2	4.03	0.10	191.0	0.97	4.18
RUN 2_009494.LAB	10:30	14.09	25.2	3.96	0.10	191.0	0.97	4.16
RUN 2_009495.LAB	10:31	14.07	25.0	3.97	0.10	191.0	0.97	4.20
RUN 2_009496.LAB	10:32	14.13	25.3	4.02	0.10	191.0	0.97	4.15
RUN 2_009497.LAB	10:33	14.01	25.1	4.04	0.10	191.0	0.97	4.16
RUN 2_009498.LAB	10:34	13.94	25.0	4.05	0.10	191.1	0.97	4.41
RUN 2_009499.LAB	10:35	13.79	25.0	4.08	0.10	191.1	0.97	4.49
RUN 2_009500.LAB	10:36	13.70	25.0	4.00	0.10	191.0	0.97	4.52
RUN 2_009501.LAB	10:37	13.60	24.7	3.94	0.10	191.0	0.97	4.48
RUN 2_009502.LAB	10:38	13.55	24.7	3.93	0.10	190.9	0.97	4.63
RUN 2_009503.LAB	10:39	13.60	24.7	4.02	0.10	190.9	0.97	4.80
RUN 2_009504.LAB	10:40	13.70	24.9	4.12	0.10	190.9	0.97	4.80
RUN 2_009505.LAB	10:41	13.82	24.6	3.95	0.10	191.0	0.97	4.71
RUN 2_009506.LAB	10:42	13.87	24.7	3.89	0.10	191.0	0.97	4.46
RUN 2_009507.LAB	10:43	13.93	24.8	3.94	0.10	191.0	0.97	4.55
RUN 2_009508.LAB	10:44	13.91	24.7	4.00	0.10	191.0	0.97	4.61
RUN 2_009509.LAB	10:45	13.92	24.6	3.96	0.10	191.0	0.97	4.73
RUN 2_009510.LAB	10:46	13.93	24.8	4.05	0.10	190.9	0.97	4.65
RUN 2_009511.LAB	10:47	13.94	24.8	4.03	0.10	190.9	0.97	4.68
RUN 2_009512.LAB	10:48	13.85	25.0	4.00	0.10	191.0	0.97	4.59
RUN 2_009513.LAB	10:49	13.99	25.0	4.08	0.10	191.0	0.97	4.57
RUN 2_009514.LAB	10:50	13.98	25.0	4.02	0.10	191.0	0.97	4.56
RUN 2_009515.LAB	10:51	13.94	25.0	4.03	0.10	191.0	0.97	4.54
RUN 2_009516.LAB	10:52	13.99	25.1	3.95	0.10	191.0	0.97	4.46
RUN 2_009517.LAB	10:53	13.96	25.2	3.91	0.10	191.0	0.97	4.42
RUN 2_009518.LAB	10:54	13.97	25.0	3.88	0.10	190.9	0.97	4.44
RUN 2_009519.LAB	10:55	14.06	25.1	3.92	0.10	190.9	0.97	4.43
RUN 2_009520.LAB	10:56	13.77	24.9	3.87	0.10	191.0	0.97	4.51
RUN 2_009521.LAB	10:57	13.91	24.8	3.97	0.10	191.0	0.97	4.62
RUN 2_009522.LAB	10:58	13.84	24.9	3.94	0.10	191.0	0.97	4.62
RUN 2_009523.LAB	10:59	13.82	24.9	3.91	0.10	191.0	0.97	4.62
RUN 2_009524.LAB	11:00	13.77	24.9	3.89	0.10	191.0	0.97	4.68
RUN 2_009525.LAB	11:01	13.82	24.8	3.83	0.10	191.0	0.97	4.72
RUN 2_009526.LAB	11:02	13.86	24.9	4.09	0.10	191.0	0.97	4.65
RUN 2_009527.LAB	11:03	13.97	24.8	4.18	0.10	191.0	0.97	4.73
RUN 2_009528.LAB	11:04	13.80	24.8	4.12	0.10	191.0	0.97	4.66
RUN 2_009529.LAB	11:05	13.70	24.8	4.10	0.10	190.9	0.97	4.71
RUN 2_009530.LAB	11:06	13.73	25.0	3.99	0.10	191.0	0.97	4.77
RUN 2_009531.LAB	11:07	13.68	24.9	4.07	0.10	191.0	0.97	4.80
RUN 2_009532.LAB	11:08	13.64	24.9	4.06	0.10	191.0	0.97	4.75
RUN 2_009533.LAB	11:09	13.58	25.1	4.06	0.10	191.0	0.97	4.82
Average		**13.83**	**24.91**	**4.01**	**0.10**	**191.01**	**0.97**	**4.60**

Client: Heidelberg Materials
Facility: Union Bridge Cement Plant
Project #: M234208
Test Location: Main Kiln Stack
Date: 10/19/23

Run 3

		FTIR Data						Analyzer Data
Spectrum	Time	H2O %	CO2 % (wet)	HCN ppmvw	HF ppmvw	Cell Temp	Pressure	O2 % (dry)
RUN 3_009654.LAB	11:55	13.47	25.1	4.1	0.10	191.0	0.97	4.68
RUN 3_009655.LAB	11:56	13.58	25.0	4.0	0.10	191.0	0.97	4.65
RUN 3_009656.LAB	11:57	13.55	25.3	4.2	0.10	191.0	0.97	4.53
RUN 3_009657.LAB	11:58	13.55	25.2	4.1	0.10	191.0	0.97	4.59
RUN 3_009658.LAB	11:59	13.68	25.2	4.1	0.10	191.0	0.97	4.55
RUN 3_009659.LAB	12:00	13.78	25.2	4.2	0.10	190.9	0.97	4.46
RUN 3_009660.LAB	12:01	13.66	25.2	4.1	0.10	190.9	0.97	4.48
RUN 3_009661.LAB	12:02	13.56	25.2	4.0	0.10	190.9	0.97	4.52
RUN 3_009662.LAB	12:03	13.57	25.1	4.1	0.10	190.9	0.97	4.62
RUN 3_009663.LAB	12:04	13.60	25.3	4.1	0.10	190.9	0.97	4.60
RUN 3_009664.LAB	12:05	13.55	25.1	4.1	0.10	191.0	0.97	4.67
RUN 3_009665.LAB	12:06	13.59	25.0	4.1	0.10	191.0	0.97	4.70
RUN 3_009666.LAB	12:07	13.58	25.1	4.0	0.10	191.0	0.97	4.67
RUN 3_009667.LAB	12:08	13.56	24.8	4.1	0.10	191.0	0.97	4.74
RUN 3_009668.LAB	12:09	13.58	24.9	4.0	0.10	191.0	0.97	4.84
RUN 3_009669.LAB	12:10	13.56	25.1	4.1	0.10	191.0	0.97	4.83
RUN 3_009670.LAB	12:11	13.58	25.2	4.1	0.10	191.0	0.97	4.70
RUN 3_009671.LAB	12:12	13.60	24.8	4.1	0.10	191.0	0.97	4.75
RUN 3_009672.LAB	12:13	13.59	24.9	4.1	0.10	191.0	0.97	4.84
RUN 3_009673.LAB	12:14	13.62	24.9	4.0	0.10	191.0	0.97	4.79
RUN 3_009674.LAB	12:15	13.64	25.0	4.0	0.10	191.0	0.97	4.69
RUN 3_009675.LAB	12:16	13.62	25.0	4.0	0.10	190.9	0.97	4.68
RUN 3_009676.LAB	12:17	13.69	25.1	4.0	0.10	190.9	0.97	4.72
RUN 3_009677.LAB	12:18	13.83	25.1	4.0	0.10	190.9	0.97	4.64
RUN 3_009678.LAB	12:19	13.82	25.0	4.0	0.10	191.0	0.97	4.58
RUN 3_009679.LAB	12:20	13.74	25.2	4.0	0.10	191.0	0.97	4.54
RUN 3_009680.LAB	12:21	13.76	25.2	4.0	0.10	191.0	0.97	4.52
RUN 3_009681.LAB	12:22	13.69	25.2	3.9	0.10	191.1	0.97	4.51
RUN 3_009682.LAB	12:23	13.71	25.2	3.9	0.10	191.1	0.97	4.45
RUN 3_009683.LAB	12:24	13.71	25.2	3.9	0.10	191.0	0.97	4.53
RUN 3_009684.LAB	12:25	13.67	25.0	3.9	0.10	190.9	0.97	4.46
RUN 3_009685.LAB	12:26	13.68	25.1	3.9	0.10	190.9	0.97	4.54
RUN 3_009686.LAB	12:27	13.65	24.9	3.9	0.10	190.9	0.97	4.61
RUN 3_009687.LAB	12:28	13.68	24.9	4.0	0.10	190.9	0.97	4.58
RUN 3_009688.LAB	12:29	13.69	24.9	3.9	0.10	190.9	0.97	4.65
RUN 3_009689.LAB	12:30	13.66	25.0	3.9	0.10	191.0	0.97	4.65
RUN 3_009690.LAB	12:31	13.62	24.9	4.0	0.10	191.0	0.97	4.67
RUN 3_009691.LAB	12:32	13.68	24.8	4.0	0.10	191.0	0.97	4.68
RUN 3_009692.LAB	12:33	13.73	24.8	4.1	0.10	191.0	0.97	4.73
RUN 3_009693.LAB	12:34	13.73	24.9	4.1	0.10	191.0	0.97	4.72
RUN 3_009694.LAB	12:35	13.64	25.0	4.1	0.10	191.1	0.97	4.75
RUN 3_009695.LAB	12:36	13.70	24.9	4.0	0.10	191.1	0.97	4.65
RUN 3_009696.LAB	12:37	13.74	25.2	4.0	0.10	190.9	0.97	4.61
RUN 3_009697.LAB	12:38	13.80	25.1	4.0	0.10	191.0	0.97	4.60
RUN 3_009698.LAB	12:39	13.75	25.0	4.0	0.10	191.0	0.97	4.65
RUN 3_009699.LAB	12:40	13.73	25.1	4.1	0.10	191.0	0.97	4.52
RUN 3_009700.LAB	12:41	13.76	25.2	4.0	0.10	191.0	0.97	4.54
RUN 3_009701.LAB	12:42	13.72	25.1	3.9	0.10	191.0	0.97	4.48
RUN 3_009702.LAB	12:43	13.75	25.3	4.0	0.10	191.0	0.97	4.48
RUN 3_009703.LAB	12:44	13.73	25.3	4.0	0.10	191.0	0.97	4.45
RUN 3_009704.LAB	12:45	13.86	25.2	4.1	0.10	191.0	0.97	4.50
RUN 3_009705.LAB	12:46	13.89	25.1	4.1	0.10	191.0	0.97	4.43
RUN 3_009706.LAB	12:47	13.82	25.2	4.0	0.10	191.0	0.97	4.43
RUN 3_009707.LAB	12:48	13.75	25.1	4.0	0.10	191.0	0.97	4.38
RUN 3_009708.LAB	12:49	13.76	25.0	4.0	0.10	191.1	0.97	4.44
RUN 3_009709.LAB	12:50	13.78	25.1	4.0	0.10	191.0	0.97	4.42
RUN 3_009710.LAB	12:51	13.75	25.0	3.9	0.10	190.9	0.97	4.46
RUN 3_009711.LAB	12:52	13.76	24.8	3.9	0.10	190.9	0.97	4.49
RUN 3_009712.LAB	12:53	13.81	24.9	4.0	0.10	191.0	0.97	4.38
RUN 3_009713.LAB	12:54	13.75	24.8	3.9	0.10	191.0	0.97	4.48
Average		**13.68**	**25.06**	**4.02**	**0.10**	**191.01**	**0.97**	**4.59**

Stratification Test Results Summary
Heidelberg Materials
Union Bridge Cement Plant
Main Kiln Stack
October 18, 2023

Number of Ports Sampled:	1
Number of Points per Port:	3
Total Number of Traverse Points:	3

Port No.	Point No.	Time	O_2%	Actual % Difference O_2%	Mean Difference O_2%
1	1	8:30	7.19	0.23	0.02
	2	8:35	7.27	0.88	0.06
	3	8:40	7.16	0.65	0.05
Average			**7.21**		

One point traverse (<5% difference)
Three point traverse (0.4, 1.2, and 2.0 meters), <10% difference
Twelve point traverse (Method 1 points) >10% difference

One point traverse (<0.3% mean difference)
Three point traverse (0.4, 1.2, and 2.0 meters), < 0.5% mean difference for O_2
Twelve point traverse (Method 1 points) >0.5% mean difference for O_2

Method 1 and 2 Cyclonic Flow Check Data

Project Number	M234208	**Source Condition:**	Mill ON
Client:	Heidelberg Materials	**Run No.:**	1
Facility:	Union Bridge Cement Plant	**Date:**	
Location:	Main Kiln Scrubber Stack	**Start Time:**	
Pitot ID:	S8-058-A	**End Time:**	
Pitot Coefficient:	0.834	**RM Testers:**	
Probe Length:	6	**Port Length:**	3.00

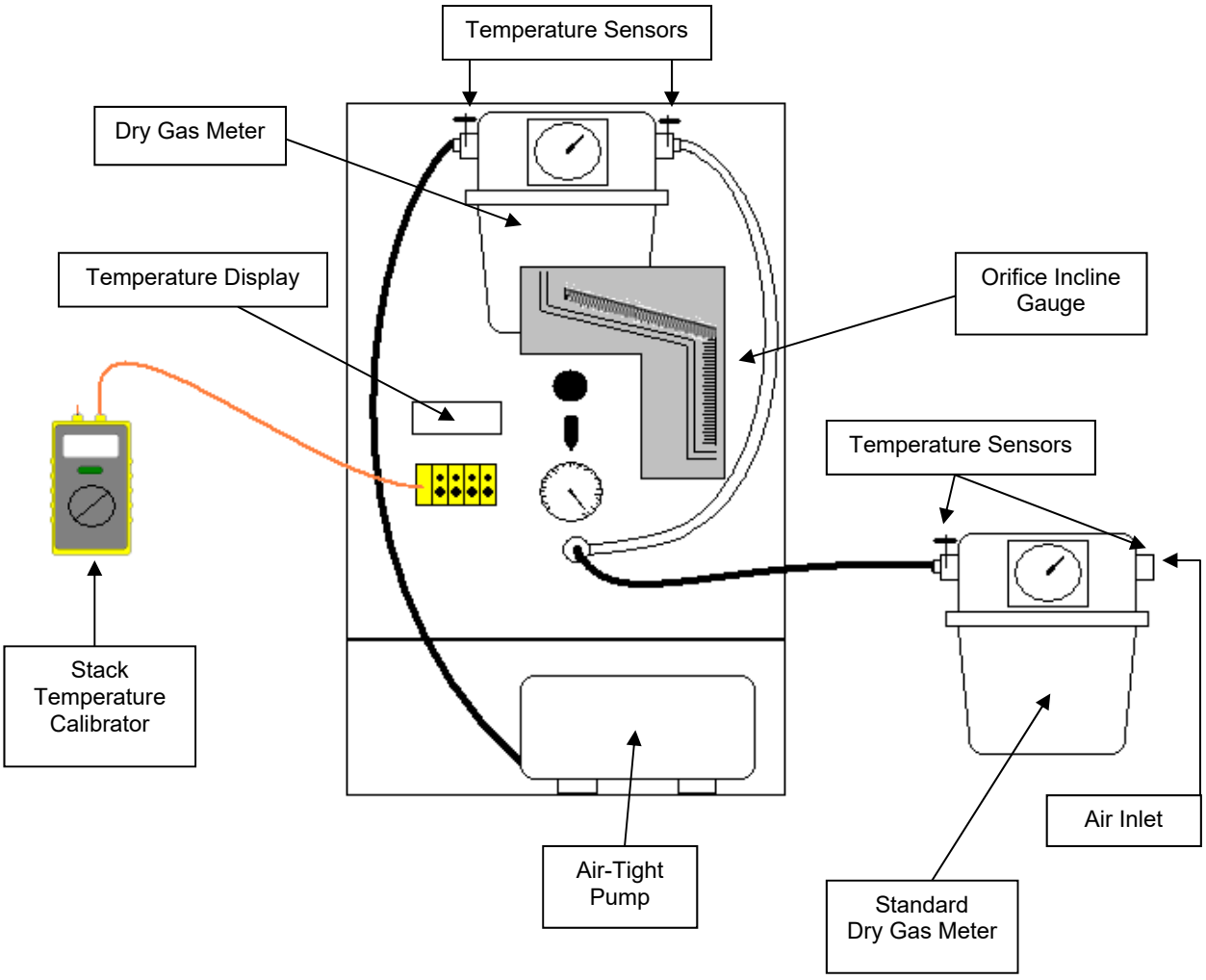
Port	Point	DP (in. H_2O)	Sqrt. DP	Temp (^oF)	Yaw (o)	
A	1	1.00	1.0000	325.0	5.0	5.0
A	2	0.97	0.9849	325.0	5.0	5.0
A	3	0.88	0.9381	325.0	10.0	10.0
B	1	1.10	1.0488	325.0	5.0	5.0
B	2	0.91	0.9539	324.0	5.0	5.0
B	3	0.81	0.9000	325.0	5.0	5.0

Port	Point	DP (in. H_2O)	Sqrt. DP	Temp (^oF)	Yaw (o)	
C	1	1.20	1.0954	325.0	5.0	5.0
C	2	0.92	0.9592	325.0	10.0	10.0
C	3	0.82	0.9055	325.0	5.0	5.0
D	1	1.10	1.0488	325.0	5.0	5.0
D	2	0.91	0.9539	325.0	5.0	5.0
D	3	0.81	0.9000	325.0	10.0	10.0

Average Yaw Angle 6.3 °

Appendix G - Calibration Data

Dry Gas Meter/Control Module Calibration Diagram



Dry Gas Meter Calibration Data

Dry Gas Meter No.	*CM25*	*Date:*	*October 5, 2023*
Standard Meter No.	*366118*	*Calibrated By:*	*NL*
Standard Meter (Y)	*0.99950*	*Barometric Pressure:*	*29.22*

Run Number		Orifice Setting in H_2O Chg (H)	Standard Meter Gas Volume vr	Dry Gas Meter Gas Volume vd	Standard Meter Temp. F^o tr	Dry Gas Meter Inlet Temp. F^o tdi	Dry Gas Meter Outlet Temp. F^o tdo	Dry Gas Meter Avg. Temp. F^o td	Time Min	Time Sec	Y	Chg (H)
Final			*104.262*	*35.625*	*73*	*75*	*74*					
Initial			*99.244*	*30.506*	*72*	*74*	*73*					
Difference	*1*	*0.20*	*5.018*	*5.119*	*73*	*75*	*74*	*74*	*20*	*45*	*0.982*	*1.982*
Final			*120.626*	*52.359*	*73*	*79*	*76*					
Initial			*115.545*	*47.145*	*73*	*77*	*76*					
Difference	*2*	*0.50*	*5.081*	*5.214*	*73*	*78*	*76*	*77*	*13*	*15*	*0.980*	*1.963*
Final			*131.650*	*63.642*	*73*	*80*	*77*					
Initial			*126.571*	*58.442*	*73*	*80*	*77*					
Difference	*3*	*0.70*	*5.079*	*5.200*	*73*	*80*	*77*	*79*	*11*	*10*	*0.985*	*1.948*
Final			*126.195*	*58.055*	*73*	*79*	*76*					
Initial			*121.200*	*52.944*	*73*	*78*	*77*					
Difference	*4*	*0.90*	*4.995*	*5.111*	*73*	*79*	*77*	*78*	*9*	*45*	*0.983*	*1.978*
Final			*115.132*	*46.733*	*73*	*79*	*76*					
Initial			*109.906*	*41.389*	*73*	*76*	*75*					
Difference	*5*	*1.20*	*5.226*	*5.344*	*73*	*78*	*76*	*77*	*8*	*55*	*0.981*	*2.019*
Final			*98.947*	*30.215*	*72*	*74*	*72*					
Initial			*93.760*	*24.965*	*71*	*71*	*70*					
Difference	*6*	*2.00*	*5.187*	*5.250*	*72*	*73*	*71*	*72*	*6*	*50*	*0.983*	*2.012*

Average	***0.982***	***1.984***

Stack Temperature Sensor Calibration			
Temperature ID :	100769	Name :	NL
Ambient Temperature, °F :	74.3	Date :	October 5, 2023

Temperature Calibrator			
Model # :	CL23A	Certification Date:	May 2, 2023
Serial # :	T-285668	Expiration Date:	May 1, 2024

Primary Standards Directly Traceable National Institute of Standards and Technology (NIST)

Reference Source Temperature (°F)	Test Thermometer Temperature (°F)	Temperature Difference %
0	-1	0.2
250	247	0.4
600	596	0.4
1200	1197	0.2

$$\frac{(\text{Ref. Temp., }^{o}\text{F} + 460) - (\text{Test Therm. Temp., }^{o}\text{F} + 460)}{\text{Ref. Temp., }^{o}\text{F} + 460} * 100 <= 1.5\ \%$$

Client: Heidelberg Materials
Facility: Union Bridge Cement Plant
Test Location: Main Kiln Scrubber Stack
Test Method: 26A
Meter ID: CM25

Alternative Method 5 Post Test Calibration - ALT-009

	Run Time (min):	Vm (dscf):	Tm (oR):	Pbar ("Hg):	DHavg ("H2O):	Md:	Orifice DH@:	Meter Yi:	Yqa:	Calibration Status:
Test Run 1	60	59.58	536.33	29.26	3.53	32.236	1.984	0.9820	0.970	
Test Run 2	60	60.34	526.79	29.26	3.63	32.1892	1.984	0.9820	0.963	**Pass**
Test Run 3	60	60.89	527.79	29.26	3.78	32.2308	1.984	0.9820	0.973	
								0.9820	0.969	

Dry Gas Meter Calibration Data

Dry Gas Meter No.	*CM27*	*Date:*	*October 6, 2023*
Standard Meter No.	*366118*	*Calibrated By:*	*ATW*
Standard Meter (Y)	*0.99950*	*Barometric Pressure:*	*29.24*

Run Number		Orifice Setting in H_2O Chg (H)	Standard Meter Gas Volume vr	Dry Gas Meter Gas Volume vd	Standard Meter Temp. F^o tr	Dry Gas Meter Inlet Temp. F^o tdi	Dry Gas Meter Outlet Temp. F^o tdo	Dry Gas Meter Avg. Temp. F^o td	Time Min	Time Sec	Y	Chg (H)
Final			*42.176*	*14.991*	*69*	*71*	*70*					
Initial			*37.105*	*9.865*	*68*	*70*	*69*					
Difference	*1*	*0.20*	*5.071*	*5.126*	*69*	*71*	*70*	*70*	*18*	*40*	*0.991*	*1.557*
Final			*53.363*	*26.326*	*69*	*74*	*72*					
Initial			*48.177*	*21.072*	*69*	*73*	*71*					
Difference	*2*	*0.50*	*5.186*	*5.254*	*69*	*74*	*72*	*73*	*12*	*0*	*0.992*	*1.534*
Final			*65.389*	*38.516*	*68*	*73*	*72*					
Initial			*60.072*	*33.122*	*68*	*73*	*72*					
Difference	*3*	*0.70*	*5.317*	*5.394*	*68*	*73*	*72*	*73*	*10*	*30*	*0.992*	*1.559*
Final			*59.326*	*32.369*	*68*	*74*	*72*					
Initial			*53.899*	*26.872*	*68*	*73*	*72*					
Difference	*4*	*0.90*	*5.427*	*5.497*	*68*	*74*	*72*	*73*	*9*	*30*	*0.993*	*1.574*
Final			*47.675*	*20.562*	*69*	*73*	*71*					
Initial			*42.482*	*15.305*	*68*	*71*	*71*					
Difference	*5*	*1.20*	*5.193*	*5.257*	*69*	*72*	*71*	*72*	*8*	*0*	*0.990*	*1.632*
Final			*36.820*	*9.580*	*68*	*71*	*69*					
Initial			*31.650*	*4.385*	*68*	*71*	*69*					
Difference	*6*	*2.00*	*5.170*	*5.195*	*68*	*71*	*69*	*70*	*6*	*15*	*0.993*	*1.677*

Average	***0.992***	***1.589***

Client: Heidelberg Materials
Facility: Union Bridge Cement Plant
Test Location: Main Kiln Scrubber Stack
Test Method: 26A
Meter ID: CM27

Alternative Method 5 Post Test Calibration - ALT-009

	Run Time (min):	Vm (dscf):	Tm (oR):	Pbar ("Hg):	DHavg ("H2O):	Md:	Orifice DH@:	Meter Yi:	Yqa:	Calibration Status:
Test Run 1	60	41.30	536.46	29.26	1.43	32.236	1.589	0.9920	0.999	
Test Run 2	60	44.94	535.42	29.26	1.64	32.1892	1.589	0.9920	0.982	**Pass**
Test Run 3	60	43.62	529.46	29.26	1.57	32.2308	1.589	0.9920	0.984	
								0.9920	0.988	

Airflow Sciences Corporation

Probe Calibration for Method 2

Data Collection and Analysis

Date:	9/21/2023
Temperature (^{o}F):	72.6
Pressure ("Hg):	29.48
Personnel:	wgj
Probe:	S8-058-A

Wind Tunnel Target DP [I.W.C]	Wind Tunnel Actual DP [I.W.C]	S-Probe DP [I.W.C.]	C_p	$C_{p(avg)}$	C_p-$C_{p(avg)}$	σ max	
0.81	0.81	1.15	0.831	0.832	0.000	0.000	Pass
0.81	0.81	1.15	0.832		0.000		
0.81	0.81	1.15	0.832		0.000		
1.81	1.82	2.55	0.837	0.837	0.000	0.001	Pass
1.81	1.82	2.55	0.837		0.000		
1.81	1.82	2.55	0.838		0.001		

Airflow Sciences Corporation

Probe Calibration for Method 2

Data Collection and Analysis

Date:	9/21/2023
Temperature (^{o}F):	72.6
Pressure ("Hg):	29.48
Personnel:	wgj
Probe:	S8-058-B

Wind Tunnel Target DP [I.W.C]	Wind Tunnel Actual DP [I.W.C]	S-Probe DP [I.W.C.]	C_p	$C_{p(avg)}$	C_p-$C_{p(avg)}$	σ max	
0.81	0.81	1.15	0.833	0.833	0.000	0.000	Pass
0.81	0.81	1.15	0.832		0.000		
0.81	0.81	1.15	0.833		0.000		
1.81	1.82	2.56	0.835	0.836	0.000	0.000	Pass
1.81	1.83	2.56	0.836		0.000		
1.81	1.83	2.56	0.836		0.000		

Airflow Sciences Corporation

Probe Calibration for Method 2

Wind Tunnel Facility:	Airflow Sciences Corporation
Wind Tunnel Location:	Livonia, MI
Probe Type:	S-Type Pitot
Probe ID:	S8-058-A
Probe Calibration Date:	09/21/23
Test Point Location:	center
Ambient Temperature (^oF):	72.6
Barometric Pressure ("Hg):	29.48

Repitition	Nominal Low Velocity Setting (ft/s)	Calibration Pitot		Tested Probe		Calculated C_p
		DP_{std} ("H_2O)	Temperature (^oF)	DP ("H_2O)	Yaw Angle (^{o})	
1	60	0.81	72.6	1.15	0	0.83
2	60	0.81	72.6	1.15	0	0.83
3	60	0.81	72.6	1.15	0	0.83
					Average ($C_{p(avg-low)}$)	0.83

Repitition	Nominal High Velocity Setting (ft/s)	Calibration Pitot		Tested Probe		Calculated C_p
		DP_{std} ("H_2O)	Temperature (^oF)	DP ("H_2O)	Yaw Angle (deg)	
1	90	1.82	72.6	2.55	0	0.84
2	90	1.82	72.6	2.55	0	0.84
3	90	1.82	72.6	2.55	0	0.84
					Average ($C_{p(avg-high)}$)	0.84

$$\% \text{ Difference} = \frac{C_{p(avg-low)} - C_{p(avg-high)}}{C_{p(avg-low)}} \times 100\% = \textbf{-0.67\%}$$ **Pass**

Note: (1) The percent difference between the low and high velocity setting C_p values shall be within +/- 3 %.
(2) If calibrating a 3-D probe for this method, the pitch angle setting must be 0^o.

C_p = 0.834

Airflow Sciences Corporation

Probe Calibration for Method 2

Wind Tunnel Facility:	Airflow Sciences Corporation
Wind Tunnel Location:	Livonia, MI
Probe Type:	S-Type Pitot
Probe ID:	S8-058-B
Probe Calibration Date:	09/21/23
Test Point Location:	center
Ambient Temperature (^oF):	72.6
Barometric Pressure ("Hg):	29.48

Repitition	Nominal Low Velocity Setting (ft/s)	Calibration Pitot		Tested Probe		Calculated C_p
		DP_{std} ("H_2O)	Temperature (^oF)	DP ("H_2O)	Yaw Angle (^{o})	
1	60	0.81	72.6	1.15	0	0.83
2	60	0.81	72.6	1.15	0	0.83
3	60	0.81	72.6	1.15	0	0.83
					Average ($C_{p(avg-low)}$)	0.83

Repitition	Nominal High Velocity Setting (ft/s)	Calibration Pitot		Tested Probe		Calculated C_p
		DP_{std} ("H_2O)	Temperature (^oF)	DP ("H_2O)	Yaw Angle (deg)	
1	90	1.82	72.6	2.56	0	0.84
2	90	1.83	72.6	2.56	0	0.84
3	90	1.83	72.6	2.56	0	0.84
					Average ($C_{p(avg-high)}$)	0.84

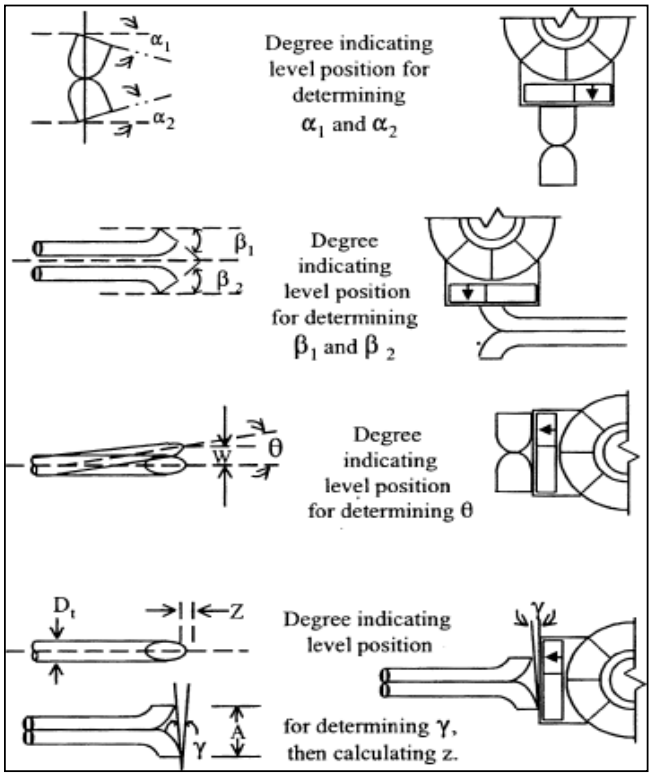
$$\% \text{ Difference} = \frac{C_{p(avg-low)} - C_{p(avg-high)}}{C_{p(avg-low)}} \times 100\% = \textbf{-0.37\%}$$ **Pass**

Note: (1) The percent difference between the low and high velocity setting C_p values shall be within +/- 3 %.
(2) If calibrating a 3-D probe for this method, the pitch angle setting must be 0^o.

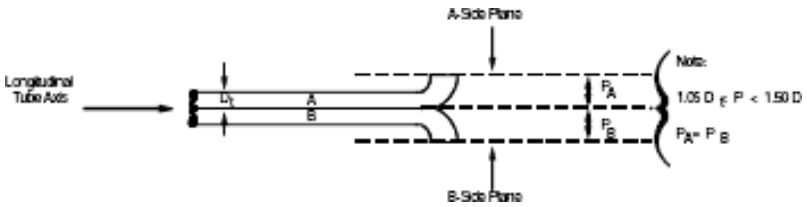
C_p = 0.834

Airflow Sciences Corporation

Probe Inspection for Method 2G



α_1	0.4 (°)	Pass
α_2	0.5 (°)	Pass
β_1	0.3 (°)	Pass
β_2	0.3 (°)	Pass
D_t	0.375 (")	Pass
P_a	0.474 (")	Pass
P_b	0.474 (")	Pass
z	<0.02 (")	Pass
w	0.007 (")	Pass



Certification

I certify that Type S probe ID **S8-058** meets or exceeds all specifications, criteria, and applicable design features.

Certified by: W Jambeck Date: 9/21/2023

Airflow Sciences Corporation

Probe Calibration for Method 2

Data Collection and Analysis

Date:	9/21/2023
Temperature (^{o}F):	72.8
Pressure ("Hg):	29.48
Personnel:	wgj
Probe:	S8-059-A

Wind Tunnel Target DP [I.W.C]	Wind Tunnel Actual DP [I.W.C]	S-Probe DP [I.W.C.]	C_p	$C_{p(avg)}$	C_p-$C_{p(avg)}$	σ max	
0.81	0.81	1.13	0.838	0.838	0.000	0.000	Pass
0.81	0.81	1.14	0.837		0.000		
0.81	0.81	1.14	0.838		0.000		
1.81	1.81	2.51	0.840	0.840	0.000	0.000	Pass
1.81	1.81	2.51	0.840		0.000		
1.81	1.81	2.51	0.840		0.000		

Airflow Sciences Corporation

Probe Calibration for Method 2

Data Collection and Analysis

Date:	9/21/2023
Temperature (^{o}F):	73.1
Pressure ("Hg):	29.47
Personnel:	wgj
Probe:	S8-059-B

Wind Tunnel Target DP [I.W.C]	Wind Tunnel Actual DP [I.W.C]	S-Probe DP [I.W.C.]	C_p	$C_{p(avg)}$	C_p-$C_{p(avg)}$	σ max	
0.81	0.81	1.16	0.828	0.828	0.000	0.000	Pass
0.81	0.81	1.16	0.828		0.000		
0.81	0.81	1.16	0.828		0.000		
1.81	1.81	2.58	0.829	0.829	0.000	0.000	Pass
1.81	1.81	2.58	0.829		0.000		
1.81	1.81	2.58	0.829		0.000		

Airflow Sciences Corporation

Probe Calibration for Method 2

Wind Tunnel Facility:	Airflow Sciences Corporation
Wind Tunnel Location:	Livonia, MI
Probe Type:	S-Type Pitot
Probe ID:	S8-059-A
Probe Calibration Date:	09/21/23
Test Point Location:	center
Ambient Temperature (^oF):	72.8
Barometric Pressure ("Hg):	29.48

Repitition	Nominal Low Velocity Setting (ft/s)	Calibration Pitot		Tested Probe		Calculated C_p
		DP_{std} ("H_2O)	Temperature (^oF)	DP ("H_2O)	Yaw Angle (^{o})	
1	60	0.81	72.8	1.13	0	0.84
2	60	0.81	72.8	1.14	0	0.84
3	60	0.81	72.8	1.14	0	0.84
					Average ($C_{p(avg-low)}$)	0.84

Repitition	Nominal High Velocity Setting (ft/s)	Calibration Pitot		Tested Probe		Calculated C_p
		DP_{std} ("H_2O)	Temperature (^oF)	DP ("H_2O)	Yaw Angle (deg)	
1	90	1.81	72.8	2.51	0	0.84
2	90	1.81	72.8	2.51	0	0.84
3	90	1.81	72.8	2.51	0	0.84
					Average ($C_{p(avg-high)}$)	0.84

$$\% \text{ Difference} = \frac{C_{p(avg-low)} - C_{p(avg-high)}}{C_{p(avg-low)}} \times 100\% = \textbf{-0.30\%}$$ **Pass**

Note: (1) The percent difference between the low and high velocity setting C_p values shall be within +/- 3 %.
(2) If calibrating a 3-D probe for this method, the pitch angle setting must be 0^o.

C_p = 0.839

Airflow Sciences Corporation

Probe Calibration for Method 2

Wind Tunnel Facility:	Airflow Sciences Corporation
Wind Tunnel Location:	Livonia, MI
Probe Type:	S-Type Pitot
Probe ID:	S8-059-B
Probe Calibration Date:	09/21/23
Test Point Location:	center
Ambient Temperature (^oF):	73.1
Barometric Pressure ("Hg):	29.47

Repitition	Nominal Low Velocity Setting (ft/s)	Calibration Pitot		Tested Probe		Calculated C_p
		DP_{std} ("H_2O)	Temperature (^oF)	DP ("H_2O)	Yaw Angle (^{o})	
1	60	0.81	73.1	1.16	0	0.83
2	60	0.81	73.1	1.16	0	0.83
3	60	0.81	73.1	1.16	0	0.83
					Average ($C_{p(avg-low)}$)	0.83

Repitition	Nominal High Velocity Setting (ft/s)	Calibration Pitot		Tested Probe		Calculated C_p
		DP_{std} ("H_2O)	Temperature (^oF)	DP ("H_2O)	Yaw Angle (deg)	
1	90	1.81	73.1	2.58	0	0.83
2	90	1.81	73.1	2.58	0	0.83
3	90	1.81	73.1	2.58	0	0.83
					Average ($C_{p(avg-high)}$)	0.83

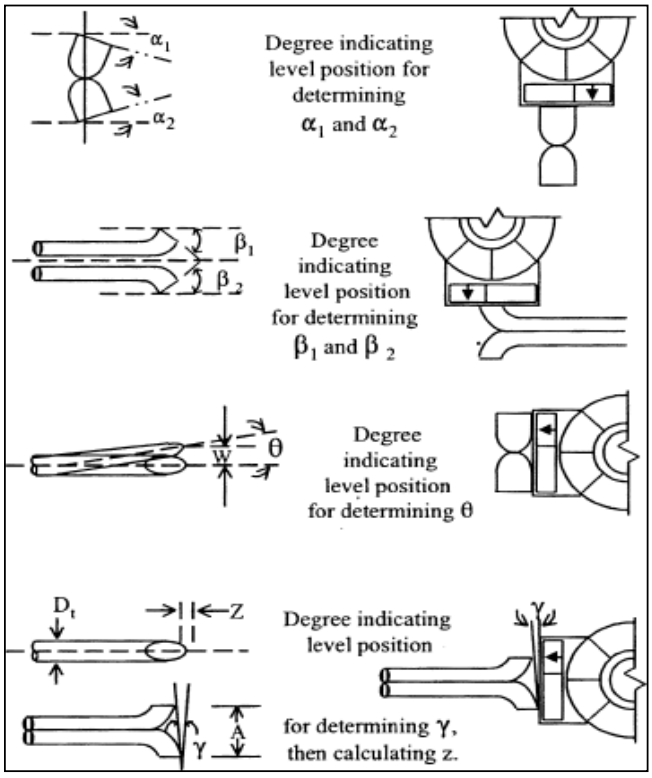
$$\% \text{ Difference} = \frac{C_{p(avg-low)} - C_{p(avg-high)}}{C_{p(avg-low)}} \times 100\% = \textbf{-0.17\%}$$ **Pass**

Note: (1) The percent difference between the low and high velocity setting C_p values shall be within +/- 3 %.
(2) If calibrating a 3-D probe for this method, the pitch angle setting must be 0^o.

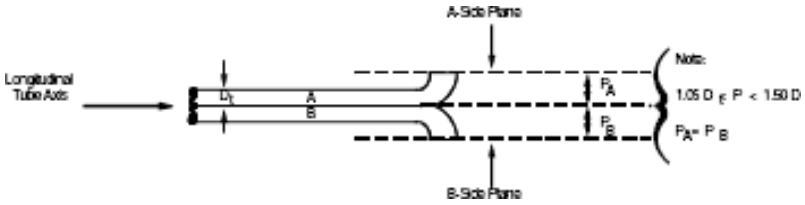
C_p = 0.829

Airflow Sciences Corporation

Probe Inspection for Method 2G



α_1	0.9 (°)	Pass
α_2	0.5 (°)	Pass
β_1	0.7 (°)	Pass
β_2	0.9 (°)	Pass
D_t	0.375 (")	Pass
P_a	0.471 (")	Pass
P_b	0.471 (")	Pass
z	<0.02 (")	Pass
w	0.005 (")	Pass



Certification

I certify that Type S probe ID **S8-059** meets or exceeds all specifications, criteria, and applicable design features.

Certified by: W Jambeck Date: 9/21/2023

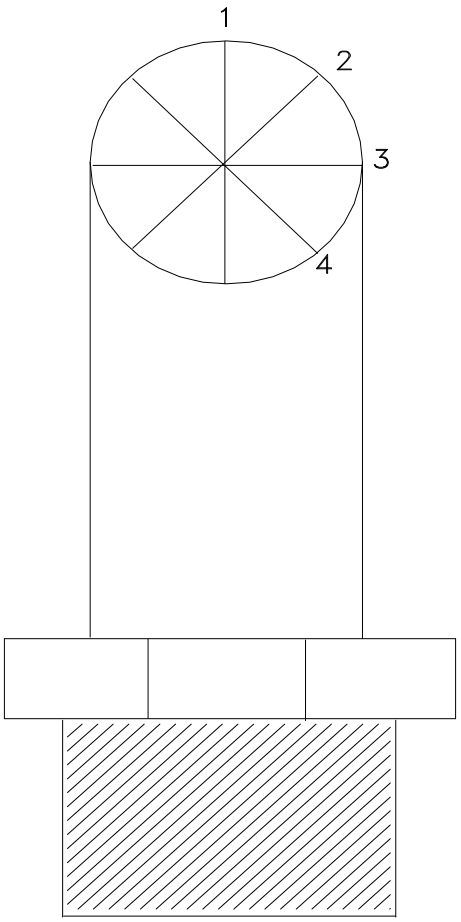
Nozzle Calibration

Date: 9/24/2019

Nozzle ID No.: 585

Analyst: DFB

Material/Type: Glass



0.238	1
0.237	2
0.238	3
0.237	4

Valid Data

Average
0.238

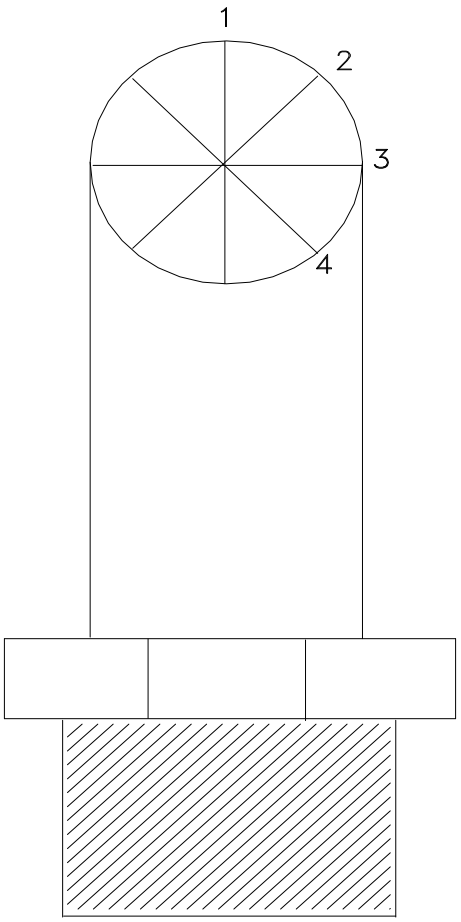
Nozzle Calibration

Date: 9/10/2019

Nozzle ID No.: 822

Analyst: CRR

Material/Type: Glass



0.280	1
0.280	2
0.280	3
0.281	4

Valid Data

Average
0.280

Client: Heidelberg Materials
Facility: Union Bridge Cement Plant
Project #: M234208
Test Location: Main Kiln Stack
Date: 10/18/2023
Operator: E. Ehlers
Operating Condition Mill on/>90% Production

Sample System:	FTIR			
Probe Length:	12.0	**ft**		
Probe Type:	FTIR			
Sample Plane:	Vertical			
Port Length:	3.5	**in.**		
Port Size (diameter):	6.5	**in.**		
Port Type:	Nipple			
Duct Shape:	Circular			
Diameter:	13.75	**ft**		
Duct Area:	148.49	**Sq. Ft.**		
Upstream Diameters:	5.00		Minimum Upstream Distance	6.9 Feet
Downstream Diameters:	21.40		Minimum Downstream Distance	27.5 Feet
Number of Ports Sampled:	1		Ideal Upstream Distance	27.5 Feet
Number of Points per Port:	1		Ideal Downstream Distance	110.0 Feet
Total Number of Traverse Points:	1			

Calibration Gases

Type	Setting	Cylinder ID	Cylinder Value	Analyzer Response	Difference, % of Span	Expiration Date	Mid cylinder % of high cylinder	Final Bottle Pressure, PSI
O2 % (dry)	Zero		0.0	0.03	-0.16%			1500
	Mid	LL45315	10.05	10.07	-0.10%	9/21/2031	52.54%	1800
	High	SG9154241BAL	19.13	19.02	0.58%	10/31/2030		1950

Type	Compound	Cylinder ID	Cylinder Value	Expiration Date	Final Bottle Pressure, PSI
Zero Gas	Nitrogen	Zero Nitrogen	0.0	N/A	
Calibration Transfer Standard	Ethylene	EB0153589	99.97	9/6/2031	
Analyte Spike Gas	HCN	CC768249	49.72	3/11/2024	
	SF6		5.022		

Response Time Data

Type	RM Analyzer Make/Model	RM Analyzer s/n	Analyzer Span	RM Gas Span
O2 % (dry)	Servomex 1440D	3934	25	19.13
HCN ppmvw	MKS 2030		100	N/A

Client: Heidelberg Materials
Facility: Union Bridge Cement Plant
Project #: M234208
Diluent: O2 %

Test Location: Main Kiln Stack
Date: 10/18/23
Operator: E. Ehlers
O2 % Correction: 7

O2 % (dry) Correction Data

Run #	Cma	Precal	Postcal	Pre zero	Post zero	Co	Cm	C	Cgas	Span Bias	Span Drift	Zero Bias	Zero Drift
1	10.050	10.08	10.05	0.05	0.04	0.05	10.07	7.20	7.2	0.10	-0.16	-0.05	-0.05
2	10.05	10.05	10.14	0.04	0.09	0.07	10.10	7.26	7.2	-0.37	0.47	-0.31	0.26
3	10.05	10.14	10.10	0.09	0.07	0.08	10.12	7.20	7.1	-0.16	-0.21	-0.21	-0.10

Concentration of Cal Gas C = Average value of test Co=Average Pre and Post Zero
erage Pre and Post Span Cgas = Corrected gas value of test

Calibration Corrected and Calculated Data

Run #	Run Date	Start Time	End Time	Moisture %	O2 % (dry)	CO2 % (wet)	CO2 % (dry)	HCN ppmvw	HCN ppmvd @ 7% O2	HF ppmvw	HF ppmvd @ 7% O2
1	10/18/23	8:30	9:29	10.92%	7.18	21.98	24.68	3.60	4.09	0.10	0.11
2	10/18/23	10:15	11:14	11.38%	7.21	21.61	24.38	3.40	3.89	0.10	0.11
3	10/18/23	12:05	17:43	11.93%	7.13	21.72	24.66	3.17	3.63	0.10	0.11

Client: Heidelberg Materials
Facility: Union Bridge Cement Plant
Test Location: Main Kiln Stack
Date: 10/18/23
Project #: M234208

Time	Linearity Cal/Pre 1 Cal O2 % (dry)	
7:47	0.09	
7:48	0.11	
7:49	0.12	
7:50	0.13	
7:51	6.37	
7:52	16.88	
7:53	19.02	ih
7:54	18.86	
7:55	6.62	
7:56	0.04	
7:57	0.03	
7:58	3.11	
7:59	0.03	
8:00	3.54	
8:01	0.04	
8:02	0.03	iz
8:03	6.75	
8:04	15.40	
8:05	10.64	
8:06	10.08	
8:07	10.07	im
8:08	12.32	
8:09	2.90	
8:10	0.07	
8:11	0.06	
8:12	0.66	
8:13	0.05	z
8:14	2.89	
8:15	10.06	
8:16	10.08	m

Client: Heidelberg Materials
Facility: Union Bridge Cement Plant
Project #: M234208
Test Location: Main Kiln Stack
Date: 10/18/23

Post 1/Pre 2			Post 2/Pre 3		
Time	O2 % (dry)		Time	O2 % (dry)	
9:44	10.05	m	11:31	0.09	z
9:45	9.82		11:32	0.09	
9:46	0.61		11:33	0.09	
9:47	0.05		11:34	6.77	
9:48	0.05		11:35	10.14	m
9:49	0.04				
9:50	0.04				
9:51	0.04	z			

Post 3		
Time	O2 % (dry)	
18:03	0.08	
18:04	0.07	z
18:05	8.57	
18:06	10.08	
18:07	10.10	m

Client: Heidelberg Materials
Facility: Union Bridge Cement Plant
Project #: M234208
Operating Condition: Mill on/>90% Production

Test Location: Main Kiln Stack
Date: 10/18/2023
Operator: E. Ehlers
FTIR s/n: 0

System Leak Check: 0.0 mL/min

Nitrogen (Zero) Direct to FTIR

Spectrum	Date	Time	H2O% %v	CO2 %v wet	HF ppmv wet	FTIR Gas Cell Temperature deg C	FTIR Gas Cell Pressure atm	Ethylene ppmv wet	HCN ppmv wet	SF6 ppmv wet
N2 DIR_007488.LAB	10/18/23	7:23:01	0.0	0.0	0.0	191.0	0.98	0.1	0.0	0.002
N2 DIR_007489.LAB	10/18/23	7:23:09	0.0	0.0	0.0	191.0	0.98	0.0	0.1	0.004
N2 DIR_007490.LAB	10/18/23	7:23:17	0.0	0.0	0.0	191.0	0.98	0.0	0.0	0.007
N2 DIR_007491.LAB	10/18/23	7:23:25	0.0	0.0	-0.1	191.0	0.98	0.1	0.0	0.001
N2 DIR_007492.LAB	10/18/23	7:23:34	0.0	0.0	-0.1	191.0	0.98	-0.1	0.0	0.009
N2 DIR_007493.LAB	10/18/23	7:23:42	0.0	0.0	0.0	191.0	0.98	0.0	0.1	0.000
N2 DIR_007494.LAB	10/18/23	7:23:50	0.0	0.0	0.0	191.0	0.98	0.0	0.0	0.002
N2 DIR_007495.LAB	10/18/23	7:23:58	0.0	0.0	0.0	191.0	0.98	0.1	0.0	0.001
N2 DIR_007496.LAB	10/18/23	7:24:06	0.0	0.0	0.0	191.0	0.98	0.0	0.0	0.003

Calibration Transfer Standard (CTS), Direct to FTIR

Spectrum	Date	Time	H2O% %v	CO2 %v wet	HF ppmv wet	FTIR Gas Cell Temperature deg C	FTIR Gas Cell Pressure atm	Ethylene ppmv wet	HCN ppmv wet	SF6 ppmv wet	Recovery % Ethylene
CTS DIR_007676.LAB	10/18/23	7:58:52	0.0	0.0	0.0	191.1	0.98	99.6	0.0	0.004	**99.6%**
CTS DIR_007677.LAB	10/18/23	7:59:00	0.0	0.0	0.0	191.1	0.98	99.2	0.0	0.001	**99.3%**
CTS DIR_007678.LAB	10/18/23	7:59:08	0.0	0.0	0.0	191.1	0.98	99.4	0.1	0.001	**99.5%**
CTS DIR_007679.LAB	10/18/23	7:59:16	0.0	0.0	0.0	191.2	0.98	99.3	0.0	0.002	**99.4%**
CTS DIR_007680.LAB	10/18/23	7:59:25	0.0	0.0	0.0	191.2	0.98	99.3	-0.1	0.009	**99.3%**
CTS DIR_007681.LAB	10/18/23	7:59:33	0.0	0.0	0.0	191.1	0.98	99.2	0.0	0.007	**99.2%**
CTS DIR_007682.LAB	10/18/23	7:59:41	0.0	0.0	0.0	191.1	0.97	99.5	0.0	0.001	**99.5%**
	Average							**99.4**			**99.4%**

Analyte Spike Gas (HCN) Direct to FTIR

Spectrum	Date	Time	H2O% %v	CO2 %v wet	HF ppmv wet	FTIR Gas Cell Temperature deg C	FTIR Gas Cell Pressure atm	Ethylene ppmv wet	HCN ppmv wet	SF6 ppmv wet
HCN DIR_007706.LAB	10/18/23	8:03:16	0.0	0.0	0.0	191.0	0.98	-0.4	49.8	4.927
HCN DIR_007707.LAB	10/18/23	8:03:24	0.0	0.0	0.0	191.0	0.98	-0.3	49.8	4.917
HCN DIR_007708.LAB	10/18/23	8:03:32	0.0	0.0	-0.1	191.0	0.98	-0.3	50.1	4.885
HCN DIR_007709.LAB	10/18/23	8:03:41	0.0	0.0	0.0	191.0	0.97	-0.3	50.8	4.858
HCN DIR_007710.LAB	10/18/23	8:03:49	0.0	0.0	0.0	191.0	0.98	-0.2	50.6	4.847
HCN DIR_007711.LAB	10/18/23	8:03:57	0.0	0.0	0.0	190.9	0.98	-0.4	50.6	4.849
HCN DIR_007712.LAB	10/18/23	8:04:05	0.0	0.0	0.0	190.9	0.98	-0.3	50.5	4.854
HCN DIR_007713.LAB	10/18/23	8:04:14	0.0	0.0	-0.1	191.0	0.98	-0.2	50.6	4.858
	Average								**50.3**	**4.874**

CTS, System Purge

Spectrum	Date	Time	H2O% %v	CO2 %v wet	HF ppmv wet	FTIR Gas Cell Temperature deg C	FTIR Gas Cell Pressure atm	Ethylene ppmv wet	HCN ppmv wet	SF6 ppmv wet	Recovery % Ethylene
CTS REMOTE_007768.LAB	10/18/23	8:12:57	0.0	0.0	-0.1	191.0	0.98	98.7	0.0	0.007	**98.7%**
CTS REMOTE_007769.LAB	10/18/23	8:13:05	0.0	0.0	0.0	191.0	0.98	98.9	0.0	0.004	**98.9%**
CTS REMOTE_007770.LAB	10/18/23	8:13:13	0.0	0.0	0.0	191.0	0.98	98.9	0.0	0.000	**99.5%**
CTS REMOTE_007771.LAB	10/18/23	8:13:21	0.0	0.0	0.0	191.0	0.98	98.8	0.0	0.002	**99.4%**
CTS REMOTE_007772.LAB	10/18/23	8:13:30	0.0	0.0	-0.1	191.1	0.98	99.1	0.0	0.004	**99.7%**
CTS REMOTE_007773.LAB	10/18/23	8:13:38	0.0	0.0	-0.1	191.1	0.98	99.0	0.0	0.010	**99.6%**
CTS REMOTE_007774.LAB	10/18/23	8:13:46	0.0	0.0	0.0	191.1	0.98	99.1	0.1	-0.002	**99.8%**
CTS REMOTE_007775.LAB	10/18/23	8:13:54	0.0	0.0	0.0	191.1	0.98	98.9	0.0	0.003	**99.6%**

Response Time Test

Spectrum	Date	Time	H2O% %v	CO2 %v wet	HF ppmv wet	FTIR Gas Cell Temperature deg C	FTIR Gas Cell Pressure atm	Ethylene ppmv wet	HCN ppmv wet	SF6 ppmv wet	Response Time (sec)
N2 REMOTE_007763.LAB	10/18/23	8:11:53	0.0	0.0	-0.1	191.0	0.98	0.2	0.0	0.005	-
N2 REMOTE_007764.LAB	10/18/23	8:12:01	0.1	0.5	-0.1	191.0	0.98	0.2	0.2	0.002	**16.214**
CTS REMOTE_007765.LAB	10/18/23	8:12:32	0.0	0.0	0.0	191.0	0.98	98.4	0.1	-0.002	**24.214**
CTS REMOTE_007766.LAB	10/18/23	8:12:40	0.0	0.0	0.0	191.0	0.98	98.8	0.1	0.000	
CTS REMOTE_007767.LAB	10/18/23	8:12:49	0.0	0.0	0.0	191.0	0.98	98.7	0.2	0.009	
CTS REMOTE_007768.LAB	10/18/23	8:12:57	0.0	0.0	-0.1	191.0	0.98	98.7	0.0	0.007	
CTS REMOTE_007769.LAB	10/18/23	8:13:05	0.0	0.0	0.0	191.0	0.98	98.9	0.0	0.004	
CTS REMOTE_007770.LAB	10/18/23	8:13:13	0.0	0.0	0.0	191.0	0.98	98.9	0.0	0.000	
CTS REMOTE_007771.LAB	10/18/23	8:13:21	0.0	0.0	0.0	191.0	0.98	98.8	0.0	0.002	

Client: Heidelberg Materials
Facility: Union Bridge Cement Plant
Project #: M234208
Operating Condition: Mill on/>90% Production

Test Location: Main Kiln Stack
Date: 10/18/2023
Operator: E. Ehlers
FTIR s/n: 0

Pre 1 Native Effluent Prior to Analyte Spike

Spectrum	Date	Time	H2O% %v	CO2 %v wet	HF ppmv wet	FTIR Gas Cell Temperature deg C	FTIR Gas Cell Pressure atm	Ethylene ppmv wet	HCN ppmv wet	SF6 ppmv wet
NATIVE_007812.LAB	10/18/23	8:19:43	11.6	21.6	-0.1	190.9	0.98	2.4	3.5	-0.027
NATIVE_007813.LAB	10/18/23	8:19:51	11.7	21.5	-0.1	190.9	0.98	2.5	3.5	-0.029
NATIVE_007814.LAB	10/18/23	8:19:59	11.6	21.5	0.0	190.9	0.98	2.3	3.5	-0.024
									3.5	**-0.027**

Pre 1 Effluent Spike Using Analyte

Spectrum	Date	Time	H2O% %v	CO2 %v wet	HF ppmv wet	FTIR Gas Cell Temperature deg C	FTIR Gas Cell Pressure atm	Ethylene ppmv wet	HCN ppmv wet	SF6 ppmv wet	Dilution Factor	Recovery % HCN
PRE SPIKE 1_007847.LAB	10/18/23	8:24:58	10.4	19.8	-0.1	191.1	0.98	2.1	7.3	0.428	**0.088**	**95.1%**
PRE SPIKE 1_007848.LAB	10/18/23	8:25:06	10.3	19.8	-0.1	191.1	0.98	2.1	7.3	0.427	**0.088**	**96.2%**
PRE SPIKE 1_007849.LAB	10/18/23	8:25:14	10.4	19.8	-0.1	191.0	0.98	1.9	7.4	0.422	**0.087**	**97.5%**
PRE SPIKE 1_007850.LAB	10/18/23	8:25:23	10.4	19.8	-0.1	191.0	0.98	2.1	7.3	0.422	**0.087**	**96.5%**
PRE SPIKE 1_007851.LAB	10/18/23	8:25:31	10.4	19.9	-0.1	191.0	0.98	2.2	7.4	0.431	**0.088**	**96.1%**
PRE SPIKE 1_007852.LAB	10/18/23	8:25:39	10.3	19.9	0.0	191.0	0.98	2.1	7.2	0.428	**0.088**	**94.2%**
PRE SPIKE 1_007853.LAB	10/18/23	8:25:47	10.4	19.9	-0.1	191.0	0.98	1.9	7.3	0.421	**0.086**	**96.7%**
PRE SPIKE 1_007854.LAB	10/18/23	8:25:56	10.4	19.8	-0.1	191.0	0.98	2.0	7.3	0.426	**0.087**	**95.5%**

Native Effluent Prior to Analyte Spike

Spectrum	Date	Time	H2O% %v	CO2 %v wet	HF ppmv wet	FTIR Gas Cell Temperature deg C	FTIR Gas Cell Pressure atm	Ethylene ppmv wet	HCN ppmv wet	SF6 ppmv wet
RUN 1_007920.LAB	10/18/23	9:34:59	10.1	22.5	-0.1	191.1	0.98	2.2	3.6	-0.013
RUN 1_007921.LAB	10/18/23	9:36:05	10.1	22.5	-0.1	191.0	0.98	2.3	3.7	-0.014
RUN 1_007922.LAB	10/18/23	9:37:11	10.2	22.4	-0.1	191.0	0.98	2.3	3.6	-0.013
									3.6	**-0.013**

Effluent Spike Using Analyte

Spectrum	Date	Time	H2O% %v	CO2 %v wet	HF ppmv wet	FTIR Gas Cell Temperature deg C	FTIR Gas Cell Pressure atm	Ethylene ppmv wet	HCN ppmv wet	SF6 ppmv wet	Dilution Factor	Recovery % HCN
RUN 1 POST SPIKE_007928.LAB	10/18/23	9:38:32	9.2	20.2	-0.1	190.9	0.98	1.8	7.7	0.421	**0.086**	**100.2%**
RUN 1 POST SPIKE_007929.LAB	10/18/23	9:38:40	9.2	20.3	-0.1	190.9	0.98	2.1	7.5	0.424	**0.087**	**97.3%**
RUN 1 POST SPIKE_007930.LAB	10/18/23	9:38:48	9.1	20.3	-0.1	190.9	0.98	1.9	7.3	0.422	**0.087**	**95.9%**
RUN 1 POST SPIKE_007931.LAB	10/18/23	9:38:57	9.2	20.2	-0.1	190.9	0.98	1.9	7.5	0.420	**0.086**	**97.6%**
RUN 1 POST SPIKE_007932.LAB	10/18/23	9:39:05	9.2	20.3	-0.1	191.0	0.98	1.8	7.3	0.420	**0.086**	**96.1%**
RUN 1 POST SPIKE_007933.LAB	10/18/23	9:39:13	9.2	20.2	-0.1	191.0	0.97	1.9	7.1	0.427	**0.088**	**92.7%**
RUN 1 POST SPIKE_007934.LAB	10/18/23	9:39:21	9.2	20.2	-0.1	191.0	0.98	1.9	7.4	0.420	**0.086**	**96.9%**
RUN 1 POST SPIKE_007935.LAB	10/18/23	9:39:30	9.2	20.2	-0.1	191.0	0.98	1.9	7.5	0.422	**0.087**	**97.3%**

CTS, System Purge

Spectrum	Date	Time	H2O% %v	CO2 %v wet	HF ppmv wet	FTIR Gas Cell Temperature deg C	FTIR Gas Cell Pressure atm	Ethylene ppmv wet	HCN ppmv wet	SF6 ppmv wet	Recovery % Ethylene
RUN 1 POST CTS_007947.LAB	10/18/23	9:41:27	0.1	0.1	0.0	191.0	0.98	99.1	0.3	0.007	**99.7%**
RUN 1 POST CTS_007948.LAB	10/18/23	9:41:35	0.0	0.1	-0.1	191.0	0.98	99.2	0.1	0.006	**99.8%**
RUN 1 POST CTS_007949.LAB	10/18/23	9:41:43	0.0	0.1	0.0	191.0	0.98	98.8	0.2	0.005	**99.5%**
RUN 1 POST CTS_007950.LAB	10/18/23	9:41:51	0.0	0.1	0.0	190.9	0.98	98.8	0.1	0.002	**99.4%**
RUN 1 POST CTS_007951.LAB	10/18/23	9:42:00	0.0	0.0	0.0	191.0	0.98	99.3	0.1	0.004	**100.0%**
RUN 1 POST CTS_007952.LAB	10/18/23	9:42:08	0.0	0.0	0.0	191.0	0.98	99.3	0.2	0.002	**99.9%**
RUN 1 POST CTS_007953.LAB	10/18/23	9:42:16	0.0	0.0	0.0	190.9	0.98	98.6	0.1	0.004	**99.2%**
RUN 1 POST CTS_007954.LAB	10/18/23	9:42:24	0.0	0.0	0.0	191.0	0.98	99.2	0.1	0.003	**99.8%**

Client: Heidelberg Materials
Facility: Union Bridge Cement Plant
Project #: M234208
Operating Condition: Mill on/>90% Production

Test Location: Main Kiln Stack
Date: 10/18/2023
Operator: E. Ehlers
FTIR s/n: 0

Native Effluent Prior to Analyte Spike

Spectrum	Date	Time	H2O% %v	CO2 %v wet	HF ppmv wet	FTIR Gas Cell Temperature deg C	FTIR Gas Cell Pressure atm	Ethylene ppmv wet	HCN ppmv wet	SF6 ppmv wet
RUN 2_008107.LAB	10/18/23	11:19:49	11.2	21.8	-0.1	191.0	0.97	2.2	3.4	-0.029
RUN 2_008108.LAB	10/18/23	11:20:53	11.2	21.8	-0.1	191.0	0.97	2.2	3.4	-0.028
RUN 2_008109.LAB	10/18/23	11:21:57	11.2	21.8	-0.1	191.0	0.97	2.2	3.4	-0.031
									3.4	**-0.029**

Effluent Spike Using Analyte

Spectrum	Date	Time	H2O% %v	CO2 %v wet	HF ppmv wet	FTIR Gas Cell Temperature deg C	FTIR Gas Cell Pressure atm	Ethylene ppmv wet	HCN ppmv wet	SF6 ppmv wet	Dilution Factor	Recovery % HCN
RUN 2 POST SPIKE_008134.LAB	10/18/23	11:27:34	10.1	19.7	-0.1	191.0	0.97	1.9	7.1	0.444	**0.091**	**91.8%**
RUN 2 POST SPIKE_008135.LAB	10/18/23	11:27:43	10.0	19.7	-0.1	191.0	0.97	2.0	7.0	0.437	**0.090**	**91.5%**
RUN 2 POST SPIKE_008136.LAB	10/18/23	11:27:51	10.0	19.6	-0.1	191.0	0.97	1.9	7.3	0.438	**0.090**	**95.3%**
RUN 2 POST SPIKE_008137.LAB	10/18/23	11:27:59	10.0	19.6	-0.1	191.0	0.97	1.8	7.3	0.437	**0.090**	**96.2%**
RUN 2 POST SPIKE_008138.LAB	10/18/23	11:28:07	10.0	19.6	0.0	190.9	0.97	2.0	7.2	0.443	**0.091**	**93.1%**
RUN 2 POST SPIKE_008139.LAB	10/18/23	11:28:16	10.0	19.6	-0.1	190.9	0.97	1.9	7.2	0.436	**0.090**	**94.9%**
RUN 2 POST SPIKE_008140.LAB	10/18/23	11:28:24	10.0	19.6	-0.1	190.9	0.97	2.0	7.3	0.436	**0.089**	**95.8%**
RUN 2 POST SPIKE_008141.LAB	10/18/23	11:28:32	10.0	19.7	-0.1	190.9	0.97	2.0	7.3	0.442	**0.091**	**94.9%**

CTS, System Purge

Spectrum	Date	Time	H2O% %v	CO2 %v wet	HF ppmv wet	FTIR Gas Cell Temperature deg C	FTIR Gas Cell Pressure atm	Ethylene ppmv wet	HCN ppmv wet	SF6 ppmv wet	Recovery % Ethylene
RUN 2 POST CTS_008154.LAB	10/18/23	11:30:40	0.0	0.1	-0.1	190.9	0.97	99.5	0.4	0.003	**100.1%**
RUN 2 POST CTS_008155.LAB	10/18/23	11:30:49	0.0	0.0	0.0	190.9	0.97	99.3	0.3	0.011	**100.0%**
RUN 2 POST CTS_008156.LAB	10/18/23	11:30:57	0.0	0.0	0.0	190.9	0.97	99.4	0.3	0.005	**100.1%**
RUN 2 POST CTS_008157.LAB	10/18/23	11:31:05	0.0	0.0	0.0	190.9	0.97	99.0	0.2	0.005	**99.7%**
RUN 2 POST CTS_008158.LAB	10/18/23	11:31:13	0.0	0.0	0.0	191.0	0.97	99.5	0.3	0.008	**100.1%**
RUN 2 POST CTS_008159.LAB	10/18/23	11:31:22	0.0	0.0	0.0	191.0	0.97	99.7	0.3	0.001	**100.3%**
RUN 2 POST CTS_008160.LAB	10/18/23	11:31:30	0.0	0.0	-0.1	191.0	0.97	99.0	0.3	-0.003	**99.6%**
RUN 2 POST CTS_008161.LAB	10/18/23	11:31:38	0.0	0.0	0.0	191.0	0.97	99.4	0.2	0.008	**100.0%**

Native Effluent Prior to Analyte Spike

Spectrum	Date	Time	H2O% %v	CO2 %v wet	HF ppmv wet	FTIR Gas Cell Temperature deg C	FTIR Gas Cell Pressure atm	Ethylene ppmv wet	HCN ppmv wet	SF6 ppmv wet
RUN 3 MILL ON_008778.LAB	10/18/23	17:55:17	12.0	21.5	-0.1	191.0	0.97	2.0	3.3	-0.031
RUN 3 MILL ON_008779.LAB	10/18/23	17:56:20	12.0	21.5	-0.1	191.0	0.97	2.0	3.3	-0.029
RUN 3 MILL ON_008780.LAB	10/18/23	17:57:24	11.9	21.6	-0.1	191.0	0.97	2.0	3.3	-0.031
									3.3	**-0.030**

Effluent Spike Using Analyte

Spectrum	Date	Time	H2O% %v	CO2 %v wet	HF ppmv wet	FTIR Gas Cell Temperature deg C	FTIR Gas Cell Pressure atm	Ethylene ppmv wet	HCN ppmv wet	SF6 ppmv wet	Dilution Factor	Recovery % HCN
RUN 3 MILL ON POST SPIKE_008794.LAB	10/18/23	18:00:26	10.9	20.4	-0.1	191.0	0.97	2.0	6.2	0.374	**0.077**	**89.2%**
RUN 3 MILL ON POST SPIKE_008795.LAB	10/18/23	18:00:34	10.8	20.3	-0.1	190.9	0.97	1.8	6.2	0.371	**0.076**	**90.3%**
RUN 3 MILL ON POST SPIKE_008796.LAB	10/18/23	18:00:43	10.8	20.3	-0.1	190.9	0.97	1.9	6.4	0.367	**0.075**	**93.5%**
RUN 3 MILL ON POST SPIKE_008797.LAB	10/18/23	18:00:51	10.9	20.3	-0.1	190.9	0.97	1.9	6.3	0.366	**0.075**	**91.9%**
RUN 3 MILL ON POST SPIKE_008798.LAB	10/18/23	18:00:59	11.0	20.3	-0.1	190.9	0.97	1.8	6.4	0.371	**0.076**	**92.8%**
RUN 3 MILL ON POST SPIKE_008799.LAB	10/18/23	18:01:07	11.0	20.4	-0.1	190.9	0.97	1.8	6.3	0.368	**0.075**	**91.7%**
RUN 3 MILL ON POST SPIKE_008800.LAB	10/18/23	18:01:15	11.0	20.4	-0.1	190.9	0.97	1.9	6.3	0.370	**0.076**	**91.9%**
RUN 3 MILL ON POST SPIKE_008801.LAB	10/18/23	18:01:24	11.0	20.4	-0.1	190.9	0.97	1.9	6.2	0.374	**0.077**	**90.1%**

CTS, System Purge

Spectrum	Date	Time	H2O% %v	CO2 %v wet	HF ppmv wet	FTIR Gas Cell Temperature deg C	FTIR Gas Cell Pressure atm	Ethylene ppmv wet	HCN ppmv wet	SF6 ppmv wet	Recovery % Ethylene
RUN 3 MILL ON POST CTS_008810.LAB	10/18/23	18:02:55	0.0	0.1	0.0	191.0	0.97	99.3	0.4	-0.002	**99.9%**
RUN 3 MILL ON POST CTS_008811.LAB	10/18/23	18:03:03	0.0	0.0	0.0	191.0	0.97	99.1	0.4	0.008	**99.7%**
RUN 3 MILL ON POST CTS_008812.LAB	10/18/23	18:03:11	0.0	0.0	-0.1	191.0	0.97	99.1	0.4	0.005	**99.8%**
RUN 3 MILL ON POST CTS_008813.LAB	10/18/23	18:03:19	0.0	0.0	0.0	191.0	0.97	99.1	0.4	0.002	**99.7%**
RUN 3 MILL ON POST CTS_008814.LAB	10/18/23	18:03:28	0.0	0.0	-0.1	191.0	0.97	99.4	0.4	0.002	**100.0%**
RUN 3 MILL ON POST CTS_008815.LAB	10/18/23	18:03:36	0.0	0.0	0.0	191.0	0.97	99.2	0.2	0.000	**99.8%**
RUN 3 MILL ON POST CTS_008816.LAB	10/18/23	18:03:44	0.0	0.0	0.0	191.0	0.97	99.3	0.4	0.012	**99.9%**
RUN 3 MILL ON POST CTS_008817.LAB	10/18/23	18:03:52	0.0	0.0	0.0	191.0	0.97	99.4	0.3	0.008	**100.0%**

Client: Heidelberg Materials
Facility: Union Bridge Cement Plant
Project #: M234208
Operating Condition: Mill on/>90% Production

Test Location: Main Kiln Stack
Date: 10/18/2023
Operator: E. Ehlers
FTIR s/n: 0

Post Test CTS, Direct Purge

Spectrum	Date	Time	H2O% %v	CO2 %v wet	HF ppmv wet	FTIR Gas Cell Temperature deg C	FTIR Gas Cell Pressure atm	Ethylene ppmv wet	HCN ppmv wet	SF6 ppmv wet	Recovery % Ethylene
POST TEST CTS DIR_009125.LAB	10/18/23	20:25:25	0.7	0.0	0.0	191.0	0.98	98.1	0.6	0.009	**98.7%**
POST TEST CTS DIR_009126.LAB	10/18/23	20:25:34	0.6	0.0	0.0	190.9	0.98	97.9	0.7	0.002	**98.5%**
POST TEST CTS DIR_009127.LAB	10/18/23	20:25:42	0.6	0.0	0.0	190.9	0.98	97.9	0.7	0.000	**98.5%**
POST TEST CTS DIR_009128.LAB	10/18/23	20:25:50	0.6	0.0	0.0	190.9	0.98	98.1	0.6	-0.004	**98.7%**
POST TEST CTS DIR_009129.LAB	10/18/23	20:25:58	0.6	0.0	0.0	191.0	0.98	98.4	0.6	0.002	**99.0%**
POST TEST CTS DIR_009130.LAB	10/18/23	20:26:07	0.5	0.0	0.0	191.0	0.98	98.0	0.6	0.007	**98.7%**
POST TEST CTS DIR_009131.LAB	10/18/23	20:26:15	0.5	0.0	0.0	191.0	0.98	98.0	0.6	0.009	**98.7%**
POST TEST CTS DIR_009132.LAB	10/18/23	20:26:23	0.5	0.0	0.0	191.0	0.98	98.5	0.6	0.000	**99.1%**
	Average							**98.1**			

Post Test N2, Direct Purge

Spectrum	Date	Time	H2O% %v	CO2 %v wet	HF ppmv wet	FTIR Gas Cell Temperature deg C	FTIR Gas Cell Pressure atm	Ethylene ppmv wet	HCN ppmv wet	SF6 ppmv wet
POST TEST N2 DIR_009139.LAB	10/18/23	20:30:07	0.2	0.0	0.0	191.0	0.98	0.0	0.4	0.002
POST TEST N2 DIR_009140.LAB	10/18/23	20:32:19	0.0	0.0	0.0	190.9	0.98	0.0	0.2	0.002
POST TEST N2 DIR_009141.LAB	10/18/23	20:34:31	0.0	0.0	0.0	190.9	0.98	0.0	0.2	0.002

Client: Heidelberg Materials
Facility: Union Bridge Cement Plant
Project #: M234208
Test Location: Main Kiln Stack
Date: 10/19/2023
Operator: E. Ehlers
Operating Condition Mill off/>90% Production

Sample System:	FTIR			
Probe Length:	12.0	**ft**		
Probe Type:	FTIR			
Sample Plane:	Vertical			
Port Length:	3.5	**in.**		
Port Size (diameter):	6.5	**in.**		
Port Type:	Nipple			
Duct Shape:	Circular			
Diameter:	13.75	**ft**		
Duct Area:	148.49	**Sq. Ft.**		
Upstream Diameters:	5.00		Minimum Upstream Distance	6.9 Feet
Downstream Diameters:	21.40		Minimum Downstream Distance	27.5 Feet
Number of Ports Sampled:	1		Ideal Upstream Distance	27.5 Feet
Number of Points per Port:	1		Ideal Downstream Distance	110.0 Feet
Total Number of Traverse Points:	1			

Calibration Gases

Type	Setting	Cylinder ID	Cylinder Value	Analyzer Response	Difference, % of Span	Expiration Date	Mid cylinder % of high cylinder	Final Bottle Pressure, PSI
O2 % (dry)	Zero		0.0	0.12	-0.63%			1500
	Mid	LL45315	10.05	10.13	-0.42%	9/21/2031	52.54%	1800
	High	SG9154241BAL	19.13	19.12	0.05%	10/31/2030		1950

Type	Compound	Cylinder ID	Cylinder Value	Expiration Date	Final Bottle Pressure, PSI
Zero Gas	Nitrogen	Zero Nitrogen	0.0	N/A	
Calibration Transfer Standard	Ethylene	EB0153589	99.97	9/6/2031	
Analyte Spike Gas	HCN	CC768249	49.72	3/11/2024	
	SF6		5.022		

Response Time Data

Type	RM Analyzer Make/Model	RM Analyzer s/n	Analyzer Span	RM Gas Span
O2 % (dry)	Servomex 1440D	3934	25	19.13
HCN ppmvw	MKS 2030		100	N/A

Client: Heidelberg Materials
Facility: Union Bridge Cement Plant
Project #: M234208
Diluent: O2 %

Test Location: Main Kiln Stack
Date: 10/19/23
Operator: E. Ehlers
O2 % Correction: 7

O2 % (dry) Correction Data

Run #	Cma	Precal	Postcal	Pre zero	Post zero	Co	Cm	C	Cgas	Span Bias	Span Drift	Zero Bias	Zero Drift
1	10.050	10.08	10.17	0.14	0.12	0.13	10.13	4.55	4.4	-0.21	0.47	0.00	-0.10
2	10.05	10.17	10.10	0.12	0.09	0.11	10.14	4.60	4.5	0.16	-0.37	0.16	-0.16
3	10.05	10.10	10.05	0.09	0.07	0.08	10.08	4.59	4.5	0.42	-0.26	0.26	-0.10

Concentration of Cal Gas C = Average value of test Co=Average Pre and Post Zero
erage Pre and Post Span Cgas = Corrected gas value of test

Calibration Corrected and Calculated Data

Run #	Run Date	Start Time	End Time	Moisture %	O2 % (dry)	CO2 % (wet)	CO2 % (dry)	HCN ppmvw	HCN ppmvd @ 7% O2	HF ppmvw	HF ppmvd @ 7% O2
1	10/19/23	8:25	9:24	13.47%	4.44	24.74	28.59	3.91	3.82	0.10	0.10
2	10/19/23	10:10	11:09	13.83%	4.50	24.91	28.91	4.01	3.95	0.10	0.10
3	10/19/23	11:55	12:54	13.68%	4.54	25.06	29.03	4.02	3.95	0.10	0.10

Client: Heidelberg Materials
Facility: Union Bridge Cement Plant
Test Location: Main Kiln Stack
Date: 10/19/23
Project #: M234208

Time	Linearity Cal/Pre 1 Cal O2 % (dry)	
7:47	20.14	
7:48	18.64	
7:49	0.12	
7:50	0.10	
7:51	0.10	
7:52	0.10	
7:53	0.10	
7:54	2.33	
7:55	0.13	
7:56	8.94	
7:57	19.11	
7:58	19.12	ih
7:59	5.46	
8:00	0.12	iz
8:01	9.07	
8:02	10.13	im
8:03	11.46	
8:04	0.59	
8:05	0.14	z
8:06	8.25	
8:07	10.13	
8:08	10.08	m

Client: Heidelberg Materials
Facility: Union Bridge Cement Plant
Project #: M234208
Test Location: Main Kiln Stack
Date: 10/19/23

Post 1/Pre 2			Post 2/Pre 3		
Time	O2 % (dry)		Time	O2 % (dry)	
9:35	0.12	z	11:25	10.10	m
9:36	4.74		11:26	10.10	
9:37	10.16		11:27	4.37	
9:38	10.17	m	11:28	0.10	
9:39	6.47		11:29	0.09	z
9:40	0.13		11:30	0.09	
9:41	0.12				

Post 3		
Time	O2 % (dry)	
13:20	10.05	m
13:21	10.05	
13:22	2.25	
13:23	0.07	
13:24	0.07	z

Client: Heidelberg Materials
Facility: Union Bridge Cement Plant
Project #: M234208
Operating Condition: Mill off/>90% Production

Test Location: Main Kiln Stack
Date: 10/19/2023
Operator: E. Ehlers
FTIR s/n: 0

System Leak Check: 0.0 mL/min

Nitrogen (Zero) Direct to FTIR

Spectrum	Date	Time	H2O% %v	CO2 %v wet	HF ppmv wet	FTIR Gas Cell Temperature deg C	FTIR Gas Cell Pressure atm	Ethylene ppmv wet	HCN ppmv wet	SF6 ppmv wet
N2 DIR_009148.LAB	10/19/23	7:53:36	0.0	0.0	0.0	190.9	0.97	0.0	0.0	0.000
N2 DIR_009149.LAB	10/19/23	7:53:44	0.0	0.0	0.0	190.9	0.97	0.0	0.0	-0.001
N2 DIR_009150.LAB	10/19/23	7:53:52	0.0	0.0	0.0	190.9	0.97	0.0	0.0	-0.003
N2 DIR_009151.LAB	10/19/23	7:54:00	0.0	0.0	0.0	190.9	0.97	0.1	-0.1	-0.004
N2 DIR_009152.LAB	10/19/23	7:54:09	0.0	0.0	0.1	190.9	0.97	0.0	-0.1	0.000
N2 DIR_009153.LAB	10/19/23	7:54:17	0.0	0.0	-0.1	190.9	0.97	0.1	-0.1	0.000
N2 DIR_009154.LAB	10/19/23	7:54:25	0.0	0.0	0.0	190.9	0.97	0.0	0.1	0.004
N2 DIR_009155.LAB	10/19/23	7:54:33	0.0	0.0	0.0	190.9	0.97	0.1	-0.1	0.006
N2 DIR_009156.LAB	10/19/23	7:54:42	0.0	0.0	0.0	190.9	0.97	0.3	0.0	-0.004

Calibration Transfer Standard (CTS), Direct to FTIR

Spectrum	Date	Time	H2O% %v	CO2 %v wet	HF ppmv wet	FTIR Gas Cell Temperature deg C	FTIR Gas Cell Pressure atm	Ethylene ppmv wet	HCN ppmv wet	SF6 ppmv wet	Recovery % Ethylene
CTS DIR_009158.LAB	10/19/23	7:55:15	0.0	0.0	0.0	190.9	0.97	99.5	0.0	-0.015	**99.5%**
CTS DIR_009159.LAB	10/19/23	7:55:23	0.0	0.0	0.0	190.9	0.97	99.4	0.0	-0.007	**99.4%**
CTS DIR_009160.LAB	10/19/23	7:55:31	0.0	0.0	0.0	190.9	0.97	99.5	0.0	-0.003	**99.5%**
CTS DIR_009161.LAB	10/19/23	7:55:39	0.0	0.0	0.0	190.9	0.97	99.4	-0.2	-0.015	**99.4%**
CTS DIR_009162.LAB	10/19/23	7:55:48	0.0	0.0	0.0	190.9	0.97	99.8	-0.1	-0.010	**99.8%**
CTS DIR_009163.LAB	10/19/23	7:55:56	0.0	0.0	0.0	190.9	0.97	99.5	0.0	-0.006	**99.5%**
CTS DIR_009164.LAB	10/19/23	7:56:04	0.0	0.0	0.0	190.9	0.97	99.7	0.0	-0.009	**99.7%**
	Average							**99.5**			**99.5%**

Analyte Spike Gas (HCN) Direct to FTIR

Spectrum	Date	Time	H2O% %v	CO2 %v wet	HF ppmv wet	FTIR Gas Cell Temperature deg C	FTIR Gas Cell Pressure atm	Ethylene ppmv wet	HCN ppmv wet	SF6 ppmv wet
HCN DIR_009185.LAB	10/19/23	7:59:42	0.0	0.0	0.0	191.0	0.97	-0.2	49.7	5.001
HCN DIR_009186.LAB	10/19/23	7:59:50	0.0	0.0	0.0	191.0	0.97	-0.1	49.7	5.007
HCN DIR_009187.LAB	10/19/23	7:59:59	0.0	0.0	0.0	191.0	0.97	-0.1	50.0	5.007
HCN DIR_009188.LAB	10/19/23	8:00:07	0.0	0.0	0.0	191.0	0.97	-0.1	50.2	5.002
HCN DIR_009189.LAB	10/19/23	8:00:15	0.0	0.0	0.0	191.0	0.97	0.0	50.0	5.007
HCN DIR_009190.LAB	10/19/23	8:00:23	0.0	0.0	0.0	191.0	0.97	-0.1	49.9	4.992
HCN DIR_009191.LAB	10/19/23	8:00:32	0.0	0.0	0.0	191.0	0.97	-0.2	49.9	5.004
HCN DIR_009192.LAB	10/19/23	8:00:40	0.0	0.0	0.0	191.0	0.97	-0.2	50.0	5.006
	Average								**49.9**	**5.003**

CTS, System Purge

Spectrum	Date	Time	H2O% %v	CO2 %v wet	HF ppmv wet	FTIR Gas Cell Temperature deg C	FTIR Gas Cell Pressure atm	Ethylene ppmv wet	HCN ppmv wet	SF6 ppmv wet	Recovery % Ethylene
CTS REMOTE_009214.LAB	10/19/23	8:04:39	0.0	0.0	0.0	191.1	0.97	99.9	0.1	-0.014	**99.9%**
CTS REMOTE_009215.LAB	10/19/23	8:04:47	0.0	0.0	0.0	191.1	0.97	99.6	0.0	-0.011	**99.6%**
CTS REMOTE_009216.LAB	10/19/23	8:04:56	0.0	0.0	0.0	191.1	0.97	100.0	0.0	-0.008	**100.5%**
CTS REMOTE_009217.LAB	10/19/23	8:05:04	0.0	0.0	0.0	191.0	0.97	99.4	0.0	-0.010	**99.8%**
CTS REMOTE_009218.LAB	10/19/23	8:05:12	0.0	0.0	0.0	191.0	0.97	99.8	-0.1	-0.011	**100.2%**
CTS REMOTE_009219.LAB	10/19/23	8:05:20	0.0	0.0	0.0	191.0	0.97	99.9	0.1	-0.010	**100.4%**
CTS REMOTE_009220.LAB	10/19/23	8:05:29	0.0	0.0	0.0	190.9	0.97	99.8	-0.1	0.001	**100.3%**
CTS REMOTE_009221.LAB	10/19/23	8:05:37	0.0	0.0	0.0	190.9	0.97	100.0	0.0	-0.003	**100.5%**

Response Time Test

Spectrum	Date	Time	H2O% %v	CO2 %v wet	HF ppmv wet	FTIR Gas Cell Temperature deg C	FTIR Gas Cell Pressure atm	Ethylene ppmv wet	HCN ppmv wet	SF6 ppmv wet	Response Time (sec)
CO2 MID DIR_009209.LAB	10/19/23	8:03:25	0.0	9.9	0.0	191.0	0.97	0.2	0.1	-0.005	-
CO2 MID DIR_009210.LAB	10/19/23	8:03:33	0.0	9.9	0.0	191.0	0.97	0.2	0.2	0.012	**16.234**
CTS REMOTE_009211.LAB	10/19/23	8:04:14	0.5	0.1	0.0	191.1	0.97	99.0	0.5	-0.005	**24.234**
CTS REMOTE_009212.LAB	10/19/23	8:04:23	0.1	0.0	0.0	191.1	0.97	99.4	0.2	-0.005	
CTS REMOTE_009213.LAB	10/19/23	8:04:31	0.0	0.0	0.0	191.1	0.97	99.6	0.0	-0.007	
CTS REMOTE_009214.LAB	10/19/23	8:04:39	0.0	0.0	0.0	191.1	0.97	99.9	0.1	-0.014	
CTS REMOTE_009215.LAB	10/19/23	8:04:47	0.0	0.0	0.0	191.1	0.97	99.6	0.0	-0.011	
CTS REMOTE_009216.LAB	10/19/23	8:04:56	0.0	0.0	0.0	191.1	0.97	100.0	0.0	-0.008	
CTS REMOTE_009217.LAB	10/19/23	8:05:04	0.0	0.0	0.0	191.0	0.97	99.4	0.0	-0.010	

Client: Heidelberg Materials
Facility: Union Bridge Cement Plant
Project #: M234208
Operating Condition: Mill off/>90% Production

Test Location: Main Kiln Stack
Date: 10/19/2023
Operator: E. Ehlers
FTIR s/n: 0

Pre 1 Native Effluent Prior to Analyte Spike

Spectrum	Date	Time	H2O% %v	CO2 %v wet	HF ppmv wet	FTIR Gas Cell Temperature deg C	FTIR Gas Cell Pressure atm	Ethylene ppmv wet	HCN ppmv wet	SF6 ppmv wet
NATIVE_009261.LAB	10/19/23	8:11:54	13.5	24.9	0.0	191.0	0.97	2.5	3.6	-0.010
NATIVE_009262.LAB	10/19/23	8:12:02	13.5	24.8	0.0	191.0	0.97	2.2	3.7	-0.017
NATIVE_009263.LAB	10/19/23	8:12:10	13.5	24.8	0.0	191.0	0.97	2.2	3.7	-0.011
									3.7	**-0.013**

Pre 1 Effluent Spike Using Analyte

Spectrum	Date	Time	H2O% %v	CO2 %v wet	HF ppmv wet	FTIR Gas Cell Temperature deg C	FTIR Gas Cell Pressure atm	Ethylene ppmv wet	HCN ppmv wet	SF6 ppmv wet	Dilution Factor	Recovery % HCN
PRE 1 SPIKE_009282.LAB	10/19/23	8:15:03	12.3	22.7	0.0	191.0	0.97	2.1	7.1	0.410	**0.082**	**95.1%**
PRE 1 SPIKE_009283.LAB	10/19/23	8:15:11	12.4	22.7	0.0	191.0	0.97	2.3	7.0	0.414	**0.083**	**93.9%**
PRE 1 SPIKE_009284.LAB	10/19/23	8:15:19	12.3	22.7	0.0	191.0	0.97	2.2	7.4	0.403	**0.081**	**99.4%**
PRE 1 SPIKE_009285.LAB	10/19/23	8:15:28	12.2	22.6	0.0	191.0	0.97	2.3	7.4	0.407	**0.081**	**99.5%**
PRE 1 SPIKE_009286.LAB	10/19/23	8:15:36	12.2	22.8	0.0	191.0	0.97	2.3	7.2	0.410	**0.082**	**96.8%**
PRE 1 SPIKE_009287.LAB	10/19/23	8:15:44	12.2	22.8	0.0	191.0	0.97	2.2	7.2	0.409	**0.082**	**96.4%**
PRE 1 SPIKE_009288.LAB	10/19/23	8:15:52	12.2	22.8	0.0	191.0	0.97	2.3	7.1	0.415	**0.083**	**94.5%**
PRE 1 SPIKE_009289.LAB	10/19/23	8:16:01	12.2	22.9	0.0	191.0	0.97	2.3	7.3	0.405	**0.081**	**98.4%**

Native Effluent Prior to Analyte Spike

Spectrum	Date	Time	H2O% %v	CO2 %v wet	HF ppmv wet	FTIR Gas Cell Temperature deg C	FTIR Gas Cell Pressure atm	Ethylene ppmv wet	HCN ppmv wet	SF6 ppmv wet
RUN 1_009363.LAB	10/19/23	9:27:02	13.6	24.8	0.0	191.0	0.97	2.3	4.0	-0.013
RUN 1_009364.LAB	10/19/23	9:28:06	13.6	24.8	0.0	191.0	0.97	2.4	4.0	-0.014
RUN 1_009365.LAB	10/19/23	9:29:10	13.5	24.8	0.0	190.9	0.97	2.3	4.0	-0.012
									4.0	**-0.013**

Effluent Spike Using Analyte

Spectrum	Date	Time	H2O% %v	CO2 %v wet	HF ppmv wet	FTIR Gas Cell Temperature deg C	FTIR Gas Cell Pressure atm	Ethylene ppmv wet	HCN ppmv wet	SF6 ppmv wet	Dilution Factor	Recovery % HCN
RUN 1 POST SPIKE_009384.LAB	10/19/23	9:32:16	12.3	22.7	-0.1	190.9	0.97	2.3	7.4	0.413	**0.083**	**94.5%**
RUN 1 POST SPIKE_009385.LAB	10/19/23	9:32:25	12.3	22.6	-0.1	190.9	0.97	2.2	7.4	0.414	**0.083**	**94.4%**
RUN 1 POST SPIKE_009386.LAB	10/19/23	9:32:33	12.3	22.6	-0.1	190.9	0.97	2.3	7.4	0.414	**0.083**	**94.3%**
RUN 1 POST SPIKE_009387.LAB	10/19/23	9:32:41	12.3	22.7	0.0	190.9	0.97	2.3	7.4	0.419	**0.084**	**94.0%**
RUN 1 POST SPIKE_009388.LAB	10/19/23	9:32:49	12.3	22.8	-0.1	190.9	0.97	2.2	7.3	0.415	**0.083**	**93.7%**
RUN 1 POST SPIKE_009389.LAB	10/19/23	9:32:58	12.3	22.8	-0.1	190.9	0.97	2.2	7.4	0.414	**0.083**	**95.1%**
RUN 1 POST SPIKE_009390.LAB	10/19/23	9:33:06	12.2	22.8	0.0	190.9	0.97	2.3	7.3	0.418	**0.084**	**92.9%**
RUN 1 POST SPIKE_009391.LAB	10/19/23	9:33:14	12.2	22.8	0.0	190.9	0.97	2.2	7.5	0.417	**0.083**	**96.0%**

CTS, System Purge

Spectrum	Date	Time	H2O% %v	CO2 %v wet	HF ppmv wet	FTIR Gas Cell Temperature deg C	FTIR Gas Cell Pressure atm	Ethylene ppmv wet	HCN ppmv wet	SF6 ppmv wet	Recovery % Ethylene
RUN 1 POST CTS_009400.LAB	10/19/23	9:34:43	0.1	0.1	0.0	191.0	0.97	99.0	0.2	-0.005	**99.5%**
RUN 1 POST CTS_009401.LAB	10/19/23	9:34:52	0.1	0.1	0.0	191.0	0.97	99.5	0.2	-0.011	**100.0%**
RUN 1 POST CTS_009402.LAB	10/19/23	9:35:00	0.1	0.1	0.0	191.0	0.97	99.0	0.2	-0.010	**99.4%**
RUN 1 POST CTS_009403.LAB	10/19/23	9:35:08	0.1	0.1	0.0	191.0	0.97	99.4	0.2	-0.011	**99.9%**
RUN 1 POST CTS_009404.LAB	10/19/23	9:35:16	0.1	0.1	0.0	191.0	0.97	99.2	0.2	-0.006	**99.7%**
RUN 1 POST CTS_009405.LAB	10/19/23	9:35:25	0.0	0.0	0.0	191.0	0.97	99.3	0.2	-0.008	**99.8%**
RUN 1 POST CTS_009406.LAB	10/19/23	9:35:33	0.0	0.0	0.0	191.0	0.97	99.6	0.1	-0.013	**100.0%**
RUN 1 POST CTS_009407.LAB	10/19/23	9:35:41	0.0	0.0	0.0	191.0	0.97	99.2	0.0	-0.012	**99.7%**

Client: Heidelberg Materials
Facility: Union Bridge Cement Plant
Project #: M234208
Operating Condition: Mill off/>90% Production

Test Location: Main Kiln Stack
Date: 10/19/2023
Operator: E. Ehlers
FTIR s/n: 0

Native Effluent Prior to Analyte Spike

Spectrum	Date	Time	H2O% %v	CO2 %v wet	HF ppmv wet	FTIR Gas Cell Temperature deg C	FTIR Gas Cell Pressure atm	Ethylene ppmv wet	HCN ppmv wet	SF6 ppmv wet
RUN 2_009533.LAB	10/19/23	11:12:26	13.6	25.1	0.0	191.0	0.97	2.3	4.1	-0.011
RUN 2_009534.LAB	10/19/23	11:13:30	13.5	25.2	0.0	191.0	0.97	2.4	4.2	-0.013
RUN 2_009535.LAB	10/19/23	11:14:34	13.5	25.0	0.0	191.0	0.97	2.3	4.1	-0.014
									4.1	**-0.013**

Effluent Spike Using Analyte

Spectrum	Date	Time	H2O% %v	CO2 %v wet	HF ppmv wet	FTIR Gas Cell Temperature deg C	FTIR Gas Cell Pressure atm	Ethylene ppmv wet	HCN ppmv wet	SF6 ppmv wet	Dilution Factor	Recovery % HCN
RUN 2 POST SPIKE_009552.LAB	10/19/23	11:18:08	12.5	22.8	0.0	191.0	0.97	2.6	7.5	0.449	**0.090**	**91.6%**
RUN 2 POST SPIKE_009553.LAB	10/19/23	11:18:16	12.5	22.9	-0.1	191.0	0.97	2.5	7.7	0.450	**0.090**	**93.6%**
RUN 2 POST SPIKE_009554.LAB	10/19/23	11:18:24	12.5	23.0	0.0	191.0	0.97	2.2	7.6	0.449	**0.090**	**93.0%**
RUN 2 POST SPIKE_009555.LAB	10/19/23	11:18:32	12.5	23.1	0.0	191.0	0.97	2.5	7.7	0.454	**0.091**	**93.4%**
RUN 2 POST SPIKE_009556.LAB	10/19/23	11:18:41	12.5	23.1	0.0	191.0	0.97	2.4	7.8	0.450	**0.090**	**94.9%**
RUN 2 POST SPIKE_009557.LAB	10/19/23	11:18:49	12.4	22.8	-0.1	191.0	0.97	2.3	7.6	0.451	**0.090**	**92.0%**
RUN 2 POST SPIKE_009558.LAB	10/19/23	11:18:57	12.4	22.8	0.0	191.0	0.97	2.4	7.6	0.453	**0.090**	**92.3%**
RUN 2 POST SPIKE_009559.LAB	10/19/23	11:19:05	12.5	22.9	-0.1	191.0	0.97	2.4	7.4	0.455	**0.091**	**89.8%**

CTS, System Purge

Spectrum	Date	Time	H2O% %v	CO2 %v wet	HF ppmv wet	FTIR Gas Cell Temperature deg C	FTIR Gas Cell Pressure atm	Ethylene ppmv wet	HCN ppmv wet	SF6 ppmv wet	Recovery % Ethylene
RUN 2 POST CTS_009566.LAB	10/19/23	11:20:23	0.1	0.1	0.0	191.1	0.97	99.2	0.2	-0.005	**99.7%**
RUN 2 POST CTS_009567.LAB	10/19/23	11:20:31	0.1	0.1	0.1	191.1	0.97	98.8	0.2	-0.004	**99.3%**
RUN 2 POST CTS_009568.LAB	10/19/23	11:20:40	0.1	0.1	0.0	191.1	0.97	99.0	0.2	-0.007	**99.5%**
RUN 2 POST CTS_009569.LAB	10/19/23	11:20:48	0.1	0.0	0.0	191.1	0.97	98.9	0.2	-0.014	**99.4%**
RUN 2 POST CTS_009570.LAB	10/19/23	11:20:56	0.0	0.0	0.0	191.1	0.97	99.3	0.1	-0.015	**99.8%**
RUN 2 POST CTS_009571.LAB	10/19/23	11:21:04	0.0	0.0	0.0	191.1	0.97	99.5	0.1	-0.014	**100.0%**
RUN 2 POST CTS_009572.LAB	10/19/23	11:21:13	0.0	0.0	0.0	191.1	0.97	99.2	0.2	-0.007	**99.7%**
RUN 2 POST CTS_009573.LAB	10/19/23	11:21:21	0.0	0.0	0.0	191.1	0.97	99.3	0.1	-0.007	**99.8%**

Native Effluent Prior to Analyte Spike

Spectrum	Date	Time	H2O% %v	CO2 %v wet	HF ppmv wet	FTIR Gas Cell Temperature deg C	FTIR Gas Cell Pressure atm	Ethylene ppmv wet	HCN ppmv wet	SF6 ppmv wet
RUN 3_009717.LAB	10/19/23	13:02:39	13.7	25.0	-0.1	191.1	0.97	2.5	3.9	-0.015
RUN 3_009718.LAB	10/19/23	13:03:42	13.7	24.9	-0.1	191.1	0.97	2.5	3.8	-0.013
RUN 3_009719.LAB	10/19/23	13:04:46	13.8	25.1	0.0	190.9	0.97	2.4	3.9	-0.014
									3.9	**-0.014**

Effluent Spike Using Analyte

Spectrum	Date	Time	H2O% %v	CO2 %v wet	HF ppmv wet	FTIR Gas Cell Temperature deg C	FTIR Gas Cell Pressure atm	Ethylene ppmv wet	HCN ppmv wet	SF6 ppmv wet	Dilution Factor	Recovery % HCN
RUN 3 POST SPIKE_009747.LAB	10/19/23	13:09:11	12.4	23.3	0.0	191.0	0.97	2.5	7.3	0.399	**0.080**	**96.8%**
RUN 3 POST SPIKE_009748.LAB	10/19/23	13:09:19	12.4	23.3	-0.1	191.0	0.97	2.5	7.1	0.397	**0.079**	**94.5%**
RUN 3 POST SPIKE_009749.LAB	10/19/23	13:09:27	12.4	23.2	-0.1	191.0	0.97	2.6	7.3	0.403	**0.081**	**95.8%**
RUN 3 POST SPIKE_009750.LAB	10/19/23	13:09:36	12.4	23.3	-0.1	191.0	0.97	2.5	7.3	0.392	**0.078**	**97.1%**
RUN 3 POST SPIKE_009751.LAB	10/19/23	13:09:44	12.5	23.3	-0.1	191.0	0.97	2.5	7.1	0.402	**0.080**	**93.1%**
RUN 3 POST SPIKE_009752.LAB	10/19/23	13:09:52	12.5	23.3	-0.1	191.0	0.97	2.7	7.3	0.397	**0.079**	**97.1%**
RUN 3 POST SPIKE_009753.LAB	10/19/23	13:10:00	12.4	23.4	-0.1	191.0	0.97	2.5	7.2	0.399	**0.080**	**95.5%**
RUN 3 POST SPIKE_009754.LAB	10/19/23	13:10:09	12.4	23.4	-0.1	191.0	0.97	2.5	7.5	0.395	**0.079**	**99.0%**

CTS, System Purge

Spectrum	Date	Time	H2O% %v	CO2 %v wet	HF ppmv wet	FTIR Gas Cell Temperature deg C	FTIR Gas Cell Pressure atm	Ethylene ppmv wet	HCN ppmv wet	SF6 ppmv wet	Recovery % Ethylene
RUN 3 POST CTS_009793.LAB	10/19/23	13:15:49	0.0	0.1	0.0	191.0	0.97	99.0	0.1	-0.009	**99.5%**
RUN 3 POST CTS_009794.LAB	10/19/23	13:15:57	0.0	0.0	0.0	190.9	0.97	99.4	0.2	-0.012	**99.8%**
RUN 3 POST CTS_009795.LAB	10/19/23	13:16:06	0.0	0.0	0.0	190.9	0.97	98.8	0.1	-0.012	**99.3%**
RUN 3 POST CTS_009796.LAB	10/19/23	13:16:14	0.0	0.0	0.0	190.9	0.97	99.1	0.0	-0.015	**99.6%**
RUN 3 POST CTS_009797.LAB	10/19/23	13:16:22	0.0	0.0	0.0	190.9	0.97	99.1	0.3	-0.008	**99.6%**
RUN 3 POST CTS_009798.LAB	10/19/23	13:16:30	0.0	0.0	0.0	190.9	0.97	99.0	0.0	-0.020	**99.5%**
RUN 3 POST CTS_009799.LAB	10/19/23	13:16:39	0.0	0.0	0.0	190.9	0.97	99.4	0.1	-0.013	**99.8%**
RUN 3 POST CTS_009800.LAB	10/19/23	13:16:47	0.0	0.0	0.0	190.9	0.97	99.2	0.2	-0.014	**99.7%**

Client: Heidelberg Materials
Facility: Union Bridge Cement Plant
Project #: M234208
Operating Condition: Mill off/>90% Production

Test Location: Main Kiln Stack
Date: 10/19/2023
Operator: E. Ehlers
FTIR s/n: 0

Post Test CTS, Direct Purge

Spectrum	Date	Time	H2O% %v	CO2 %v wet	HF ppmv wet	FTIR Gas Cell Temperature deg C	FTIR Gas Cell Pressure atm	Ethylene ppmv wet	HCN ppmv wet	SF6 ppmv wet	Recovery % Ethylene
POST CTS DIR_009848.LAB	10/19/23	13:24:01	0.6	0.0	-0.1	191.1	0.97	98.2	0.5	-0.007	**98.7%**
POST CTS DIR_009849.LAB	10/19/23	13:24:09	0.6	0.0	0.0	191.1	0.97	98.3	0.5	-0.016	**98.8%**
POST CTS DIR_009850.LAB	10/19/23	13:24:17	0.5	0.0	0.0	191.1	0.97	98.2	0.6	-0.017	**98.7%**
POST CTS DIR_009851.LAB	10/19/23	13:24:26	0.5	0.0	-0.1	191.1	0.97	98.4	0.6	-0.002	**98.9%**
POST CTS DIR_009852.LAB	10/19/23	13:24:34	0.5	0.0	0.0	191.1	0.97	98.2	0.6	-0.016	**98.6%**
POST CTS DIR_009853.LAB	10/19/23	13:24:42	0.4	0.0	0.0	191.1	0.97	98.3	0.4	-0.014	**98.7%**
POST CTS DIR_009854.LAB	10/19/23	13:24:50	0.4	0.0	0.0	191.1	0.97	98.7	0.4	-0.011	**99.2%**
POST CTS DIR_009855.LAB	10/19/23	13:24:59	0.4	0.0	0.0	191.1	0.97	98.2	0.4	-0.017	**98.7%**
	Average							**98.3**			

Post Test N2, Direct Purge

Spectrum	Date	Time	H2O% %v	CO2 %v wet	HF ppmv wet	FTIR Gas Cell Temperature deg C	FTIR Gas Cell Pressure atm	Ethylene ppmv wet	HCN ppmv wet	SF6 ppmv wet
POST N2 DIR_009859.LAB	10/19/23	13:27:56	0.2	0.0	0.0	191.1	0.97	0.1	0.3	-0.004
POST N2 DIR_009860.LAB	10/19/23	13:30:08	0.1	0.0	0.0	190.9	0.97	0.0	0.2	-0.002
POST N2 DIR_009861.LAB	10/19/23	13:32:20	0.0	0.0	0.0	190.9	0.97	0.0	0.0	-0.002

Heidelberg Materials
Union Bridge Cement Plant
10/18/2023
Main Kiln Stack
Mill on

	DL summary - zero gas			DL summary - in stack	
Time	HCN	HF	Time	HCN	HF
7:23:09 AM	-0.02	0.09	8:41:14 AM	-0.09	2.98
7:23:17 AM	-0.02	-0.05	8:42:20 AM	-0.07	2.90
7:23:25 AM	-0.05	0.04	8:43:25 AM	-0.08	2.91
7:23:34 AM	-0.06	0.01	8:44:31 AM	-0.08	2.93
7:23:42 AM	-0.04	0.05	8:45:37 AM	-0.06	2.92
7:23:50 AM	0.02	0.03	8:46:43 AM	-0.07	2.85
7:23:58 AM	-0.05	-0.01	8:47:49 AM	-0.07	3.04
Standard Deviation	**0.02**	**0.04**	**Standard Deviation**	**0.01**	**0.06**
3x = DL	**0.07**	**0.12**	**3x = DL**	**0.03**	**0.17**

Appendix H - Gas Cylinder Certifications

Airgas Specialty Gases
Airgas USA LLC
6141 Easton Road
Plumsteadville, PA 18949
Airgas.com

CERTIFICATE OF ANALYSIS

Grade of Product: CERTIFIED STANDARD-SPEC

Customer:	MOSTARDI PLATT		
Part Number:	X03NI99C15AC0W8	Reference Number:	160-402841763-1
Cylinder Number:	CC768249	Cylinder Volume:	144.4 CF
Laboratory:	124 - Plumsteadville - PA	Cylinder Pressure:	2015 PSIG
Analysis Date:	Sep 11, 2023	Valve Outlet:	350SS
Lot Number:	160-402841763-1		

Expiration Date: Mar 11, 2024

Product composition verified by direct comparison to calibration standards traceable to N.I.S.T. weights and/or N.I.S.T. Gas Mixture reference materials.

ANALYTICAL RESULTS

Component	Req Conc	Actual Concentration (Mole %)	Analytical Uncertainty
SULFUR HEXAFLUORIDE	5.000 PPM	5.022 PPM	+/- 5%
HYDROGEN CYANIDE	50.00 PPM	49.72 PPM	+/- 5%
NITROGEN	Balance		

Signature on file
Approved for Release

Airgas
an Air Liquide company

Airgas Specialty Gases
Airgas USA LLC
24075 US Hwy 6
Stryker, OH 43557
Airgas.com

CERTIFICATE OF ANALYSIS

Grade of Product: PRIMARY STANDARD

Part Number:	X02NI99P15AD524	Reference Number:	141-402838188-1
Cylinder Number:	EB0153589	Cylinder Volume:	140.0 CF
Laboratory:	124 - Stryker (SAP) - OH	Cylinder Pressure:	2015 PSIG
Analysis Date:	Sep 06, 2023	Valve Outlet:	350
Lot Number:	141-402838188-1		

Expiration Date: Sep 06, 2031

Primary Standard Gas Mixtures are traceable to N.I.S.T. weights and/or N.I.S.T. Gas Mixture reference materials.

ANALYTICAL RESULTS

Component	Req Conc	Actual Concentration (Mole %)	Analytical Uncertainty
ETHYLENE	100.0 PPM	99.97 PPM	+/- 1%
NITROGEN	Balance		

Signature on file
Approved for Release

Airgas
an Air Liquide company

Airgas Specialty Gases
Airgas USA LLC
12722 S. Wentworth Ave.
Chicago, IL 60628
Airgas.com

CERTIFICATE OF ANALYSIS

Grade of Product: EPA PROTOCOL STANDARD

Part Number:	E03NI80E80A7767	Reference Number:	54-402838047-1
Cylinder Number:	LL45315	Cylinder Volume:	87.0 CF
Laboratory:	124 - Chicago (SAP) - IL	Cylinder Pressure:	2214 PSIG
PGVP Number:	B12023	Valve Outlet:	590
Gas Code:	CO2,O2,BALN	Certification Date:	Sep 21, 2023

Expiration Date: Sep 21, 2031

Certification performed in accordance with "EPA Traceability Protocol for Assay and Certification of Gaseous Calibration Standards (May 2012)" document EPA 600/R-12/531, using the assay procedures listed. Analytical Methodology does not require correction for analytical interference. This cylinder has a total analytical uncertainty as stated below with a confidence level of 95%. There are no significant impurities which affect the use of this calibration mixture. All concentrations are on a mole/mole basis unless otherwise noted. The results relate only to the items tested. The report shall not be reproduced except in full without approval of the laboratory. Do Not Use This Cylinder below 100 psig, i.e. 0.7 megapascals.

ANALYTICAL RESULTS

Component	Requested Concentration	Actual Concentration	Protocol Method	Total Relative Uncertainty	Assay Dates
CARBON DIOXIDE	10.00 %	9.856 %	G1	+/- 1.0% NIST Traceable	09/21/2023
OXYGEN	10.00 %	10.05 %	G1	+/- 0.5% NIST Traceable	09/21/2023
NITROGEN	Balance				

CALIBRATION STANDARDS

Type	Lot ID	Cylinder No	Concentration	Uncertainty	Expiration Date
NTRM	190604-14	6162723Y	11.105 % CARBON DIOXIDE/NITROGEN	+/- 0.6%	Dec 04, 2025
NTRM	10010604	K002585	9.967 % OXYGEN/NITROGEN	+/- 0.3%	Mar 22, 2028

ANALYTICAL EQUIPMENT

Instrument/Make/Model	Analytical Principle	Last Multipoint Calibration
CO2-2 SIEMENS ULTRAMAT 6E N1N4470	NDIR	Sep 08, 2023
O2-1 HORIBA MPA-510 3VUYL9NR	Paramagnetic	Aug 31, 2023

Triad Data Available Upon Request

Signature on file
Approved for Release

Airgas
an Air Liquide company

Airgas Specialty Gases
Airgas USA, LLC
12722 S. Wentworth Ave.
Chicago, IL 60628
Airgas.com

CERTIFICATE OF ANALYSIS

Grade of Product: EPA Protocol

Part Number:	E03NI62E15A3356	Reference Number:	54-401024953-1A
Cylinder Number:	SG9154241BAL	Cylinder Volume:	158.6 CF
Laboratory:	124 - Chicago (SAP) - IL	Cylinder Pressure:	2015 PSIG
PGVP Number:	B12017	Valve Outlet:	590
Gas Code:	CO2,O2,BALN	Certification Date:	Oct 31, 2017

Expiration Date: Oct 31, 2025

Certification performed in accordance with "EPA Traceability Protocol for Assay and Certification of Gaseous Calibration Standards (May 2012)" document EPA 600/R-12/531, using the assay procedures listed. Analytical Methodology does not require correction for analytical interference. This cylinder has a total analytical uncertainty as stated below with a confidence level of 95%. There are no significant impurities which affect the use of this calibration mixture. All concentrations are on a volume/volume basis unless otherwise noted.

Do Not Use This Cylinder below 100 psig, i.e. 0.7 megapascals.

ANALYTICAL RESULTS

Component	Requested Concentration	Actual Concentration	Protocol Method	Total Relative Uncertainty	Assay Dates
CARBON DIOXIDE	19.00 %	19.07 %	G1	+/- 0.8% NIST Traceable	10/31/2017
OXYGEN	19.00 %	19.13 %	G1	+/- 0.6% NIST Traceable	10/27/2017
NITROGEN	Balance				

CALIBRATION STANDARDS

Type	Lot ID	Cylinder No	Concentration	Uncertainty	Expiration Date
NTRM	13060635	CC413759	13.359 % CARBON DIOXIDE/NITROGEN	+/- 0.6%	May 09, 2019
NTRM	09061418	CC273593	22.53 % OXYGEN/NITROGEN	+/- 0.4%	Mar 08, 2019

ANALYTICAL EQUIPMENT

Instrument/Make/Model	Analytical Principle	Last Multipoint Calibration
Nicolet 6700 AHR0801332	FTIR	Oct 21, 2017
O2-1 HORIBA MPA-510 3VUYL9NR	Paramagnetic	Sep 29, 2017

Triad Data Available Upon Request

Approved for Release

END OF THE REPORT